Chapter 10: Noise and Vibration

URS-EIA-REP-204635

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10 Noise and Vibration

10.1 Introduction

This chapter presents an assessment of the likely impacts of noise and vibration generated by the Project on human receptors. Assessment of noise and vibration impacts on ecological receptors is addressed in **Chapter 11 Terrestrial Ecology** and in **Chapter 12 Marine Ecology**.

Both noise and vibration may impact the health and wellbeing of human receptors particularly with regards to disturbance of relaxation and sleep (Ref. 10.1). This could lead to elevated stress levels and other health impacts (Ref. 10.1). As such, both regional and international legislation and guidance have been used when assessing noise and vibration at sensitive receptor locations.

Aside from health impacts, noise and vibration can also impact community areas such as cemeteries, beaches and public open spaces, where elevated noise levels can be a nuisance.

This chapter characterises the existing ambient noise and vibration environment of the closest receptors to the Project Area (Section 10.3). Calculations have been undertaken to determine the noise and vibration levels that will be generated by the Project at sensitive receptors. The resulting noise and vibration assessments have been used to determine potentially significant impacts in terms of relevant international and Russian national standards and guidance. Where significant impacts are likely to occur, suitable mitigation measures are identified.

This chapter has been prepared in tandem with **Chapter 14 Socio-Economics**. Where relevant, **Chapter 14 Socio-Economics** draws upon the findings of this noise and vibration assessment.

10.2 Scoping

The scope of this noise and vibration impact assessment was defined through a scoping process that identified sensitive receptors and potentially significant impacts related to the Project. Key steps in the scoping process comprised:

- A review of the Project details to identify activities with the potential to generate significant levels of noise and vibration;
- Identification of sensitive receptors within the likely noise and vibration Zone of Influence (Section 10.3) through a review of secondary data (Section 10.4), a review of studies undertaken for the South Stream Offshore Pipeline and using professional expertise; and
- A review of relevant national and international legislative requirements and standards and guidelines for financing to ensure legislative and policy compliance.

An Environmental Issues Identification (ENVIID) process was undertaken to assist in the identification of impacts and receptors. During the ENVIID process, each activity was examined, drawing upon the experience of technical specialists and their understanding of the extent and nature of the Project Activities and the natural environment, to understand:

- How activities may give rise to noise and vibration impacts; and
- Which receptors would potentially be impacted by each activity and the potential significance of each impact.

The output of the ENVIID was an ENVIID register, which identified the various elements of the Project and their interaction with, or potential impact on, sensitive receptors.

10.3 Spatial and Temporal Boundaries

The Project Area is defined in **Chapter 1 Introduction**.

The Project will consist of the following phases: Construction and Pre-Commissioning, Operational, and Decommissioning Phase. The impact of each of these has been considered separately, and the assessment of the impact has considered the duration of each phase.

Sources of noise and vibration during the Construction Phase will include vehicles, vessels, plant and machinery used to undertake earthworks, pipeline fabrication and laying, construction of the microtunnels, and offshore dredging works at the microtunnel exit locations.

The Pre-Commissioning Phase will involve cleaning, gauging and hydro-testing of the Pipeline. During hydro-testing, pumps that provide the necessary testing pressure after flooding the Pipeline are likely to generate noise.

Sources of noise and vibration during the Operational Phase will be limited to activities associated with maintenance and repair, vessel operation, noise from vehicles, and unplanned events.

Decommissioning activities are not anticipated to give rise to higher noise levels than the Construction Phase.

The temporal boundaries of the impacts related to each phase are defined by the duration of each activity associated with the phase. All the sources of noise and vibration associated with the Project are temporary in nature and no noise and vibration will be generated that will last beyond each phase.

The spatial boundaries of the impact assessment of each phase will be defined by the presence of terrestrial receptors that are sensitive to noise and vibration resulting from the Project Activities. These include present and proposed human receptors, such as residential properties, and any sensitive ecological areas. These are identified and described in Section 10.6.1.3. Thus, sensitive terrestrial receptors closest to the Project Activities define the Study Area.

The applicable standards that have been used during the impact assessment (Section 10.6.1.4) include Russian noise and vibration limits for day and night-time periods. These standards apply absolute noise and vibration level criteria at sensitive receptors.

For the purpose of the noise and vibration assessment, two study areas have been defined and are referred to as follows:

- The Study Area comprises the landfall and the nearshore sections of the Project and encompasses terrestrial receptors sensitive to noise and vibration located in close proximity to these locations (Figure 10.2). Marine receptors are not included in the Study Area as these are discussed in **Chapter 12 Marine Ecology**; and

- The Wider Study Area comprises the Study Area along with the port at Novorossiysk, and includes representative receptors in proximity to the proposed access roads used for the transportation of material from the port to the landfall section. Whilst a final decision on the use of the Novorossiysk port has not been made at this point in time, it is considered to be a fair representation of a potential scenario which defines the Wider Study Area.

As this chapter is concerned only with effects on *terrestrial* noise and vibration receptors, a list of impacts which are excluded from assessment in this chapter is included below:

- The impact of occupational noise and vibration on the employees in the Project team. Occupational health and safety is discussed in Appendix 15.1: Occupational Health Appendix;
- The impact of noise on ecological receptors. This chapter provides the baseline noise levels at ecological receptors, and the noise levels that will be present at them due to the Project Activities. These are provided for information only, and are used to determine the magnitude of impact and significance of effect in **Chapter 11 Terrestrial Ecology**;
- The impact of offshore works (i.e. those beyond the nearshore) as these will have no impact on terrestrial noise and vibration receptors, owing to the considerable distance and resulting attenuation of noise and vibration levels;
- The impact of underwater noise and vibration which is discussed in Appendix 12.3: Underwater Noise Study; and
- The impact of vibration on indirect human receptors, such as infrastructure, livestock and fisheries. The criteria for impact magnitude on human receptors, such as residential, are much more stringent than those that could be applied to indirect human receptors. Hence the assessment of the impact on human receptors will be the worst case, and the significance of the impact on indirect human receptors will be lower than that for human receptors.

The Wider Study Area for noise and vibration, therefore, incorporates the sensitive human receptors in proximity to the landfall and nearshore sections of the Project (Figure 10.2), the port, and the access roads that will be used for the transportation of material to the landfall section.

10.4 Baseline Data

10.4.1 Methodology and Data

Baseline noise and vibration data are necessary to provide a description of the current ambient conditions at receptor locations. The secondary data review, gap analysis and further baseline monitoring that have been undertaken are discussed within the following sections.

10.4.2 Secondary Data

No baseline information regarding the ambient noise and vibration characteristics at sensitive receptor locations throughout the Wider Study Area was available at the Scoping Stage[1]. This was not unexpected given the rural and semi-rural nature of the Wider Study Area.

There are a number of development proposals in the area; however, assessments and reports[2] could not be obtained at the time of baseline review.

Consequently, no secondary data was identified for any of the sensitive receptor locations within the Wider Study Area. Baseline surveys were therefore scoped and planned.

10.4.3 Primary Data and Baseline Surveys

Baseline surveys were undertaken in December 2011, December 2012, June through July 2013 (Ref. 10.2 and 10.3), and September / October 2013 to characterise the ambient noise environment within the Wider Study Area. The noise survey locations are shown in Figure 10.1. The measurements were taken in accordance with the requirements of the standards and legislation adopted.

Given that many of the identified noise monitoring locations are representative of remote properties, and that there were no identifiable sources of vibration, vibration baseline monitoring was not undertaken at all locations. Baseline vibration monitoring has been undertaken at four of the monitoring locations, 10, 12, 22 and 23. These locations were selected for baseline vibration monitoring owing to their proximity to the existing road network, which has the potential to result in ground borne vibration from passing vehicles.

During the baseline surveys a number of noise parameters were measured, in order to provide a detailed understanding of the variability of the ambient noise levels at the monitoring locations. The most important parameters, because of their use in the Russian legislation, were considered as follows:

- L_{Aeq} - Equivalent continuous A-weighted sound pressure level over a given period of time (i.e. the single continuous sound level that conveys the same acoustic energy as a variable noise source over a given period of time); and
- L_{AFmax} - The maximum A-weighted sound pressure level over a given period of time (i.e. to the human ear, the maximum sound level recorded in a given time).

The vibration monitoring surveys at the identified receptor locations measured the ground borne vibration in terms of the acceleration (mm/s^2) as defined within the Russian legislation.

[1] Peter Gaz report on 'Complex Engineering Surveys…' (2011, Ref. 10.2) reviewed available secondary data, and concluded that there were no Project-relevant secondary data for noise and vibration. Consequently, primary data were collected specifically for the Project.

[2] Although these reports were not obtained at the time of baseline review, it is unlikely that they would have contained valuable secondary data; Russian standards rely on absolute noise level criteria, and therefore baseline ambient surveys of noise and vibration are not required for the acceptability assessment of most developments.

Received noise within the Wider Study Area varies significantly depending upon the location of the receptor. In particular, the proximity of the receptor to urban development is a defining factor. Two general receptor types with associated noise climates were identified:

- Rural Residential (and Ecological Receptors) - the noise climate outside of the major residential areas is not dominated by any one noise source but is instead made up of road traffic noise (from the inter village roads), ecological noise (primarily bird song), and meteorological noise (primarily wind through trees); and
- Urban Residential Receptors - the dominant noise source in urban areas, such as Varvarovka, is road traffic noise. Other significant noise sources include aircraft, construction activities, and operation of industrial and commercial facilities.

The baseline surveys included measurements of the day (0700 – 2200), and night (2200 – 0700) noise levels. The survey locations were selected considering both the location of human settlements and isolated residents, as well as key potential ecological receptors in the area immediately surrounding the proposed Pipeline corridor or in proximity to the access road and Varvarovka bypass road. A summary of the baseline measurements is provided in Table 10.1.

The measured ground borne vibration levels for the day (0700 – 2200), and night (2200 – 0700) time periods are summarised in Table 10.2.

10.4.4 Data Gaps

The primary baseline data are considered adequate to facilitate a robust assessment of existing ambient noise and vibration levels at key human receptors within the Wider Study Area. No data gaps exist that could limit the assessment of the impacts associated with the Project.

10.5 Baseline Characteristics

10.5.1 Baseline Summary

Details of the baseline ambient noise surveys (Ref. 10.2 and Ref. 10.3) are presented below in Table 10.1.

The measured noise levels are shown to reach or exceed the Russian daytime noise limit (Ref. 10.4) for residential areas (55 dB L_{Aeq}) at measurement points 2, 3, 6, 7, and 21. All other positions are below the limit.

The measured night-time noise levels are shown to reach or exceed the Russian noise limit (Ref. 10.4) for residential areas (45 dB L_{Aeq}) at measurement points 1 to 10 (inclusive), 12, and 21. All other positions are below the limit.

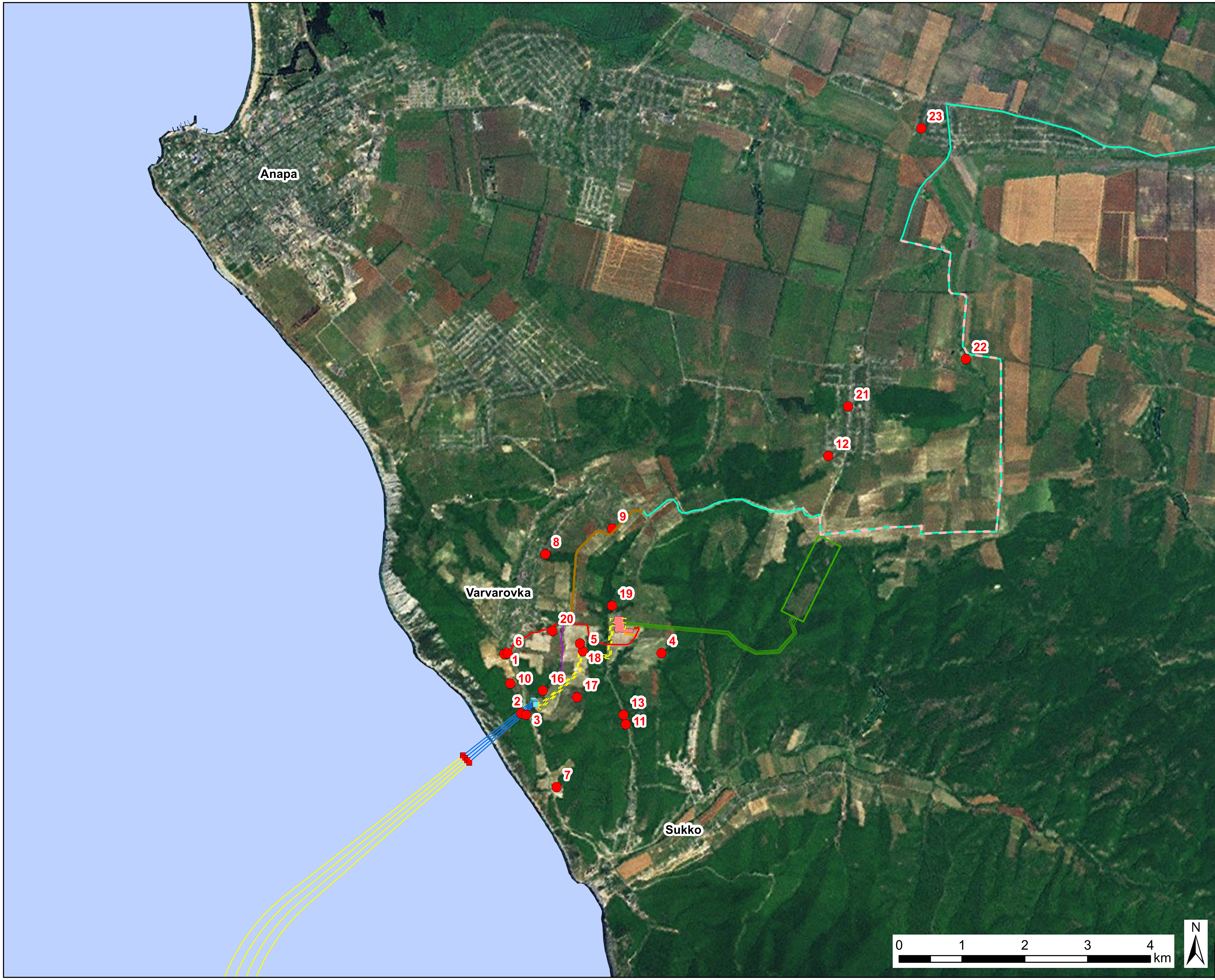
It is considered that, for the sites sampled, the main noise sources were:

- Road traffic;
- Ecological noise (e.g. bird song); and
- Meteorological processes (e.g. wind in vegetation).

This is reflected in the L_{AFmax} results (Table 10.1), which are consistent with passing of vehicles as likely sources of the maximum noise levels recorded.

The measured vibration levels are presented in Table 10.2.

The measured vibration levels are shown to reach or exceed the Russian vibration limit (Ref. 10.5) for residential receptors (4 mm/s^2) at positions 10 and 23 during the night, and at positions 22 and 23 during the day. These levels were likely due to the vibration generated by the nearby road traffic. It should be noted that the Russian vibration criteria do not distinguish different limits for day and night time periods.



LEGEND

- Noise monitoring location

Access Roads

- Proposed delivery route from Novorossiysk Port
- Permanent access road to be constructed by SSTTBV
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United Gas Supply System

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Projection: Lambert Conformal Conic

Revision Details	By / Check	Check Date	Suffix

Purpose of Issue

For Information

Client

South Stream Offshore Pipeline — Energising Europe

Project Title

SOUTH STREAM
OFFSHORE PIPELINE

Drawing Title

NOISE MONITORING
LOCATIONS

Drawn	Checked	Approved	Date
DH	RW	MW	28/02/2014

URS Internal Project No.	Scale @ A3
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Figure 10.1

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File Name:I:\5004 - Information Systems\46369082_South_Stream\MXDs\Report Maps - Russia\Russian ESIA v2\Chapter 10 Noise\Figure 10.1 Noise Monitoring Locations.mxd

Table 10.1 Baseline Noise Results

No.	Measurement location	Average L_{Aeq}, (dB)		Maximum L_{Amax}, (dB)	
		Day (0700 – 2300)	Night (2300 – 0700)	Day (0700 – 2300)	Night (2300 – 0700)
1	AAL-1 (along the road of Bol. Utrish - Varvarovka)	54.5	*50.1*	61.9	56.1
2	AAL -2 (near the road of Bol. Utrish - Varvarovka)	*58.2*	*52.1*	68.6	54.1
3	AAL -3 (near the road of Bol. Utrish - Varvarovka)	*55.9*	*50.1*	56.4	53.3
4	AAL -4 (near country road)	48.5	*47.3*	51.6	48.0
5	AAL -5 (near country road)	53.2	*52.3*	55.2	53.1
6	A group of residential dwellings situated in the southern extremity of the nearby town Varvarovka, approximately 800 m north of the microtunnel entry points.	*66.0*	*58.2*	*88.3*	*73.6*
7	A group of dwellings on the coast, which include the Shingari holiday complex and the Don holiday complex, approximately 1.3 km south of the microtunnel entry points.	*64.7*	*60.3*	*84.0*	*87.0*
8	Residential area in Varvarovka, approximately 1.5 km northwest of the landfall facilities.	49.2	*46.5*	*75.9*	59.7
9	A residential dwelling situated in the north-eastern part of Varvarovka, approximately 1.4 km north of the landfall facilities, and 50 m to the north of the Varvarovka bypass road.	46.2	*48.5*	67.8	*60.1*
10	The southern boundary of a proposed residential development currently under construction, approximately 500 m northwest of the landfall facilities. An extension of the town of Varvarovka.	53.8	*45.6*	68.0	*70.8*

Continued…

No.	Measurement location	Average L_{Aeq}, (dB)		Maximum L_{Amax}, (dB)	
		Day (0700 – 2300)	Night (2300 – 0700)	Day (0700 – 2300)	Night (2300 – 0700)
11	A group of residential dwellings situated 1.5 km south of the landfall facilities.	49.4	35.6	*71.8*	*63.2*
12	The southern edge of the nearby town, Gai Kodzor, approximately 4.5 km northeast of the landfall facilities.	42.5	50.8	*70.3*	*75.4*
13	Two log cabins that have recently been built on cleared land, approximately 1.1 km south of the landfall facilities.	50.6	29.5	62.7	*64.0*
16	Ecological receptors along the proposed Pipeline corridor.	53.2	39.6	73.2	57.3
17	Ecological receptors along the proposed Pipeline corridor.	51.7	38.4	40.1	52.1
18	Ecological receptors along the proposed Pipeline corridor.	43.0	40.7	62.7	52.0
19	Ecological receptors along the proposed Pipeline corridor.	50.3	40.7	58.4	62.7
20	Varvarovka village cemetery located to the northwest of the Pipeline corridor at a closest approach of approximately 530 m.	48.8	44.9	*79.1*	*66.8*
21	Gai Kodzor war memorials located to the northeast of the proposed landfall facilities at a distance of approximately 4.5 km.	*66.8*	*53.5*	*87.3*	*84.5*
22	Residential properties to the far east of Gai Kodzor.	39.6	35.8	*71.7*	57.0
23	Residential properties within Rassvet.	49.9	40.4	68.8	*69.2*

Note - The measured baseline noise levels that exceed the Russian regulation criteria (as given in Table 10.7) are shown in italics above for human receptors only.

Complete.

Table 10.2 Baseline Vibration Results

No.	Measurement point	Acceleration (mm/s^2)	
		Day (0700 – 2300)	Night (2300 – 0700)
10	The southern boundary of a proposed residential development currently under construction, approximately 430 m northwest of the landfall facilities. An extension of the town of Varvarovka.	3.3	*4.1*
12	The southern edge of the nearby town, Gai Kodzor, approximately 4.0 km northeast of the landfall facilities.	3.3	3.5
22	Residential properties to the far east of Gai Kodzor.	*4.4*	2.8
23	Residential properties within Rassvet.	*4.4*	*4.4*

Note - The measured baseline vibration levels that exceed the Russian regulation criteria (as given in Table 10.9) are shown in italics above.

10.6 Impact Assessment

10.6.1 Impact Assessment Methodology

The assessment of potential noise and vibration impacts took into consideration applicable international standards, Russian national standards and recognised Good International Industry Practice (GIIP) regarding the control of environmental noise and vibration.

The closest human receptors to the Project Activities have been identified within the Wider Study Area to define the spatial scope of the assessment; as defined in Section 10.6.1.3. The sensitivities of individual receptors have been categorised by their nature using the criteria in Table 10.6 to help determine the potential significance of effects.

The assessment of impacts has been undertaken by identifying and evaluating a range of activities and scenarios that are likely to occur throughout the phases of the Project. The key activities likely to generate noise and vibration during each of the Project phases are included below in Table 10.3.

It is important to note that the methodology has been designed specifically to assess noise and vibration impacts upon a recipient population and cannot be applied to the assessment of occupational noise and vibration effects associated with the Project works. Occupational health and safety is discussed in Appendix 15.1.

Table 10.3 Key Project Activities Likely to Result in Noise and Vibration

Phase	Activity	Project Section		
		Offshore	Nearshore	Landfall
Construction	Micro-tunnel construction			N, V
	Construction plant, equipment and construction generator operation associated with the onshore construction spread			N, V
	Dredging of the micro-tunnel exit pits		N	N
	Vehicle and rail movements onshore			N, V
Pre-Commissioning and Commissioning	Operation of extraction pumps, flooding pumps, compressors, and associated generators			N, V

Continued…

Phase	Activity	Project Section		
		Offshore	Nearshore	Landfall
Operational	Mobilisation of vessels for checking the Pipeline or repairs	N	N	
	Gas flow through the Pipeline			N, V
	Pigging activities and venting of gas during a planned shut down or maintenance activities			N
Decommissioning	Assumed to be similar to construction		N	N, V

N- Noise, V – Vibration

Complete.

10.6.1.1 Impact Assessment Criteria

Criteria have been developed for assessing the potential impacts of noise and vibration from the Construction and Pre-Commissioning, Operational and Decommissioning Phases of the Project, and include impact magnitude and receptor sensitivity. The impact significance matrix in **Chapter 3 Impact Assessment Methodology** is used to determine the significance of each impact.

Sensitive human receptors have been identified (Section 10.6.1.3, Table 10.5) in proximity to the proposed Pipeline route, potential port and along construction traffic routes. Human receptors have been classified based on their likely sensitivity to noise and vibration impacts.

Specific ecological receptors have been identified in proximity to the Pipeline route. No assessment of the potential impacts on ecological receptors has been addressed within this chapter, although predicted noise levels are presented. The assessment of such impacts is considered within **Chapter 11 Terrestrial Ecology** and **Chapter 12 Marine Ecology**.

Impacts have been assessed and classified using the appropriate noise level criteria as described in **Chapter 2 Policy, Regulatory and Administrative Framework** and Section 10.6.1.4.

10.6.1.2 Receptor Sensitivity

The sensitivity of receptors to noise and vibration is primarily dependent upon the activities which take place at the receptor location. Locations where people rest or sleep are considered to be more sensitive to noise and vibration than industrial areas. This approach is supported by the applicable Russian noise legislation (Section 10.6.1.4), which delineates standards based on the nature of the potentially affected receptors and the time at which the impact may arise (e.g. night or day). A combination of professional judgement, GIIP experience and Russian noise and vibration legislation (Section 10.6.1.4) has been used to develop noise and vibration receptor sensitivity categories as shown in Table 10.4.

Table 10.4 Noise and Vibration Receptor Sensitivity

Sensitivity	Description
Noise and Vibration	
High	Locations used for rest, sleep and quiet reflection such as residential properties, hospitals, cemeteries, educational establishments and places of worship.
Moderate	Locations used for work requiring concentration, such as offices.
Low	Locations used for recreation and industrial activities, such as industrial units, workshops, etc.
Negligible	Locations not regularly utilised.

10.6.1.3 Receptor Identification

The nearest human receptors (and ecological receptors for the purpose of **Chapter 11 Terrestrial Ecology** and **Chapter 12 Marine Ecology**) were identified through use of available aerial photography and field surveys. It is considered that the selection of the closest sensitive receptors to the Project Activities will reflect the largest impacts, as noise and vibration levels will attenuate with greater distance.

The proposed pipelines cross under the coastline approximately 1 km to the north of the Shingari holiday complex and 1 km to the south of Varvarovka. The pipelines then proceed in a northeast direction for approximately 2.5 km where they terminate at the proposed landfall facilities.

In addition to Varvarovka and the Shingari holiday complex, residential dwellings are located to the south of the proposed Pipeline route.

Receptor 8 is representative of the closest residential receptors located to the south of the Pipeline corridor. The settlement of Sukko is located to the south of the Pipeline corridor at a distance of approximately 3 km. It is considered that achieving the noise level criteria at Receptor 8 would ensure that noise levels would be well below the criteria at Sukko, owing to its greater distance from the Pipeline corridor, and the topographical screening from the inter-lying hills.

A description of the identified receptors used for the assessment and corresponding assigned sensitivities are presented in Table 10.5 and shown on Figure 10.2.

Receptor 5 is representative of a site for proposed residential use, located at a distance of approximately 430 m to the northwest of the microtunnels. This site has been considered within the assessment as having a negligible sensitivity, as it is anticipated that the site will not be developed and occupied during the Construction Phase of the Project. Consequently, it is anticipated that there will be no residential receptors at this location during the Construction Phase.

Receptors 13 and 14 are representative of the Varvarovka village cemetery and Gai Kodzor War Memorials, respectively. Russian legislation does not stipulate noise levels for such land uses, and therefore noise levels are not regulated at these locations. However, people visit these sites during the day and evening periods and such sites may be used for services and burials. Therefore, these locations have been considered as receptors with a high sensitivity within this assessment; the sensitivity classification assigned for cemeteries and war memorials is the same as for residential dwellings.

Receptors 9-12 (inclusive) are identified as ecological receptors. The sensitivity of specific ecological receptors will be dependent upon the species affected. A diverse range of fauna has been identified within the area surrounding the proposed Pipeline including mammals, reptiles and avian species. Sensitivities have therefore not been assigned to ecological receptor locations; receptor sensitivity and impact significance for ecological receptors is discussed under **Chapter 11 Terrestrial Ecology**.

Table 10.5 Description of Identified Receptors

Receptor Number	Measurement location	Description	Receptor Sensitivity*
Landfall			
1	6	A group of residential dwellings situated in the southern extremity of the nearby town Varvarovka, approximately 800 m north of the microtunnel entry points.	High
2	7	A group of dwellings on the coast, which include the Shingari holiday complex and the Don holiday complex, approximately 1.3 km south of the microtunnel entry points.	High
3	8	Residential area in Varvarovka, approximately 1.5 km northwest of the landfall facilities.	High
4	9	A residential dwelling situated in the north-eastern part of Varvarovka, approximately 1.5 km north of the landfall facilities, and 50 m to the north of the Varvarovka bypass road.	High
5	10	The southern boundary of a proposed residential development currently under construction, approximately 500 m northwest of the landfall facilities. An extension of the town of Varvarovka.	Negligible
6	11	A group of residential dwellings situated 1.5 km south of the landfall facilities.	High

Continued...

Receptor Number	Measurement location	Description	Receptor Sensitivity*
7	12	The southern edge of the nearby town, Gai Kodzor, approximately 3.5 km northeast of the landfall facilities at a position representative of residential properties located along the construction traffic route.	High
8	13	Two log cabins that have recently been built on cleared land, approximately 1.1 km south of the landfall facilities.	High
9 – 12	16 – 19	Ecological receptors along the proposed Pipeline corridor.	†
13	20	Varvarovka village cemetery located to the northwest of the Pipeline corridor at a closest approach of approximately 530 m.	High
14	21	Gai Kodzor war memorials located to the northeast of the proposed landfall facilities at a distance of approximately 4.5 km.	High
15	22	Residential properties to the far east of Gai Kodzor, which are representative of the closest property to the proposed construction traffic bypass route.	High
16	23	Residential properties within Rassvet, which are representative of the properties closest to the proposed construction traffic route	High

* Receptor sensitivities are applicable to both noise and vibration.
† Addressed in **Chapter 11 Terrestrial Ecology**.
Note: The receptor locations defined and described in the above table are in the same position as the measurement location numbers specified, as taken from Table 10.1.

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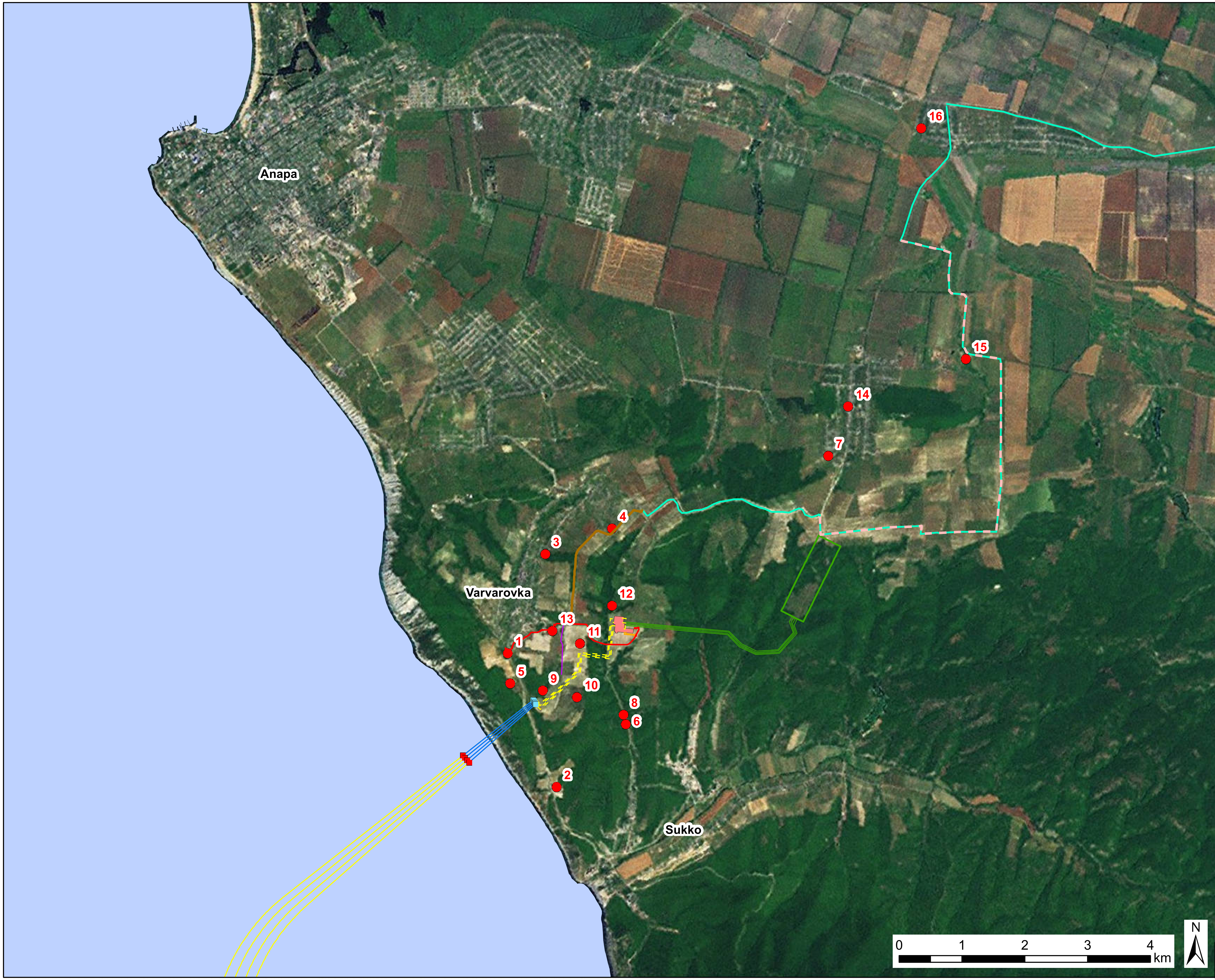

LEGEND

- Noise and vibration receptor location

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- Temporary access road constructed by SSTTBV
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- Russkaya compressor station
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Projection: Lambert Conformal Conic

Revision Details	By / Check	Check Date	Suffix

Purpose of Issue
For Information

Client
South Stream Offshore Pipeline — ENERGISING EUROPE

Project Title
SOUTH STREAM
OFFSHORE PIPELINE

Drawing Title
NOISE AND VIBRATION
RECPETOR LOCATIONS

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DH	RW	MW	28/02/2014

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Figure 10.2

Rev

Plot Date: 28 Feb 2014
File Name:I:\5004 - Information Systems\46369082_South_Stream\MXDs\Report Maps - Russia\Russian ESIA v2\Chapter 10 Noise\Figure 10.2 Noise and Vibration Receptor Locations.mxd

10.6.1.4 Standards and Guidance

The significance criteria utilised are based on applicable Russian legislation, international guidance (e.g. International Finance Corporation (IFC) performance standards) and recognised GIIP. The required and voluntary standards for noise are detailed below in Table 10.6.

Table 10.6 Summary of Applicable Standards and Guidance

Standard	Description	Criteria
International Guidance		
IFC General Environmental, Health and Safety (EHS) Guidelines: Environmental – Section 1.7 noise (Ref. 10.6)	This document provides criteria and guidance to inform the control of noise from a development beyond the property boundaries. The guidance provided relates more to the control of operational noise impacts and is not well suited for the assessment of temporary construction noise effects. The guidance provides absolute noise level limits. However, where the existing ambient noise level is above the prescribed level, it suggests that the noise source being considered should not elevate the ambient by more than 3 dB.	*Residential; institutional and educational receptors* Daytime (07:00 – 22:00) - $L_{Aeq,1\ hr}$ 55 dB Night-time (22:00 – 07:00) $L_{Aeq,1hr}$ 45 dB *Industrial and commercial receptors* Daytime (07:00 – 22:00) - $L_{Aeq,1\ hr}$ 70 dB Night-time (22:00 – 07:00) $L_{Aeq,1hr}$ 70 dB
World Health Organisation (WHO) Guidelines for Community Noise (Ref. 10.1)	This document details the results of research undertaken by the WHO into effects of noise on the community. It provides guidance on the levels of internal noise which can have a detrimental effect on resting, sleeping and work requiring concentration amongst others. This is specifically related to noise sources such as road traffic and is not applicable to construction noise.	*Inside dwellings* Speech intelligibility, and moderate annoyance, day time and evening L_{Aeq} 35 dB Sleep disturbance L_{Aeq} 30 dB Effective communication in office and schools L_{Aeq} 35 dB *Outside dwellings* To prevent serious annoyance during the daytime and evening L_{Aeq} 55 dB. To prevent sleep disturbance during the night-time period for occupants sleeping with an open bedroom window L_{Aeq} 45 dB.

Continued...

Standard	Description	Criteria
Russian Regulations		
Sanitary norms (CH 2.2.4 / 2.1.8.562-96) – Noise at the working places in rooms of residential and public buildings and in residential areas (Ref. 10.4)	The health requirements for noise pollution (p.9 Table 3) provide regulatory requirements to determine environmental noise impact levels. The allowable broadband noise levels are given within the criteria section. However, octave band limits and L_{Amax} levels are also incorporated into the limits and these are provided below.	*Areas adjacent to residential dwellings* Daytime (07:00 – 23:00) L_{Aeq} 55 dB Night-time (23:00 – 07:00) L_{Aeq} 45 dB *Areas adjacent to hospitals and sanatoria* Daytime (07:00 – 23:00) L_{Aeq} 55 dB Night-time (23:00 – 07:00) L_{Aeq} 45 dB
Sanitary-epidemiological rules and regulations SanPin 2.1.2.2645-10 (Ref. 10.5)	This document details allowable vibration levels in dwellings, due to internal and external sources.	Shown in Table 10.10

Complete.

The Russian regulations (Ref. 10.4) provide a more stringent approach to the limiting of noise than that given in the IFC General EHS Guidelines (Ref. 10.6) as there is no allowance for elevated noise levels where the prevailing ambient noise climate is already over the prescribed noise limit. The Russian standards also incorporate limits within each octave band level, in addition to a limit value on the maximum noise level L_{Amax}. Therefore, as the Russian regulations provide the most stringent criteria from the standards and guidance applicable, these have been adopted for the purposes of assessing noise impacts. The noise level criteria from page 9, Table 3 of the Russian regulations (Ref. 10.4) are reproduced below in Table 10.7.

Table 10.7 Allowable Sound Levels from Russian Regulation Sanitary Norms

Receptor	Time of day	Octave Band Centre Frequency / Hz with corresponding sound pressure level / dB									L_{Aeq} / dB	L_{Amax} / dB
		31.5	63	125	250	500	1k	2k	4k	8k		
Areas immediately adjacent to residential receptors	07:00 – 23:00	90	75	66	59	54	50	47	45	44	55	70
	23:00 – 07:00	83	67	57	49	44	40	37	35	33	45	60

Continued…

Receptor	Time of day	Octave Band Centre Frequency / Hz with corresponding sound pressure level / dB									L_{Aeq} / dB	L_{Amax} / dB
		31.5	63	125	250	500	1k	2k	4k	8k		
Areas immediately adjacent to hospital and sanatoria	07:00 – 23:00	83	67	57	49	44	40	37	35	33	45	60
	23:00 – 07:00	76	59	48	40	34	30	27	25	23	35	50

Complete.

It should be noted that according to Note 2 which accompanies the above Russian regulations (Ref. 10.4), the equivalent and maximum noise levels for noise generated by motor vehicles and railway transport are allowable at levels 10 dB(A) above the limit stipulated. However, it is understood that this limit is solely used for the purposes of noise from railway transport, and noise from motor vehicles should instead be assessed against the noise criteria given in Table 10.7. Therefore, Note 2 has not been considered in the assessment for the impacts of noise from construction equipment and vehicle movements; a more conservative appraisal of the potential noise impacts has thus been undertaken.

The above standards were considered to develop impact assessment criteria compliant with Russian legislation and which can be meaningfully applied to the Project.

As the Russian legislation defines a single absolute noise level limit, it has been necessary to develop noise level criteria that can be applied to define the "high" to "not significant" impact magnitudes. It is considered that as the broadband daytime (55 dB(A)) and night time (45 (dB(A)) noise levels correspond to the WHO levels to prevent serious annoyance and to prevent sleep disturbance during the night time with an open bedroom window, respectively, these noise levels are attributed to correspond to a "low" impact magnitude.

The defined absolute noise level limits apply solely to noise emitted by the Project, and have no regard to prevailing baseline noise levels. It has been established that the prevailing ambient noise climate at a range of receptors already exceeds the absolute criteria. These exceedances are considered to be part of prevailing baseline environment and are not as a result of activities associated with the Project. Therefore, it will be necessary to attribute the noise from activities associated with the Project at these locations in the absence of the prevailing ambient noise. This issue will be further detailed within the overarching Monitoring Programme.

Adoption of the absolute noise level criteria and applying these to the noise from the South Stream Offshore Pipeline operations only will ensure that there is no significant change in the noise climate where prevailing ambient noise levels may exceed the limit. In such circumstances where the ambient noise climate may exceed the adopted day and night time limits, the IFC guidelines suggest that the overall change in noise level should be limited to no more than 3 dB(A). Adopting the Russian legislation noise limits and applying these to noise from the South Stream Offshore Pipeline operations will ensure that, where prevailing ambient noise levels are greater than the limit, the resulting change in noise level will be no more than 3 dB(A), and therefore compliant with the IFC guidelines.

It should be noted that the IFC guidelines define the daytime period as 07:00 to 22:00 hours, and the night time period as 22:00 to 07:00 hours. However, the Russian regulation Sanitary Norms specify the daytime period as 07:00 to 23:00 hours, and the night time period as 23:00 to 07:00 hours. Therefore the IFC guidelines time periods are considered to be slightly more onerous as they specify a slightly longer night time period. Therefore, for the assessment of the noise impacts the IFC guideline time periods for day and night time have been adopted, thereby ensuring a worst case approach to the assessment.

The development of the noise impact magnitude classifications has also considered human perception to changes in noise levels. A 3 dB(A) change in noise level is only just perceptible to the human ear. Therefore, noise level bands covering 5 dB have been adopted where changes in the corresponding noise level would be clearly perceptible to any receptors. The adopted noise bands corresponding to defined impact magnitudes are shown in Table 10.8.

10.6.1.5 Impact Magnitude

Table 10.8 defines the magnitude of noise impacts on human receptors during all Project phases. The limit values and categorisation criteria are based on applicable noise legislative requirements and guidance. Russian standards and legislation do not differentiate between long and short duration noise sources affecting residential receptors. Therefore, the magnitude of impacts has been developed on the absolute noise level criteria within these standards.

Table 10.8 Noise Impact Magnitude at Receptors

Magnitude	**Description**	**Limits Values**											
High	Noise levels greater than 5 dB above the Allowable Sound Levels from Russian Standard Sanitary norms (CH 2.2.4 / 2.1.8.562-96) (Ref. 10.4)	*Time of day*	*Octave Band Centre Frequency / Hz with corresponding sound pressure level / dB*									*LAeq / dB*	*Lmax / dB*
			31.5	*63*	*125*	*250*	*500*	*1k*	*2k*	*4k*	*8k*		
		07:00 – 22:00	>=95	>=80	>=71	>=64	>=59	>=55	>=52	>=50	>=49	>=60	>=75
		22:00 – 07:00	>=88	>=72	>=62	>=54	>=49	>=45	>=42	>=40	>=38	>=50	>=65
Moderate	Noise levels up to 5 dB above the Allowable Sound Levels from Russian Standard Sanitary norms (CH 2.2.4 / 2.1.8.562-96) (Ref. 10.4)	*Time of day*	*Octave Band Centre Frequency / Hz with corresponding sound pressure level / dB*									*LAeq / dB*	*Lmax / dB*
			31.5	*63*	*125*	*250*	*500*	*1k*	*2k*	*4k*	*8k*		
		07:00 – 22:00	90=<95	75=<80	66=<71	59=<64	54=<59	50=<55	47=<52	45=<50	44=<49	55=<60	70=<75
		22:00 – 07:00	83=<88	67=<72	57=<62	49=<54	44=<49	40=<45	37=<42	35=<40	33=<38	45=<50	60=<65

Continued…

Magnitude	Description	Limits Values											
Low	Noise levels below 5 dB of the Allowable Sound Levels from Russian Standard Sanitary norms (CH 2.2.4 / 2.1.8.562-96) (Ref. 10.4)	*Time of day*	*Octave Band Centre Frequency / Hz with corresponding sound pressure level / dB*									*LAeq / dB*	*Lmax / dB*
			31.5	***63***	***125***	***250***	***500***	***1k***	***2k***	***4k***	***8k***		
		07:00 – 22:00	85=<90	70=<75	61=<66	54=<59	49=<54	45=<50	42=<47	40=<45	39=<44	50=<55	65=<70
		22:00 – 07:00	78=<83	62=<67	52=<57	44=<49	39=<44	35=<40	32=<37	30=<35	28=<33	40=<45	55=<60
Negligible	Noise levels less than 5 dB below the Allowable Sound Levels from Russian Standard Sanitary norms (CH 2.2.4 / 2.1.8.562-96) (Ref. 10.4)	*Time of day*	*Octave Band Centre Frequency / Hz with corresponding sound pressure level / dB*									*LAeq / dB*	*Lmax / dB*
			31.5	***63***	***125***	***250***	***500***	***1k***	***2k***	***4k***	***8k***		
		07:00 – 22:00	<85	<70	<61	<54	<49	<45	<42	<40	<39	<50	<65
		22:00 – 07:00	<78	<62	<52	<44	<39	<35	<32	<30	<28	<40	<55

Complete.

Vibration impact magnitude criteria were developed based on Russian Regulation SanPin 2.1.2.2645-10, which imposes absolute limits on vibration within residential buildings (Ref. 10.5). The specific vibration limits at residential receptors are summarised in Table 10.9.

Table 10.9 Vibration Limits at Residential Receptors

Octave Band Centre Frequency / Hz	Vibration Acceleration Limit mm/s^2	Vibration Velocity Limit mm/s
2	4.0	0.32
4	4.5	0.18
8	5.6	0.11
16	11.0	0.11
31.5	22.0	0.11
63	45.0	0.11
Overall	4.0	0.11

The adopted vibration criteria have been derived from the above limits and are based upon the vibration velocity. For vibration velocities below the criterion of 0.11 mm/s the resulting levels are unlikely to be perceptible to human subjects. Therefore, for vibration levels below 0.11 mm/s, the impact magnitude is classified as being negligible. Vibration velocities less than 1 mm/s are generally tolerable by human subjects for short-term construction operations, where the residents are kept informed of the progress of such works (Ref. 10.7). Therefore, for vibration velocities below 1 mm/s the impact magnitude is categorised as low. At vibration velocities of 10 mm/s, there is the potential for superficial damage to building structures, for example cracks may appear in plaster. Therefore, for vibration velocities up to 10 mm/s the impact magnitude is classified as being moderate. For vibration velocities of 10 mm/s and above the impact magnitude is classified as being high. The above criteria have been used to derive the vibration magnitude criteria presented in Table 10.10.

The adopted criteria for construction vibration impact magnitudes are shown in Table 10.10. The laying of the Pipeline below ground and the relatively low levels of vibration anticipated from gas flow through the Pipeline or pigging activities, coupled with the offshore exclusion zone that will prohibit certain types of development within 410 metres of the Pipeline corridor have been collectively considered and it is concluded that the resulting potential impacts from operational vibration will be negligible. As there are no identified significant sources of ground borne vibration during other phases of the development, vibration has not been considered for other phases.

Table 10.10 Construction Vibration Impact Magnitude

Magnitude	Description
High	Vibration velocity >= 10 mm/s
Moderate	Vibration velocity 1 mm/s =< 10 mm/s
Low	Vibration velocity 0.11 mm/s =< 1 mm/s
Negligible	Vibration velocity less than 0.11 mm/s

10.6.1.6 Modelling Methodology

Noise predictions have been carried out using International Organisation for Standardisation (ISO) Standard 9613, Acoustics – Attenuation of Sound during Propagation Outdoors (Ref. 10.8). The propagation model described in Part 2 of this standard provides for the prediction of sound pressure levels based on either short-term downwind (i.e. worst case) conditions or long-term overall averages. For a downwind condition (for wind blowing 1 to 5 m/s from the proposed site towards the nearby receptors) worst-case noise levels will occur. When the wind is blowing in the opposite direction, noise levels may be significantly lower than those predicted. The ISO propagation model calculates the predicted sound pressure level by taking the source sound power level for each source and subtracting a number of attenuation factors according to the following:

Predicted Noise Level = $L_{WA} + D - A_{geo} - A_{atm} - A_{gr} - A_{bar} - A_{misc}$

These factors are discussed in detail below.

The Sound Power Level (L_{WA}) defines the total acoustic power radiated by a noise source expressed in decibels (dB) per 1 pico Watt (pW). Source noise terms for the various noise sources that will be utilised during the Construction Phase have been obtained from published data detailed within British Standard 5228 (Ref. 10.7).

The directivity factor (D) allows for an adjustment to be made where the sound radiated in the direction of interest is higher than that for which the sound power level is specified. For the purposes of the assessment, which considers construction plant operating at ground level and vessels on water, no directivity factor is considered. Other Project Activities as part of the Pre-Commissioning and Operational Phases have a different directivity factor; however, these have not been modelled for reasons explained in the relevant sections.

The geometrical divergence (A_{geo}) accounts for spherical spreading of the noise from the source within free-field conditions. The construction plant and associated noise sources can be considered as point noise sources, given the distance of receptors from proposed works, and therefore the attenuation due to distance may be calculated from:

- $A_{geo} = 20.\log(d) + 11$; and
- Where (d) is the distance from the source to the receptor.

The atmospheric absorption factor (A_{atm}) considers the attenuation offered by the atmosphere as a result of the conversion of sound to heat. The degree of attenuation is dependent on the relative humidity and temperature of the air through which the sound is travelling and is frequency dependent. Increasing attenuation occurs towards the higher frequencies of sound.

Modelling parameters have assumed an ambient temperature of 10°C and 70% relative humidity which are found to result in worst case noise propagation. The annual average air temperature is 12.1°C, which fits well with the modelled parameters. The corresponding atmospheric attenuation factors are summarised below in Table 10.11.

Table 10.11 Atmospheric Attenuation (dB/km) at 10°C and 70% Relative Humidity

Octave Band Centre Frequency / Hz	63	125	250	500	1k	2k	4k	8k
Atmospheric Absorption Coefficient dB / km	0.122	0.411	1.04	1.93	3.68	9.66	32.8	117

The ground effect (A_{gr}) is the result of sound reflected by the ground interfering with the sound propagating directly from source to receiver, and the interaction of the sound with porous and absorptive ground cover. The prediction of ground effects depends on the source height, receiver height, propagation height between the source and receiver and the ground conditions.

The ground conditions are described according to a variable defined as G, which varies between 0 for 'hard' ground (includes paving, water, ice, concrete and any locations with low porosity) and 1 for 'soft' ground (includes ground covered by grass, trees or other vegetation). Predictions have been carried out using a receiver height of 1.5 m and an assumed ground factor (G=0.8). This ground factor corresponds to 20% of the ground being hard ground conditions between the source and receiver and represents a worst-case scenario. All areas where the sound is travelling over water are treated as being acoustically reflective (G=0).

The effect of any barrier or topographical obstruction (A_{bar}) between the noise source and the receiver position is that noise will be reduced according to the relative heights of the source, receiver and barrier and the frequency spectrum of the noise.

The predicted noise levels have been calculated using CADNA-A noise modelling software (Ref. 10.9), which implements the ISO 9613-2 prediction methodology. The predicted noise levels at receptors consider solely the noise from activities associated with the Project. Pre-existing ambient noise levels are not considered within the predictions, as the Russian regulations require that noise from South Stream activities achieves the absolute noise level criteria.

Noise levels have been calculated at the identified discrete receptor locations. Additionally, noise contour maps have been produced across the Wider Study Area at a height of 1.5 m above ground level.

Construction activity will vary in both intensity and location over time. Consequently, for the purposes of this noise impact assessment, eight different sub-phases within the Construction Phase were identified, focusing on stages where different activities overlap, some with pre-commissioning phases, and which likely represent peak activity levels for the Project (Table

10.12). It should be noted that this includes pre-commissioning activities during the later stages of the construction schedule.

Seven of these sub-phases relate to daytime construction activities and the eighth to night time construction activities

There are seven sub-phases that were used as the basis for different model simulations during the daytime period (Model References 1 – 7 in Table 10.12), which have been used to generate the set of noise contour plots. The different model simulations consider the peak activities that would occur throughout the Construction Phase. These, therefore, consider the worst-case noise impacts that may arise.

The scenarios have not considered the effects of offshore pipe-laying vessels. However, the Scenarios 4 to 7, inclusive, incorporate the impacts associated with the dredging of the micro-tunnel exit pits. This is considered to be representative of the worst case offshore noise impacts associated with the construction of the Pipeline. This is as a result of the dredger being moored at the closest point to the shore, and assumed to be operating continuously, thereby having a great impact at onshore receptor locations. Noise sources terms for the dredger and gantry cranes on the pipe-laying vessels, are broadly comparable. Therefore as pipe-laying vessels will be located at a greater distance offshore than the dredger, and will move further offshore as the construction of the Pipeline progresses, reduced noise levels at onshore receptor locations are anticipated to the levels predicted from dredging activities.

The noise impacts associated with the Varvarovka bypass access road have been modelled based on the vehicle flow data for each of the Scenario time periods. The vehicle flow data comprises a majority of HGV traffic with a small percentage of light vehicles. For the purposes of the assessment it has been assumed that all vehicles predicted to use the Varvarovka bypass route are HGVs, which represents a worst case scenario. The noise impacts have been predicted assuming point noise sources travelling along the access road at the vehicular flow rates shown in Table 10.12. For the purposes of the assessment it has also been assumed that vehicles speeds on the access road are 30 km/h, as a higher speed would not be representative of producing a worst case noise impact.

Night-time noise will result from tunnel boring activities and the operation of generator sets to supply power. This has been assessed in Model Reference 8.

Table 10.12 details the noise models run for the different time periods within the construction and pre-commissioning programme. The source references within Table 10.12 relate to the general activities undertaken. A further breakdown of the plant utilised for each source reference is given in Table 10.13.

Table 10.12 Summary of Noise Models Considered

Model Reference	Time period	General Construction and Pre-Commissioning Activities Involved	Source Reference
1	Q1 2014	Landfall mobilisation (Construction of site facilities and access roads)	S01
		Microtunnel 1 preparation of launch pit (excavation etc.)	S02
		Secant Piling for Microtunnel 1	S09
		Varvarovka Bypass Traffic – 55 vehicle movements / day	S11
2	Q2 2014	Landfall mobilisation (Construction of site facilities and access roads)	S01
		Pipeline Trench excavation (Pipe line 1)	S04
		Microtunnel 1 tunnel boring	S02
		Generator Sets	S10
		Varvarovka Bypass Traffic – 55 vehicle movements / day	S11
3	Q3 2014	Backfill Trench (pipe line 1)	S08
		Pipe lay (pipe line 2)	S07
		Pipe trench excavation (pipe line 3)	S04
		Landfall mobilisation (Construction of site facilities and access roads)	S01
		Landfall facilities (ground levelling, foundations, etc.)	S06
		Microtunnel 1 tunnel boring	S10
		Generator Sets	S10
		Varvarovka Bypass Traffic – 558 vehicle movements / day	S11

Continued…

Model Reference	Time period	General Construction and Pre-Commissioning Activities Involved	Source Reference
4	Q1 2015	Backfill Trench (pipe line 1)	S08
		Pipe lay (pipe line 2)	S07
		Pipe lay (pipe line 3)	S07
		Pipe trench excavation (pipe line 4)	S04
		Landfall mobilisation (Construction of site facilities and access roads)	S01
		Landfall facilities (ground levelling, foundations etc.)	S06
		Microtunnel 1 tunnel boring	S10
		Dredging Exit of Microtunnels	S03
		Varvarovka Bypass Traffic – 138 vehicle movements / day	S11
5	Q2 2015	Backfill Trench (pipe line 2)	S08
		Backfill Trench (pipe line 3)	S08
		Pipe lay (pipe line 4)	S07
		Landfall civils (ground levelling, foundations etc.)	S08
		Microtunnel 1 tunnel boring	S10
		Microtunnel 2 (prepare launch pit)	S02
		Generator Sets	S10
		Dredging Exit of Microtunnels	S03
		Varvarovka Bypass Traffic – 159 vehicle movements / day	S11

Continued…

Model Reference	Time period	General Construction and Pre-Commissioning Activities Involved	Source Reference
6	Q3 2015	Backfill Trench (pipe line 3)	S08
		Backfill Trench (pipe line 4)	S08
		Landfall civils (ground levelling, foundations etc)	S06
		Microtunnel 1 tunnel boring	S10
		Microtunnel 2 (prepare launch pit)	S02
		Generator Sets	S10
		Dredging Exit of Microtunnels	S03
		Varvarovka Bypass Traffic – 91 vehicle movements / day	S11
7	Q4 2015	Microtunnel 2 tunnel boring	S10
		Microtunnel 3 (prepare launch pit)	S02
		Generator Sets	S10
		Dredging Exit of Microtunnels	S03
		Secant Piling of ramps	S09
		Varvarovka Bypass Traffic – 91 vehicle movements / day	S11
		Pre-commissioning landfall and nearshore Pipeline via hydro-testing	S12
8	Night-time period Q4 2014 – Q1 2016	Microtunnel boring	S10
		Generator Sets	S10
		Pre-commissioning whole Pipeline	S13

Complete.

To account for the shifting nature of work locations, various point source locations were used to aggregate the impacts of multiple noise sources, as detailed by the source reference number shown in Table 10.12. Point source locations were selected to represent the areas that would be expected to have the highest levels of activity and greatest number of noise sources.

Work to be undertaken in the nearshore section of the Project is included in the assessment. Activities considered include the dredging of the microtunnel exits. These activities are close to the shoreline and have the potential to impact on terrestrial receptors.

The details of the different plant items used for each source reference given in Table 10.12 are given below in Table 10.13. Source noise data have mainly been sourced from British Standard 5228-1 (Ref. 10.7), which provides sound level data (L_{Aeq}), maximum (L_{Amax}), and octave band data for a wide range of construction machinery. Each of the model simulations utilised this equipment data to predict construction noise level contours, as well as to predict noise levels at the closest sensitive receptors. All the simulations assumed a worst case scenario in which all equipment was operating simultaneously.

Table 10.13 Summary of Source Reference Plant Used in Models

Source Reference	Plant Type	Number	Sound Data Source
S01 – Landfall Mobilisation	Bull-Dozer	4	British Standard 5228 Table C.2 Ref 10
	Grader	2	British Standard 5228 Table D.3 Ref 74
	Tracked Excavator	4	British Standard 5228 Table C.2 Ref 3
	Tipper Lorry	6	British Standard 5228 Table C.2 Ref 32
	Shovel	2	British Standard 5228 Table C.2 Ref 5
	Generator	2	British Standard 5228 Table C.4 Ref 84
S02 – Microtunnel Launch Pit Preparation	Mobile Crane	1	British Standard 5228 Table C.3 Ref 28
	Excavators	4	British Standard 5228 Table C.2 Ref 3
S03 – Dredging Microtunnel Exit Pits	Dredging Vessel	1	British Standard 5228 Table C.7 Ref 2
S04 – Trench Excavation	Bull-Dozer	1	British Standard 5228 Table C.2 Ref 10
	Grader	1	British Standard 5228 Table D.3 Ref 74
	Tracked Excavator	4	British Standard 5228 Table C.2 Ref 3
	Tipper Lorry	2	British Standard 5228 Table C.2 Ref 32
	Shovel	2	British Standard 5228 Table C.2 Ref 5
	Generator	2	British Standard 5228 Table C.4 Ref 84
S05 – Generator Sets	1130 kVA gen set	2	Manufacturers' data – included in overall source terms of micro-tunnelling operations source S10
	810 kVA gen set	2	

Continued…

Source Reference	Plant Type	Number	Sound Data Source
S06 – Landfall Facilities	Bull-Dozer	2	British Standard 5228 Table C.2 Ref 10
	Grader	1	British Standard 5228 Table D.3 Ref 74
	Tracked Excavator	2	British Standard 5228 Table C.2 Ref 3
	Tipper Lorry	2	British Standard 5228 Table C.2 Ref 32
	Shovel	1	British Standard 5228 Table C.2 Ref 5
	Crane	2	British Standard 5228 Table C.4 Ref 52
	Generator	4	British Standard 5228 Table C.4 Ref 84
S07 – Pipeline Installation	Bull-Dozer	1	British Standard 5228 Table C.2 Ref 10
	Grader	1	British Standard 5228 Table D.3 Ref 74
	Tracked Excavator	2	British Standard 5228 Table C.2 Ref 3
	Tipper Lorry	1	British Standard 5228 Table C.2 Ref 32
	Shovel	1	British Standard 5228 Table C.2 Ref 5
	Tracked Side booms	6	British Standard 5228 Table C.2 Ref 5
	Welding Machine	10	British Standard 5228 Table C.4 Ref 85
	Generator	4	British Standard 5228 Table C.4 Ref 84

Continued…

Source Reference	Plant Type	Number	Sound Data Source
S08 – Demobilisation / Reinstatement	Bull-Dozer	1	British Standard 5228 Table C.2 Ref 10
	Grader	1	British Standard 5228 Table D.3 Ref 74
	Tracked Excavator	2	British Standard 5228 Table C.2 Ref 3
	Tipper Lorry	1	British Standard 5228 Table C.2 Ref 32
	Shovel	1	British Standard 5228 Table C.2 Ref 5
	Tracked Side booms	6	British Standard 5228 Table C.2 Ref 5
	Welding Machine	10	British Standard 5228 Table C.4 Ref 85
	Generator	4	British Standard 5228 Table C.4 Ref 84
S09 – Secant Piling	Large rotary bored piling rig	2	British Standard 5228 Table C.3 Ref 14
	Excavator	4	British Standard 5228 Table C.2 Ref 3
	100t-120t rated Tracked Crawler Crane	4	British Standard 5228 Table C.3 Ref 28
	Hydraulic power pack	2	British Standard 5228 Table C.3 Ref 7
S10 – Microtunnel Plant	Separation Plant	2	Manufacturers' data
	Centrifugal Plant	3	
S11 – Varvarovka Bypass Traffic	4 axle HGVs	Variable	British Standard 5228 Table C.2 Ref 34

Continued...

Source Reference	Plant Type	Number	Sound Data Source
S-12 – Pre-commissioning landfall and nearshore Pipeline	Diesel water extraction pumps	2	Manufacturers' data
	Diesel flooding pumps	2	
	Diesel hydrostatic test pumps	2	
	Primary high pressure compressor	2	
	Air drying unit	1	
	Nitrogen membrane unit	1	
S-13 – Pre-commissioning whole Pipeline	Booster compressor	80	Manufacturers' data

Complete.

Each of the source references has been used to establish the overall sound power level for the plant in octave bands. The resulting agglomeration of plant for each source reference has been modelled as a point source within the model. A summary of the sound power levels used for each of the source references is given Table 10.14.

Table 10.14 Summary of Source Reference Sound Power Levels / dB(A)

Source Reference	Octave Band Centre Frequency / Hz							
	63	125	250	500	1k	2k	4k	8k
S01 – Landfall Mobilisation	98.4	109.3	109.0	108.0	111.3	109.2	109.1	101.8
S02 - Microtunnel Launch Pit Preparation	85.7	89.2	96.2	97.6	99.7	99.9	106.6	96.5
S03 – Dredging Microtunnel Exits	86.2	104.3	100.8	104.2	107.4	103.6	96.4	86.3
S04 – Trench Excavation	94.9	106.0	107.2	107.9	110.4	109.0	109.4	102.3
S05 – Generator Sets	91.1	98.2	109.7	109.1	111.3	108.5	99.3	88.2
S06 – Landfall Facilities	97.0	108.0	107.4	107.3	111.4	108.8	108.4	101.4
S07 – Pipeline Installation	93.9	103.7	106.8	106.8	109.3	108.2	110.9	102.0
S08 – Demobilisation/Reinstatement	94.9	105.5	106.9	107.1	109.8	108.2	109.0	101.2
S09 – Secant Piling	91.0	105.7	103.6	106.9	108.4	107.6	103.0	97.1
S10 – Microtunnel Plant	74.0	86.0	100.0	104.0	107.0	106.0	102.0	65.0
S11 – HGV per vehicle	101	106	106	106	102	101	96	94
S12 - Pre-commissioning plant (all)	109.5	109.5	109.5	109.5	109.5	109.5	109.5	109.5
S13 – Booster compressor (single)	122.6	127.6	126.6	124.6	127.6	132.6	129.6	122.6

It is also necessary to consider the L_{Amax} noise levels from construction operations, with regard to the criteria defined within the Russian Standard (Ref. 10.4).

Therefore, a review of available L_{Amax} data has been undertaken from the published data contained within British Standard 5228. Data have been identified for specific items of plant where data exists for both the L_{Aeq} and L_{Amax} noise levels. The corresponding L_{Amax} levels have been compared with the L_{Aeq} levels to identify how much higher they are. A summary of the plant identified, the corresponding noise levels, and noise level difference are given below in Table 10.15.

Table 10.15 Comparison of L_{Aeq} and L_{Amax} Noise Levels for Specific Plant

Plant	British Standard 5228 Reference	Activity L_{Aeq} @10 m / dB	British Standard 5228 Reference	Activity L_{Amax} @10 m/ dB	Difference / dB(A)
Bull-Dozer	C.2 Ref 10	80	C.5 Ref 11	86	6
Grader	D.3 Ref 74	77	C.6 Ref 31	86	9
Tipper	C.2 Ref 32	85	C.6 Ref 15	90	5
Shovel	C.2 Ref 5	76	C.10 Ref 16	85	9

The analysis of typical construction plant noise levels indicates that typically the L_{Amax} noise levels range from 5 to 9 dB(A) above the corresponding L_{Aeq} noise level. Therefore, in order to assess the typical L_{Amax} noise levels that may arise from construction activities, it is assumed that L_{Amax} noise levels are 10 dB(A) above the predicted L_{Aeq} noise levels at all receptor locations.

10.6.2 Assessment of Potential Impacts: Construction and Pre-Commissioning Phase

10.6.2.1 Introduction

This section of the chapter assesses the noise and vibration impacts arising during the Construction and Pre-Commissioning Phase in the nearshore and landfall sections of the Project.

10.6.2.2 Assessment of Potential Impacts (pre-mitigation)

Pipeline and Landfall Construction and Pre-Commissioning Activities

The noise emissions from activities associated with traffic on existing roads and port operations are treated separately.

The following noise generating activities have been identified:

- Onshore construction activities (e.g. noise emissions associated with the operation of construction vehicles, plant and equipment);
- Microtunnelling activities (e.g. noise emissions associated with the operation of construction vehicles, plant and equipment); and
- Pre-commissioning activities (e.g. noise emissions associated with operation of pumps used during hydro-testing, and boost compressors).

The assessment of noise impacts on human receptors resulting from these activities is discussed below. Only human receptors in the vicinity of the landfall area have been included in this assessment.

The predicted daytime noise levels for Model References 1 to 7, inclusive, are presented below in Table 10.16 to Table 10.22 respectively.

The predicted night time noise levels from Model Reference 8 are presented below in Table 10.23. The tables also provide the Impact Magnitude, based on the criteria in Table 10.8, developed from the Russian Standard (Ref. 10.4).

It should be noted that Model Reference 8 considers the impacts associated with the operations that will be undertaken 24 hour per day. These have been assessed with regard to the night time noise level criteria only. Achieving the night time noise level limit, which is 10 dB below the daytime limit, will ensure that noise from these sources will make a negligible contribution to cumulative construction and pre-commissioning daytime noise levels.

Table 10.16 Model Reference 1 - Predicted Daytime Construction Noise Levels

Receptor	Predicted Noise Level (dB)										Impact Magnitude
	Octave Band Centre Frequency / Hz										
	63	125	250	500	1k	2k	4k	8k	L_{Aeq}	L_{Amax}	
1	55	47	36	35	33	22	22	0	38	48	Negligible
2	51	42	31	31	28	16	16	0	33	43	Negligible
3	44	43	32	31	27	18	18	0	33	43	Negligible
4	47	46	38	41	41	40	40	33	45	55	Negligible
5	60	55	40	43	46	42	42	27	49	59	Negligible
6	46	45	34	31	28	16	16	0	34	44	Negligible
7	36	33	21	16	8	0	0	0	20	30	Negligible
8	47	46	35	32	29	18	18	0	35	45	Negligible
9	55	59	46	48	47	43	43	34	51	61	N/A
10	58	50	38	38	37	28	28	3	42	52	N/A
11	54	55	43	41	41	37	37	26	46	56	N/A
12	65	57	43	41	45	40	40	28	49	59	N/A

Continued...

Receptor	Predicted Noise Level (dB)										Impact Magnitude
	Octave Band Centre Frequency / Hz										
	63	125	250	500	1k	2k	4k	8k	L_{Aeq}	L_{Amax}	
13	50	49	38	37	35	29	29	17	40	50	Negligible
14	34	32	19	13	4	0	0	0	18	28	Negligible
15	31	28	14	7	0	0	0	0	14	24	Negligible
16	28	24	8	0	0	0	0	0	9	19	Negligible

Note - The predicted noise levels for receptors of low sensitivity (Receptor 5 – unoccupied residential property) and ecological receptors (Receptors 9, 10, 11, and 12) are presented within the greyed out cells. The impact magnitude for Receptor 5 within the table is based on the property being occupied during construction works and hence having a high sensitivity – although it is not expected that this will occur. Predicted noise levels above the criteria are shown in bold italics.

Complete.

Table 10.17 Model Reference 2 - Predicted Daytime Construction Noise Levels

Receptor	Predicted Noise Level (dB)										Impact Magnitude
	Octave Band Centre Frequency / Hz										
	63	125	250	500	1k	2k	4k	8k	L_{Aeq}	L_{Amax}	
1	55	45	42	39	36	26	26	1	41	51	Negligible
2	51	40	37	35	33	21	21	0	37	47	Negligible
3	45	42	35	33	29	19	19	0	34	44	Negligible
4	47	46	39	41	41	40	40	33	45	55	Negligible
5	62	51	48	47	***51***	46	***46***	33	53	63	Low
6	47	44	38	34	31	18	18	0	36	46	Negligible
7	36	33	23	17	8	0	0	0	21	31	Negligible
8	48	45	38	34	31	19	19	0	37	47	Negligible
9	56	54	53	52	52	48	48	41	56	66	N/A
10	58	48	44	41	40	31	31	8	44	54	N/A

Continued...

Receptor	Predicted Noise Level (dB)										Impact Magnitude
	Octave Band Centre Frequency / Hz										
	63	125	250	500	1k	2k	4k	8k	L_{Aeq}	L_{Amax}	
11	55	55	44	42	42	37	37	26	46	56	N/A
12	65	57	43	42	45	40	40	28	49	59	N/A
13	50	48	41	39	37	30	30	17	41	51	Negligible
14	35	31	21	15	4	0	0	0	19	29	Negligible
15	32	28	16	8	0	0	0	0	14	24	Negligible
16	28	24	8	0	0	0	0	0	9	19	Negligible

Note - The predicted noise levels for receptors of low sensitivity (Receptor 5 – unoccupied residential property) and ecological receptors (Receptors 9, 10, 11, and 12) are presented within the greyed out cells. The impact magnitude for Receptor 5 within the table is based on the property being occupied during construction works and hence having a high sensitivity – although it is not expected that this will occur. Predicted noise levels above the criteria are shown in bold italics

Complete.

Table 10.18 Model Reference 3 - Predicted Daytime Construction Noise Levels

Receptor	Predicted Noise Level (dB)										Impact Magnitude
	Octave Band Centre Frequency / Hz										
	63	125	250	500	1k	2k	4k	8k	L_{Aeq}	L_{Amax}	
1	58	49	40	39	38	29	29	5	42	52	Negligible
2	56	44	35	34	34	22	22	0	38	48	Negligible
3	48	46	37	39	34	28	28	9	40	50	Negligible
4	54	55	48	51	***51***	***50***	***50***	43	***55***	65	Moderate
5	64	55	44	45	49	45	45	34	52	62	Low
6	50	48	38	36	34	24	24	0	39	49	Negligible
7	39	36	25	24	15	0	0	0	25	35	Negligible
8	50	49	39	38	35	26	26	1	40	50	Negligible

Continued...

Receptor	Predicted Noise Level (dB)										Impact Magnitude
	Octave Band Centre Frequency / Hz										
	63	125	250	500	1k	2k	4k	8k	L_{Aeq}	L_{Amax}	
9	67	63	52	52	54	51	51	48	58	68	N/A
10	62	55	46	45	45	39	39	32	49	59	N/A
11	57	58	47	47	48	45	45	34	52	62	N/A
12	67	59	46	45	49	43	43	30	52	62	N/A
13	53	52	43	43	42	39	39	27	46	56	Negligible
14	37	34	23	21	11	0	0	0	22	32	Negligible
15	34	31	18	13	0	0	0	0	17	27	Negligible
16	31	27	12	7	0	0	0	0	13	23	Negligible

Note - The predicted noise levels for receptors of low sensitivity (Receptor 5 – unoccupied residential property) and ecological receptors (Receptors 9, 10, 11, and 12) are presented within the greyed out cells. The impact magnitude for Receptor 5 within the table is based on the property being occupied during construction works and hence having a high sensitivity – although it is not expected that this will occur. Predicted noise levels above the criteria are shown in bold italics

Complete.

Table 10.19 Model Reference 4 - Predicted Daytime Construction Noise Levels

Receptor	Predicted Noise Level (dB)										Impact Magnitude
	Octave Band Centre Frequency / Hz										
	63	125	250	500	1k	2k	4k	8k	L_{Aeq}	L_{Amax}	
1	60	49	40	39	39	30	30	7	43	53	Negligible
2	55	45	36	34	33	21	21	0	37	47	Negligible
3	51	45	36	34	32	21	21	1	37	47	Negligible
4	49	49	41	44	43	42	42	35	48	58	Negligible
5	63	52	43	43	48	43	43	31	50	60	Low
6	51	49	40	37	35	24	24	0	40	50	Negligible

Continued...

Receptor	Predicted Noise Level (dB)										Impact Magnitude
	Octave Band Centre Frequency / Hz										
	63	125	250	500	1k	2k	4k	8k	L_{Aeq}	L_{Amax}	
7	39	36	24	20	11	0	0	0	23	33	Negligible
8	52	50	41	39	36	26	26	2	41	51	Negligible
9	59	58	50	50	50	47	47	43	54	64	N/A
10	67	59	47	46	49	45	45	38	53	63	N/A
11	67	60	47	46	49	44	44	33	53	63	N/A
12	66	56	44	43	47	41	41	27	50	60	N/A
13	54	52	42	41	40	33	33	19	44	54	Negligible
14	38	34	22	17	7	0	0	0	21	31	Negligible
15	35	31	18	10	0	0	0	0	17	27	Negligible
16	31	27	11	3	0	0	0	0	12	22	Negligible

Note - The predicted noise levels for receptors of low sensitivity (Receptor 5 – unoccupied residential property) and ecological receptors (Receptors 9, 10, 11, and 12) are presented within the greyed out cells. The impact magnitude for Receptor 5 within the table is based on the property being occupied during construction works and hence having a high sensitivity – although it is not expected that this will occur. Predicted noise levels above the criteria are shown in bold italics

Complete.

Table 10.20 Model Reference 5 - Predicted Daytime Construction Noise Levels

Receptor	Predicted Noise Level (dB)										Impact Magnitude
	Octave Band Centre Frequency / Hz										
	63	125	250	500	1k	2k	4k	8k	L_{Aeq}	L_{Amax}	
1	57	48	40	39	38	29	29	6	42	52	Negligible
2	54	45	36	35	34	23	23	0	38	48	Negligible
3	45	43	34	34	29	20	20	1	35	45	Negligible
4	48	48	40	43	43	42	42	35	48	58	Negligible

Continued...

Receptor	Predicted Noise Level (dB)										Impact Magnitude
	Octave Band Centre Frequency / Hz										
	63	125	250	500	1k	2k	4k	8k	L_{Aeq}	L_{Amax}	
5	64	54	44	44	48	43	43	30	51	61	Low
6	48	46	38	36	32	21	21	0	37	47	Negligible
7	36	33	22	18	9	0	0	0	21	31	Negligible
8	49	47	39	36	33	23	23	0	38	48	Negligible
9	62	62	53	52	52	50	50	49	57	67	N/A
10	63	56	45	43	45	40	40	29	49	59	N/A
11	64	57	46	45	47	43	43	34	51	61	N/A
12	62	53	42	41	44	39	39	28	47	57	N/A
13	52	50	41	40	39	33	33	19	43	53	Negligible
14	35	32	20	16	5	0	0	0	19	29	Negligible
15	32	28	15	9	0	0	0	0	14	24	Negligible
16	25	20	7	0	0	0	0	0	6	16	Negligible

Note - The predicted noise levels for receptors of low sensitivity (Receptor 5 – unoccupied residential property) and ecological receptors (Receptors 9, 10, 11, and 12) are presented within the greyed out cells. The impact magnitude for Receptor 5 within the table is based on the property being occupied during construction works and hence having a high sensitivity – although it is not expected that this will occur. Predicted noise levels above the criteria are shown in bold italics

Complete.

Table 10.21 Model Reference 6 - Predicted Daytime Construction Noise Levels

Receptor	Predicted Noise Level (dB)										Impact Magnitude
	Octave Band Centre Frequency / Hz										
	63	125	250	500	1k	2k	4k	8k	L_{Aeq}	L_{Amax}	
1	56	47	38	36	36	25	25	0	39	49	Negligible
2	52	44	34	33	31	20	20	0	36	46	Negligible

Continued…

Receptor	Predicted Noise Level (dB)										Impact Magnitude
	Octave Band Centre Frequency / Hz										
	63	125	250	500	1k	2k	4k	8k	L_{Aeq}	L_{Amax}	
3	45	43	33	32	28	18	18	0	34	44	Negligible
4	47	46	38	40	40	38	38	31	44	54	Negligible
5	61	51	42	43	46	42	42	27	49	59	Negligible
6	48	46	37	34	31	20	20	0	37	47	Negligible
7	37	34	22	18	9	0	0	0	21	31	Negligible
8	49	47	37	35	33	22	22	0	38	48	Negligible
9	56	56	47	48	48	44	44	37	52	62	N/A
10	60	51	42	40	40	31	31	9	44	54	N/A
11	62	56	44	43	45	41	41	30	49	59	N/A
12	65	56	43	42	47	40	40	28	50	60	N/A
13	51	49	39	38	37	29	29	15	41	51	Negligible
14	35	32	20	15	5	0	0	0	19	29	Negligible
15	32	29	15	8	0	0	0	0	15	25	Negligible
16	29	24	9	1	0	0	0	0	10	20	Negligible

Note - The predicted noise levels for receptors of low sensitivity (Receptor 5 – unoccupied residential property) and ecological receptors (Receptors 9, 10, 11, and 12) are presented within the greyed out cells. The impact magnitude for Receptor 5 within the table is based on the property being occupied during construction works and hence having a high sensitivity – although it is not expected that this will occur. Predicted noise levels above the criteria are shown in bold italics

Complete.

Table 10.22 Model Reference 7 - Predicted Daytime Construction Noise Levels

Receptor	Predicted Noise Level (dB)										Impact Magnitude
	Octave Band Centre Frequency / Hz										
	63	125	250	500	1k	2k	4k	8k	L_{Aeq}	L_{Amax}	
1	66	48	37	36	33	24	24	0	44	54	Negligible
2	62	43	32	32	29	18	18	0	40	50	Negligible
3	55	43	33	31	26	16	16	0	35	45	Negligible
4	55	45	36	38	37	36	36	29	43	53	Negligible
5	66	54	41	43	47	42	42	27	50	60	Low
6	57	45	35	33	28	17	17	0	37	47	Negligible
7	46	34	21	17	6	0	0	0	25	35	Negligible
8	58	46	36	34	29	19	19	0	38	48	Negligible
9	59	59	46	49	48	45	45	37	53	63	N/A
10	69	50	39	39	37	29	29	4	47	57	N/A
11	65	55	43	42	39	37	37	26	47	57	N/A
12	76	57	44	43	43	40	40	29	54	64	N/A
13	60	49	38	38	34	28	28	13	41	51	Negligible
14	45	32	19	14	2	0	0	0	23	33	Negligible
15	42	28	14	7	0	0	0	0	20	30	Negligible
16	39	24	8	0	0	0	0	0	17	27	Negligible

Note - The predicted noise levels for receptors of low sensitivity (Receptor 5 – unoccupied residential property) and ecological receptors (Receptors 9, 10, 11, and 12) are presented within the greyed out cells. The impact magnitude for Receptor 5 within the table is based on the property being occupied during construction works and hence having a high sensitivity – although it is not expected that this will occur. Predicted noise levels above the criteria are shown in bold italics

Table 10.23 Model Reference 8 - Predicted Night Time Construction Noise Levels

Receptor	Predicted Noise Level (dB)										Impact Magnitude
	Octave Band Centre Frequency / Hz										
	63	125	250	500	1k	2k	4k	8k	L_{Aeq}	L_{Amax}	
1	**70**	**66**	**61**	**60**	**63**	**58**	**58**	14	**66**	**66**	High
2	63	**62**	**58**	**55**	**55**	**46**	**46**	0	**58**	58	High
3	60	**63**	**59**	**56**	**56**	**50**	**50**	5	**60**	**60**	High
4	62	**65**	**61**	**59**	**59**	**52**	**52**	6	**62**	**62**	High
5	**68**	**65**	**61**	**59**	**62**	**56**	**56**	24	**64**	**64**	High
6	65	**68**	**64**	**62**	**63**	**59**	**59**	25	**66**	**66**	High
7	52	54	48	42	38	15	15	0	44	44	Low
8	66	**69**	**65**	**64**	**65**	**62**	**62**	32	**69**	**69**	High
9	62	64	60	57	58	54	54	29	62	62	N/A
10	71	70	66	65	68	67	67	39	72	72	N/A
11	80	77	72	72	77	80	80	62	83	83	N/A
12	78	77	72	72	76	78	78	61	81	81	N/A
13	66	**69**	**65**	**63**	**65**	**64**	**64**	**36**	**69**	**69**	High
14	49	50	44	38	33	6	6	0	40	40	Low
15	46	46	38	31	23	0	0	0	35	35	Negligible
16	45	46	37	27	13	0	0	0	33	33	Negligible

Note - The predicted noise levels for receptors of low sensitivity (Receptor 5 – unoccupied residential property) and ecological receptors (Receptors 9, 10, 11, and 12) are presented within the greyed out cells. The impact magnitude for Receptor 5 within the table is based on the property being occupied during construction works and hence having a high sensitivity – although it is not expected that this will occur. Predicted noise levels above the criteria are shown in bold italics. The predicted noise levels from daytime construction operations are shown graphically within Figures 10.3 to 10.9 for Model References 1 to 7, inclusive. The 55 dB L_{Aeq} noise level contour is shown in red on the figures relative to the identified receptor locations.

The predicted daytime noise impacts from Models References 1 to 7, inclusive, are given in Figure 10.3 to Figure 10.9, respectively, which indicates the location of the 55 dB L_{Aeq} noise contour.

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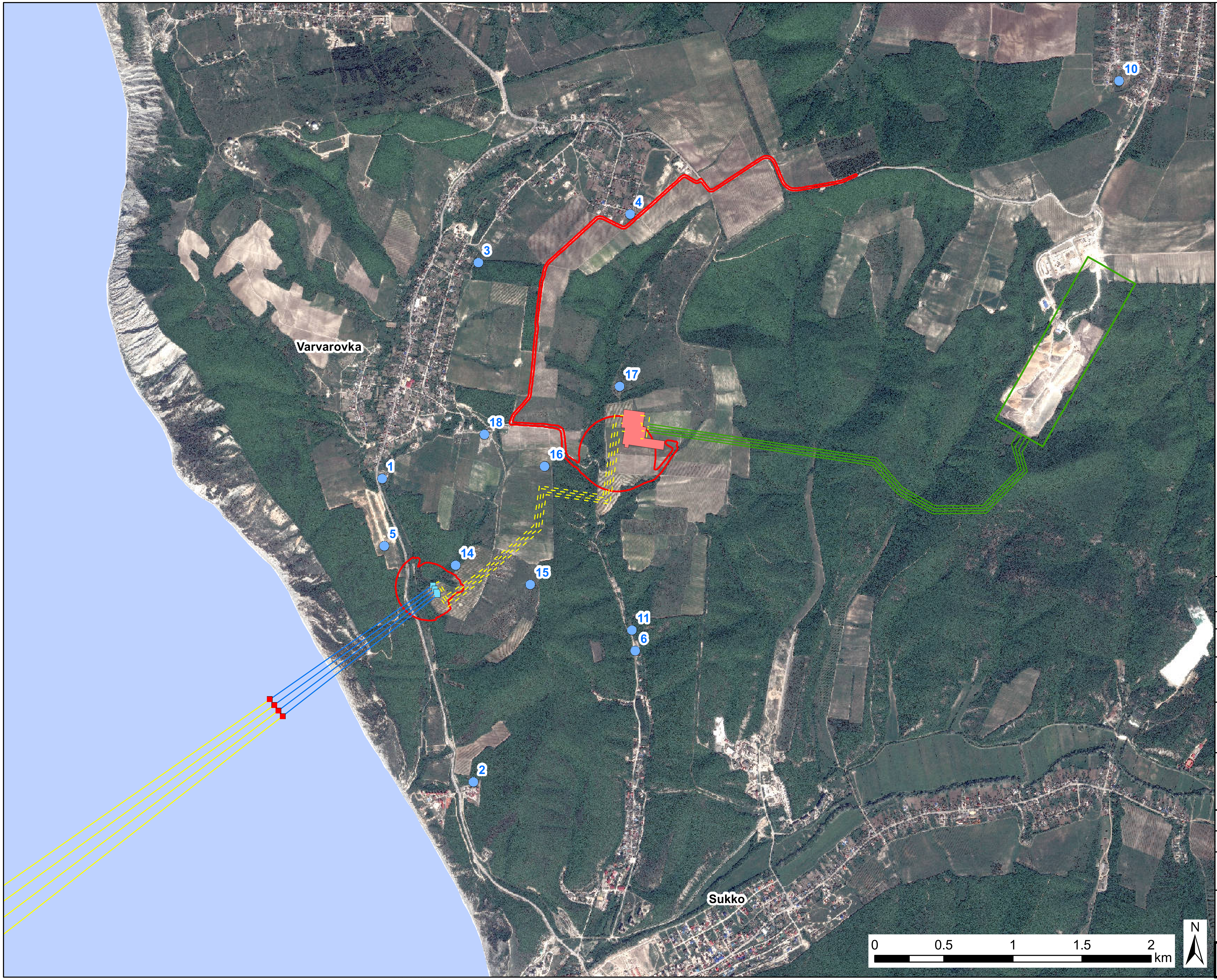

LEGEND

Scenario 1

55dB(A)

Noise survey locations

Russian Sector of South Stream Offshore Pipeline

Proposed landfall section pipelines

Landfall facilities

Proposed microtunnels

Proposed offshore pipelines

Microtunnel entry shaft

Microtunnel exit pit

United Gas Supply System

Russkaya compressor station

United Gas Supply System Pipelines

Projection: Lambert Conformal Conic

Revision Details	By / Check	Check Date	Suffix

Purpose of Issue

For Information

Client

South Offshore Pipeline — Stream ENERGISING EUROPE

Project Title

SOUTH STREAM OFFSHORE PIPELINE

Drawing Title

SCENARIO 1 DAYTIME NOISE LEVELS

Drawn	Checked	Approved	Date
DH	RW	MW	28/02/2014

URS Internal Project No.	Scale @ A3
46369082	1:25,000

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Drawing Number	Rev
Figure 10.3	

Plot Date: 28 Feb 2014
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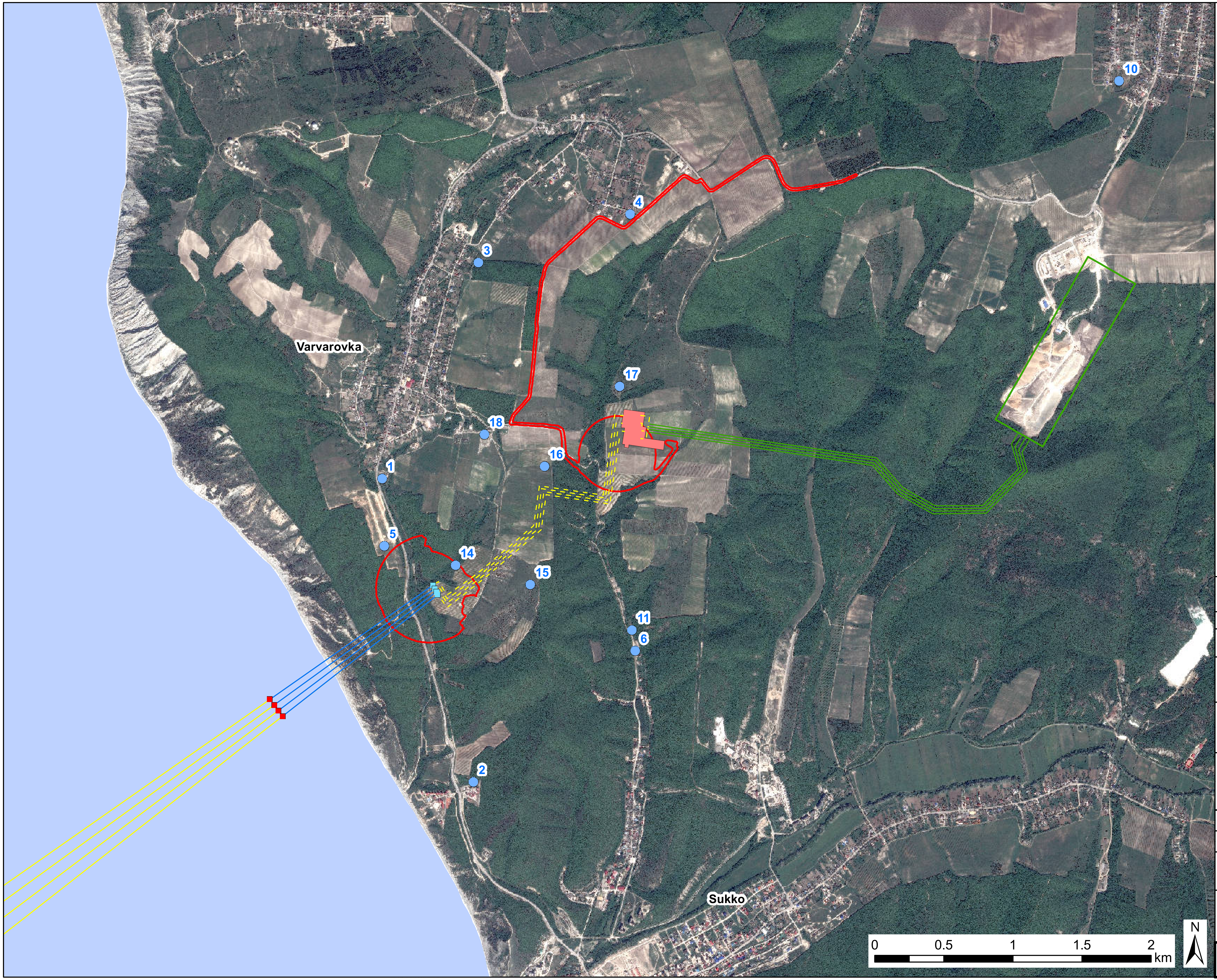

LEGEND

Scenario 2

- 55dB(A)
- Noise survey locations

Russian Sector of South Stream Offshore Pipeline

- Proposed landfall section pipelines
- Landfall facilities
- Proposed microtunnels
- Proposed offshore pipelines
- Microtunnel entry shaft
- Microtunnel exit pit

United Gas Supply System

- Russkaya compressor station
- United Gas Supply System Pipelines

Projection: Lambert Conformal Conic

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South Stream Offshore Pipeline — ENERGISING EUROPE

Project Title

SOUTH STREAM OFFSHORE PIPELINE

Drawing Title

SCENARIO 2 DAYTIME NOISE LEVELS

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Figure 10.4	

Plot Date: 28 Feb 2014
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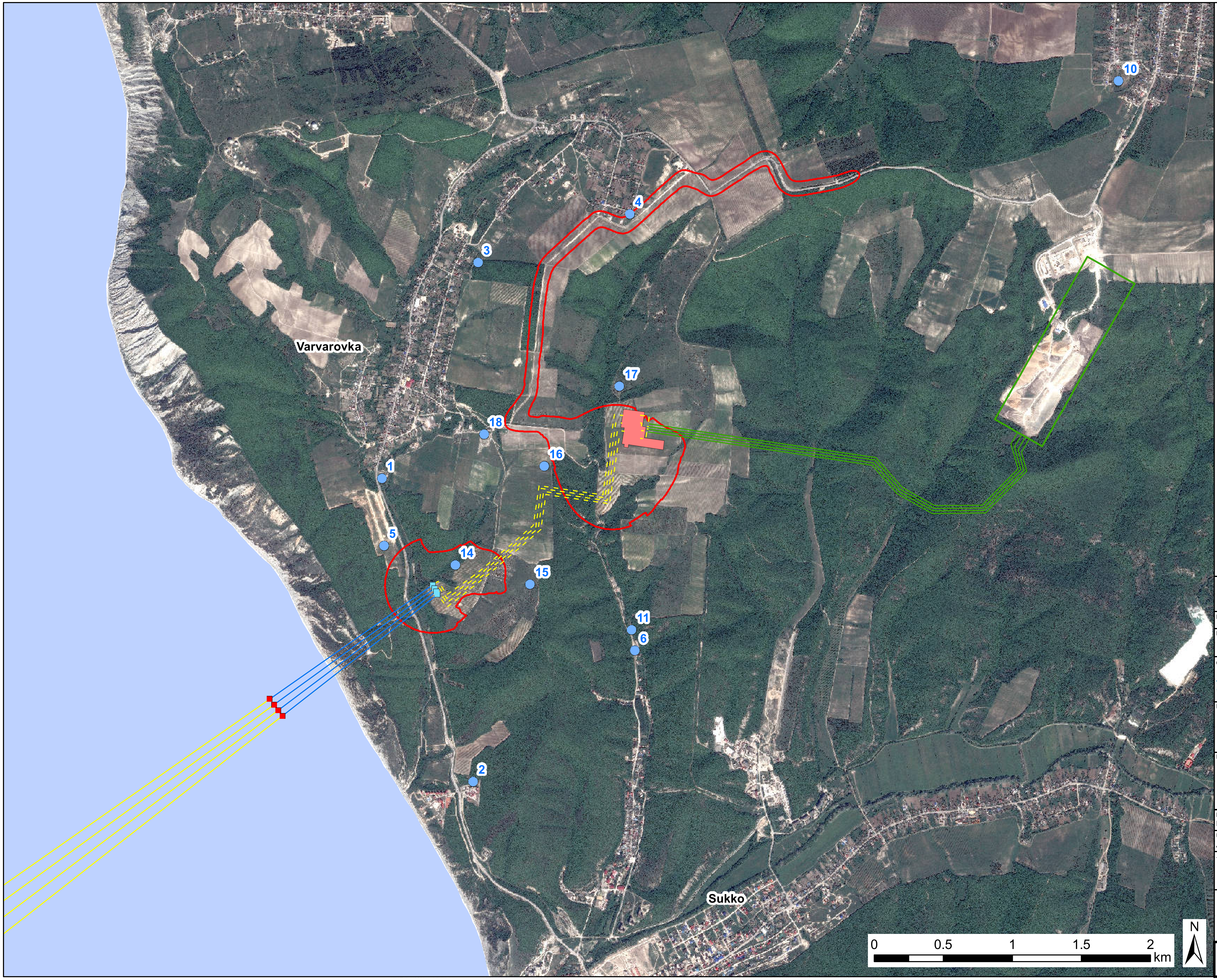

LEGEND

Scenario 3

- 55dB(A)
- Noise survey locations

Russian Sector of South Stream Offshore Pipeline

- Proposed landfall section pipelines
- Landfall facilities
- Proposed microtunnels
- Proposed offshore pipelines
- Microtunnel entry shaft
- Microtunnel exit pit

United Gas Supply System

- Russkaya compressor station
- United Gas Supply System Pipelines

Projection: Lambert Conformal Conic

Revision Details	By Check	Check Date	Suffix

Purpose of Issue: For Information

Client: South Stream Offshore Pipeline — Energising Europe

Project Title: SOUTH STREAM OFFSHORE PIPELINE

Drawing Title: SCENARIO 3 DAYTIME NOISE LEVELS

Drawn	Checked	Approved	Date
DH	RW	MW	28/02/2014

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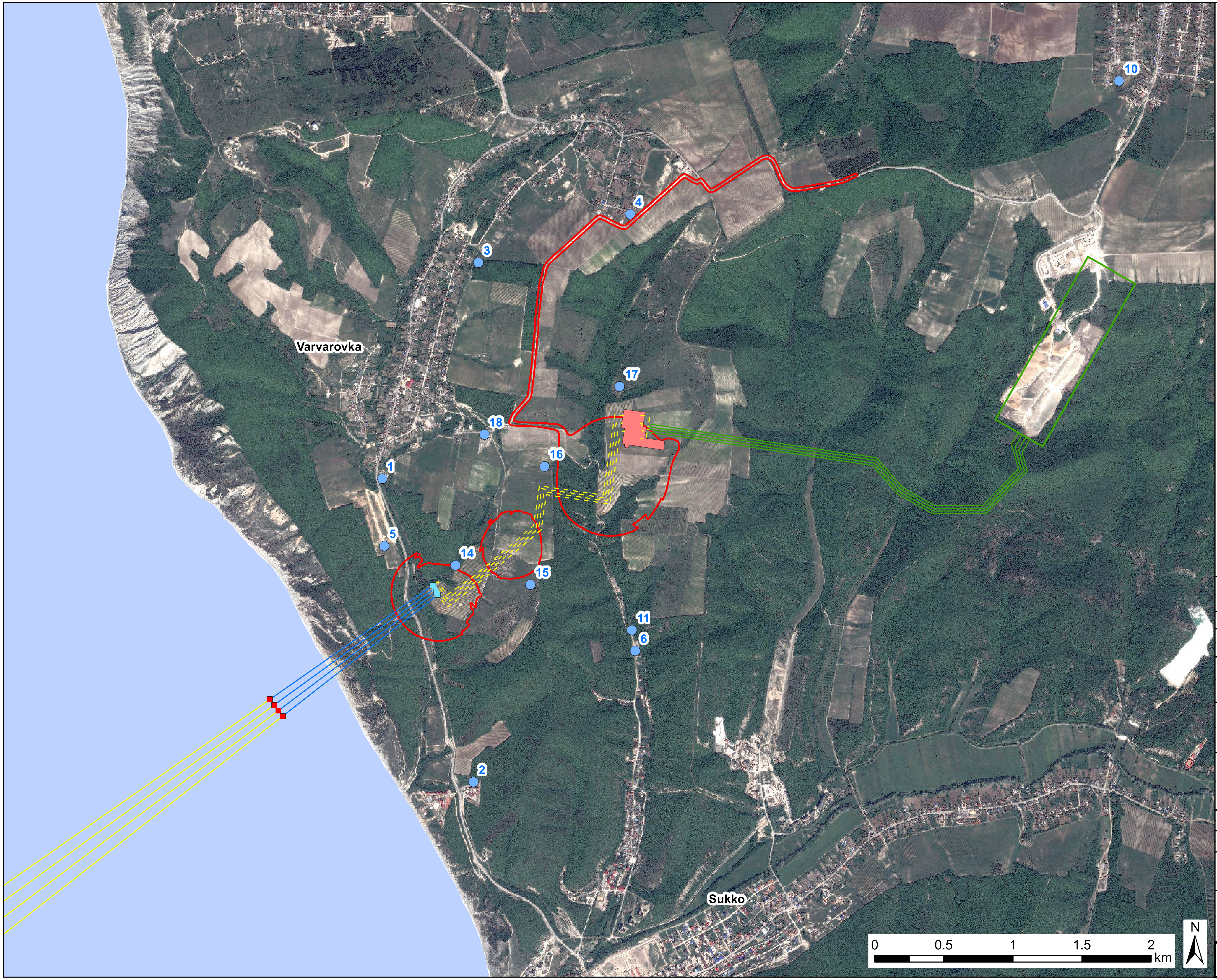

LEGEND

Scenario 4

- 55dB(A)
- Noise survey locations

Russian Sector of South Stream Offshore Pipeline

- Proposed landfall section pipelines
- Landfall facilities
- Proposed microtunnels
- Proposed offshore pipelines
- Microtunnel entry shaft
- Microtunnel exit pit

United Gas Supply System

- Russkaya compressor station
- United Gas Supply System Pipelines

Projection: Lambert Conformal Conic

Revision Details	By / Check	Check Date	Suffix

Purpose of Issue

For Information

Client

South Stream Offshore Pipeline — ENERGISING EUROPE

Project Title

SOUTH STREAM OFFSHORE PIPELINE

Drawing Title

SCENARIO 4 DAYTIME NOISE LEVELS

Drawn	Checked	Approved	Date
DH	RW	MW	28/02/2014

URS Internal Project No.	Scale @ A3
46369082	1:25,000

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Drawing Number

Figure 10.6

Rev

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File Name:I:\5004 - Information Systems\46369082_South_Stream\MXDs\Report Maps - Russia\Russian ESIA v2\Chapter 10 Noise\Figure 10.6 Scenario 4 Daytime Noise Levels.mxd

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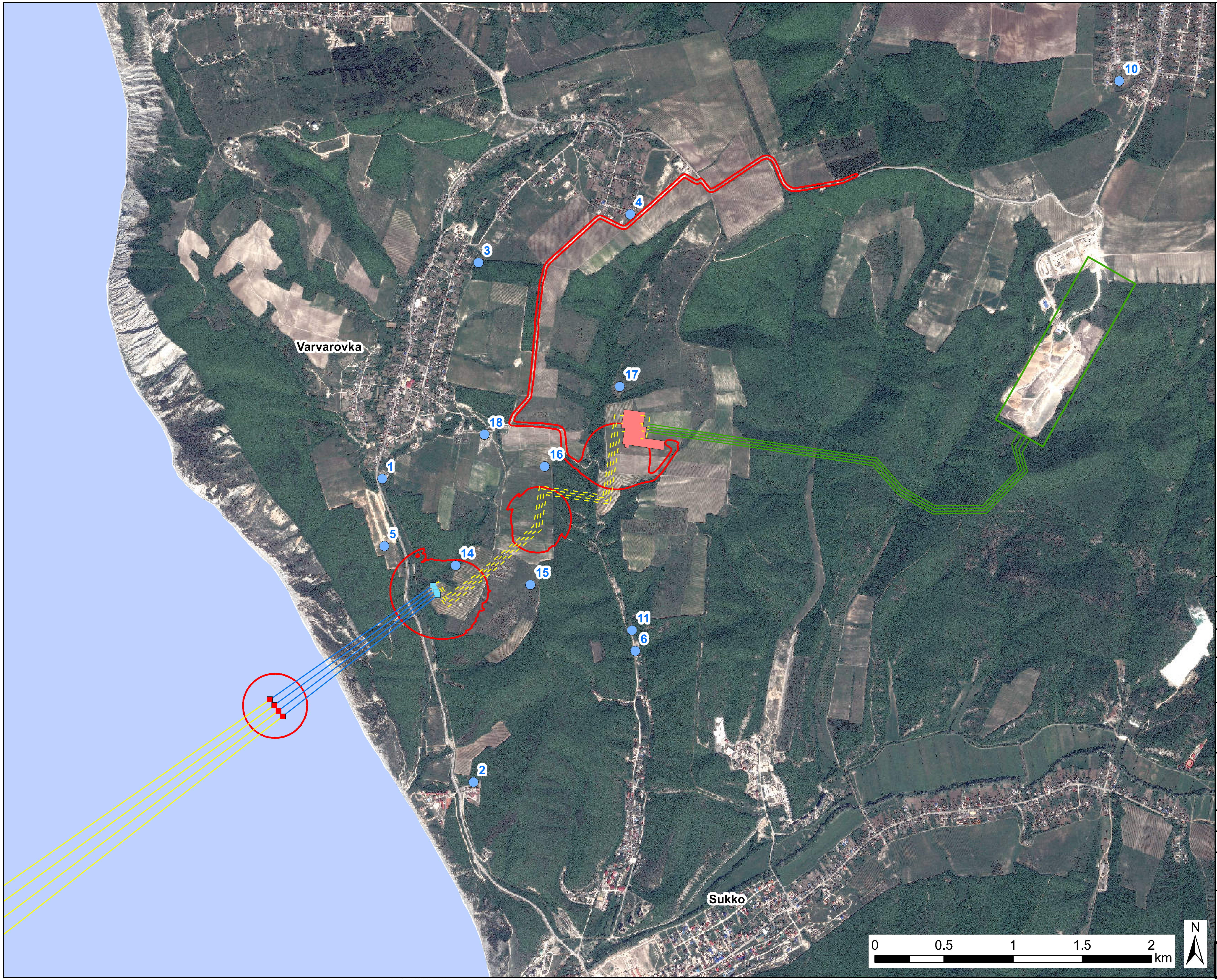

LEGEND

Scenario 5

55dB(A)

Noise survey locations

Russian Sector of South Stream Offshore Pipeline

Proposed landfall section pipelines

Landfall facilities

Proposed microtunnels

Proposed offshore pipelines

Microtunnel entry shaft

Microtunnel exit pit

United Gas Supply System

Russkaya compressor station

United Gas Supply System Pipelines

Projection: Lambert Conformal Conic

Revision Details	By Check	Check Date	Suffix

Purpose of Issue

For Information

Client

South Stream
Offshore Pipeline
ENERGISING EUROPE

Project Title

SOUTH STREAM
OFFSHORE PIPELINE

Drawing Title

SCENARIO 5
DAYTIME NOISE LEVELS

Drawn	Checked	Approved	Date
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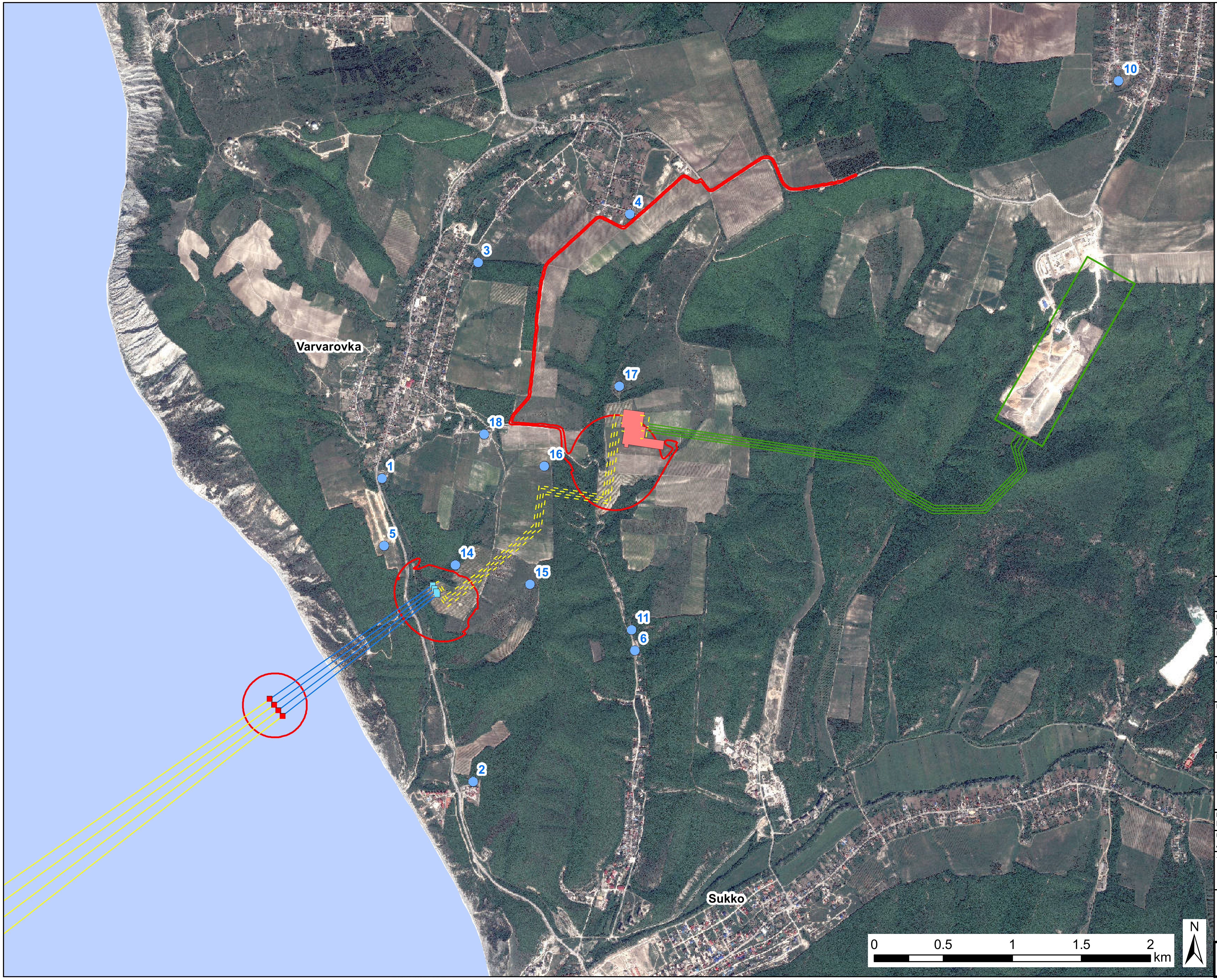

LEGEND

Scenario 6

- 55dB(A)
- Noise survey locations

Russian Sector of South Stream Offshore Pipeline

- Proposed landfall section pipelines
- Landfall facilities
- Proposed microtunnels
- Proposed offshore pipelines
- Microtunnel entry shaft
- Microtunnel exit pit

United Gas Supply System

- Russkaya compressor station
- United Gas Supply System Pipelines

Projection: Lambert Conformal Conic

Revision Details	By / Check	Check Date	Suffix

Purpose of Issue

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Project Title

SOUTH STREAM OFFSHORE PIPELINE

Drawing Title

SCENARIO 6 DAYTIME NOISE LEVELS

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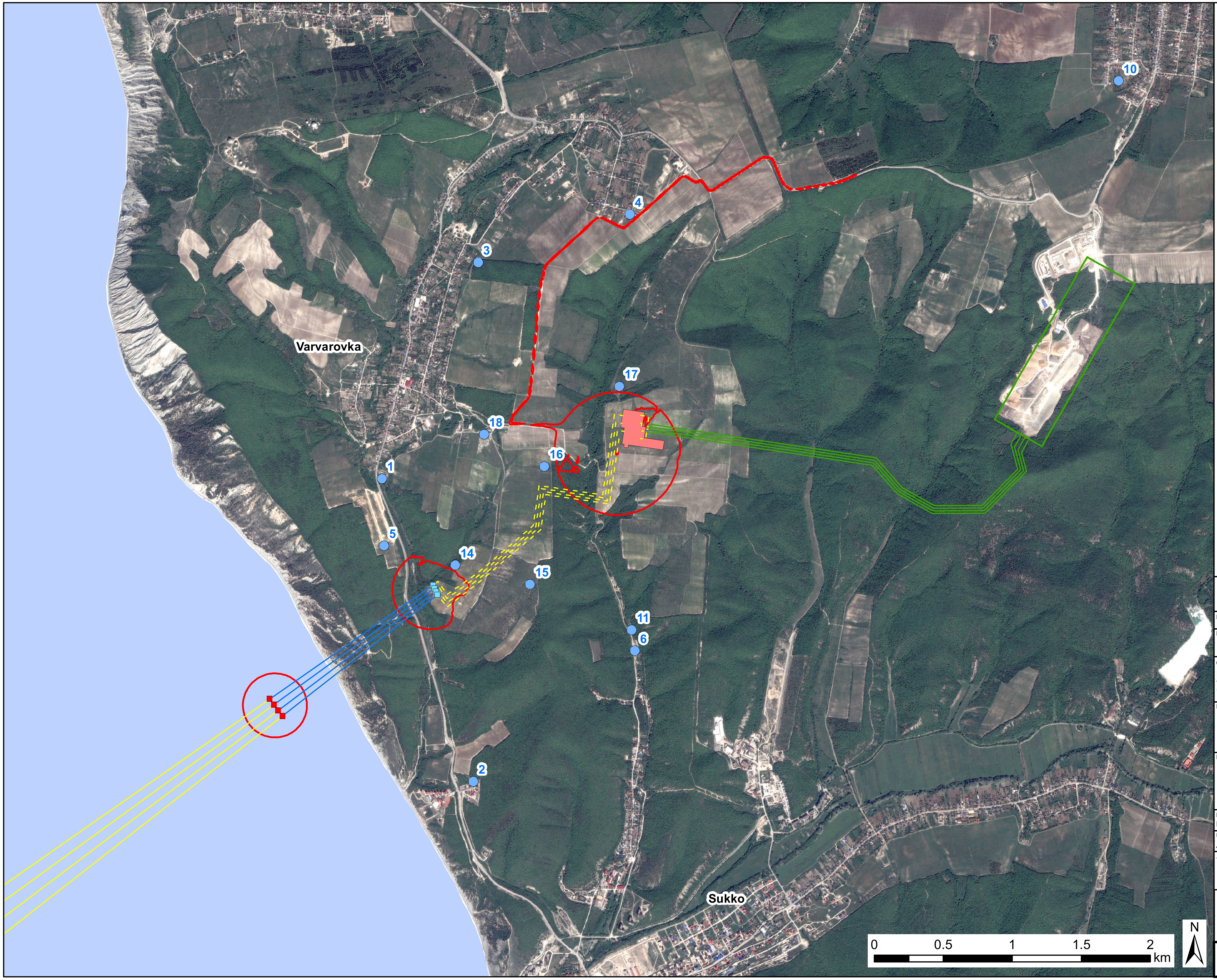
File Name:I:\5004 - Information Systems\46369082_South_Stream\MXDs\Report Maps - Russia\Russian ESIA v2\Chapter 10 Noise\Figure 10.8 Scenario 6 Daytime Noise Levels.mxd



LEGEND

Scenario 7

55dB(A)

Noise survey locations

Russian Sector of South Stream Offshore Pipeline

Proposed landfall section pipelines

Landfall facilities

Proposed microtunnels

Proposed offshore pipelines

Microtunnel entry shaft

Microtunnel exit pit

United Gas Supply System

Russkaya compressor station

United Gas Supply System Pipelines

Projection: Lambert Conformal Conic

Revision Details	By / Check	Check / Date	Suffix

Purpose of Issue: For Information

Client: South Stream Offshore Pipeline — Stream ENERGISING EUROPE

Project Title: SOUTH STREAM OFFSHORE PIPELINE

Drawing Title: SCENARIO 7 DAYTIME NOISE LEVELS

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The night-time noise levels are shown graphically within Figure 10.10 for Model Reference 8. This figure indicates the location of the 45 dB LAeq noise contour which is the applicable night-time noise limit. It should be noted that the plant will operate during both the day and night time period. However, as the night time noise limit is more stringent than the daytime the noise impacts have therefore been assessed the night time criterion (45 dB LAeq) in both Table 10.23 and Figure 10.10.

As mentioned previously, the noise levels at the ecological receptors (receptors 9 to 12) have been calculated for use in **Chapter 11 Terrestrial Ecology**. Only the predicted noise levels at these receptors have been presented and no assessment of impact significance is included within this chapter.

A summary of the predicted impact significance for the construction noise Model References 1 to 8, inclusive, is given below in Table 10.24. This summary utilised the impact significance matrix provided in **Chapter 3 Impact Assessment Methodology** employing the predicted magnitude of the impact (Table 10.16 to Table 10.23) in combination with the sensitivity of the receptor (Table 10.6).

For the daytime period for the majority of the existing receptors, currently identified as occupied sites in proximity to the construction activities, sensitivity is high and the impact magnitude is negligible; therefore, according to the impacts significance matrix, the overall impact is **Not Significant**.

However, during Scenario 3 the impacts at Receptor 4, representative of a cluster of residential dwellings on the north-eastern part of Varvarovka, are moderate. As these receptors have a high sensitivity, the impact significance is **High**.

At Receptor 5, which is a new-build proposed residential building that is unlikely to be occupied during the Construction Phase, the sensitivity is negligible and the impact magnitude is, at worst, low; therefore the overall impact significance is **Not Significant**. Table 10.24 assumes that receptor location 5 is uninhabited during the Construction Phase.

The predicted noise levels have the potential to create greater impacts should Receptor 5 support human occupants during the Construction Phase. If this were to happen, the sensitivity would be high and the worst case impact magnitude would occur during the night-time period and is classified as low; therefore, the overall impact significance would be **Moderate**, as based on the overall broadband noise level (L_{Aeq}).

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LEGEND

Scenario 8

- 45dB(A)
- Noise survey locations

Russian Sector of South Stream Offshore Pipeline

- Proposed landfall section pipelines
- Landfall facilities
- Proposed microtunnels
- Proposed offshore pipelines
- Microtunnel entry shaft
- Microtunnel exit pit

United Gas Supply System

- Russkaya compressor station
- United Gas Supply System Pipelines

Projection: Lambert Conformal Conic

Revision Details	By / Check	Check Date	Suffix

Purpose of Issue
For Information

Client
South Stream Offshore Pipeline / Stream ENERGISING EUROPE

Project Title
SOUTH STREAM
OFFSHORE PIPELINE

Drawing Title
SCENARIO 8
NIGHTTIME NOISE LEVELS

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File Name:I:\5004 - Information Systems\46369082_South_Stream\MXDs\Report Maps - Russia\Russian ESIA v2\Chapter 10 Noise\Figure 10-10 Scenario 8 Nighttime Noise Levels.mxd

The Russian regulations also require an assessment of the spectral noise levels at the receivers. If it is assumed that Receptor 5 is occupied during the Construction Phase it can be seen from

Table 10.17 (Scenario 2) that the noise level within the 1 KHz octave band may exceed the limit by 1 dB(A). The noise levels during the night time also exceed the 1 kHz and 2 kHz octave band levels by 2 dB(A) and 1 dB(A). The sensitivity of Receptor 5 (if occupied) is high and the impact magnitude is moderate; therefore, the overall impact significance would be **High**.

The predicted noise impacts during the night time period (Scenario 8), which indicate the cumulative noise impacts from micro-tunnelling and pre-commissioning using the booster compressor spread, indicate a high impact magnitude at the majority of receptors. As the receptors have a high sensitivity, the impact significance is **High**, for the majority of receptor locations. It should be noted that the significant noise source during this scenario is the booster compressors. Noise impacts arising from the micro-tunnelling plant, when considered in isolation, are **Not Significant**.

Construction Vibration Impact Significance

There are several sources of ground borne vibration anticipated during construction activities or from plant and equipment to be used (**Chapter 5 Project Description**).

At the microtunnel construction site, secant wall piling will involve the use of continuous flight augers, which give rise to levels of ground borne vibration that would be imperceptible beyond approximately 30 m (Ref. 10.7). Microtunnelling will be undertaken using a remotely controlled tunnel boring machine (TBM). The microtunnels will extend through soft to hard clay (<10 m) and loose to dense clayey gravel over predominantly marlstone, which has subordinate layering of sandstone, limestone and siltstone. When considering the worst case levels of ground borne vibration from the operation of the TBM (e.g. when encountering rock formations) the resulting levels of vibration would be imperceptible to human receptors at a distance of 100 m from the cutting face.

The proposed Pipeline corridors will employ a cut and fill method. Heavy plant associated with such operations will not give rise to high levels of ground borne vibration. Typically, the levels of ground borne vibration from a bulldozer are imperceptible to humans at a distance of approximately 20 m.

As the closest human receptors to the majority of construction works are at a distance of approximately 920 m (430 m for Receptor 5, if occupied) then the resulting levels of ground borne vibration will be imperceptible to occupants.

Table 10.24 Construction Noise Predicted Impact Significance

Receptor	Receptor Sensitivity	Model Reference and Predicted Impact Significance							
		1	2	3	4	5	6	7	8
1	High	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	High
2	High	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	High
3	High	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	High
4	High	Not Significant	Not Significant	High	Not Significant	Not Significant	Not Significant	Not Significant	High
5	Negligible	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Low
6	High	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	High
7	High	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Moderate
8	High	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	High
13	High	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	High
14	High	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Moderate
15	High	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant
16	High	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant

Note: The impact significance table assumes that Receptor 5 will not be occupied during the Construction Phase.

The Varvarovka bypass road is not anticipated to generate any significant level of ground borne vibration during construction as dynamic compaction, vibro compaction or piling techniques are not proposed to be used. The construction of a new level road surface, which will be adequately maintained, will ensure that ground borne vibration from vehicle movements will be negligible.

The booster compressors utilised during the pre-decommissioning stage are not anticipated to give rise to significant levels of ground borne vibration, as modern reciprocating engines are well balanced. Typically ground borne vibration would be imperceptible within tens of metres from such engines. Whilst there may be cumulative increases in the ground borne vibration where 80 such units are employed, given that the closest sensitive receptor is at a distance of approximately 1 km, it can be concluded that any ground borne vibration impacts will be negligible.

The existing residential receptors, cemetery and places of worship sensitivity classifications are high and the impact magnitude is negligible; therefore, the overall impact significance is **Not Significant**.

The impact of ground borne vibration on ecological receptors is not considered within this chapter, but is considered in **Chapter 11 Terrestrial Ecology**.

Construction Traffic

The impact of construction traffic is determined by assessing changes in road traffic noise levels due to the incidence of construction vehicles. The proposed construction traffic route will pass from the M25 through Rassvet, bypass Gai Kodzor and then onto the access road. The only other vehicles accessing the site will travel via the Anapa-Varvarovka road. The proposed transport routes are shown in **Chapter 5 Project Description**.

Data on the road traffic flows on the proposed transport routes have been gathered, the results of which have been presented in Appendix 9.1: Traffic and Transport Study. This includes figures showing the road links at which the traffic flow was counted. These locations were as follows:

- Link 1 – Varvarovka, southern end of settlement, south of junction with access road;
- Link 2 – Varvarovka, southern end of settlement, north of junction with access road;
- Link 3 – North of Varvarovka, south of junction of Anapa to Sukko road and road from Gai Kodzor;
- Link 4 – North of Varvarovka, east of junction of Anapa to Sukko road and road from Gai Kodzor;
- Link 5 – Supsekh, western edge of settlement on Anapa to Sukko road;
- Link 6 – Gai Kodzor, south of junction of temporary construction bypass and road from Rassvet;
- Link 7 – Gai Kodzor, north of junction of temporary construction bypass and road from Rassvet;

- Link 8 – Gai Kodzor, east of junction of temporary construction bypass and road from Rassvet;
- Link 9 – Rassvet, south of junction of M25 and road to Gai Kodzor;
- Link 10 – Rassvet, east of junction of M25 and road to Gai Kodzor; and
- Link 11 – Rassvet, west of junction of M25 and road to Gai Kodzor southbound.

The total construction traffic proposed for the Project comprises a maximum of 531 HGV and 27 light vehicle movements per day; this peak will last from August to November 2014. During June and July 2014, there will be 498 HGV and 14 light vehicle movements per day. The proportions of vehicles that will access the different roads around the site have been estimated in Appendix 9.1.

The absolute change in the noise levels that will be generated by the increase in road traffic flow at these locations has been predicted using the Calculation of Road Traffic Noise (Ref. 10.10). The absolute change in the noise level generated by the increased traffic flow resulting from construction traffic using the pre-existing routes is shown below in Table 10.25.

Table 10.25 Predicted Change in Road Traffic Noise Levels from Construction Movements

Location	Predicted Change in Noise Level L_{Aeq} (dB) – June to July 2014	Predicted Change in Noise Level L_{Aeq} (dB) – August to November 2014
Link 1	0.03	0.04
Link 2	0.01	0.01
Link 3	0.01	0.01
Link 4	0.01	0.01
Link 5	0.00	0.00
Link 6	0.01	0.01
Link 7	2.96	3.14
Link 8	1.56	1.67
Link 9	1.26	1.34
Link 10	0.62	0.67
Link 11	0.54	0.58

According to GIIP, it is generally accepted that a change of less than 3 dB in noise level is not perceptible to human subjects, and therefore the magnitude of the impact at Links 1 to 6 and 8 to 11 will be negligible, and the magnitude of impact at Link 7 will be low. The sensitivity of the receptors in the vicinity of the Links is high; therefore, the significance of the noise impact is **Not Significant** at receptors neighbouring Links 1 to 6 and 8 to 11, and **Moderate** at receptors neighbouring Link 7.

Port Activities

At the time of writing, a decision had not been made on the port that will be used to receive equipment and material for the purposes of the onshore construction activities. As detailed in **Chapter 5 Project Description**, the port of Novorossiysk is a potential option.

The port selected will be an existing commercial port. Consequently, ship movements and the handling of material would be part of the existing noise climate. It is therefore considered that whichever port is selected for the delivery of equipment and materials, it would be operated within the existing confines of potential impacts on neighbouring receptors.

10.6.2.3 Mitigation and Monitoring

The impact significance has been assessed as being **Not Significant** for the majority of the Construction and Pre-Commissioning Phase, and therefore the implementation of mitigation measured are not required for the majority of phases.

The exceptions where greater impacts have been identified, whereby mitigation measures need to be considered, result from periods of higher road traffic volumes (daytime), and pre-commissioning using the booster compressor spread (night time).

The residential area around Receptor 4 during Scenario 3, when the greatest road traffic flows will be experienced on the Varvarovka bypass road, will require mitigation to be implemented.

An acoustic screen along the boundary of the properties and Varvarovka bypass road will be installed to mitigate the noise impact. Typically this can be constructed from a timber fence, wall or earth bund, or any combination of the two. For fencing, example design principles to ensure effective mitigation include two layers of staggered boards, giving a minimum superficial mass of 10 kg/m^2, and ensuring that no air gaps exist at the base of the structure. The specification will be determined based on the number of vehicle movements on the road along with consultation with the owners of adjacent properties. An indicative location of the screen along with the noise contour plot is shown in Figure 10.11.

The predicted noise levels at the closest premises to the Varvarovka bypass road are predicted to fall to below 50 dB(A) with the implementation of a 3 m high barrier.

The resulting impact magnitude, with mitigation, is negligible, the receptor sensitivity is high, and the impact significance is **Low**.

The impact significance of Pre-Commissioning has indicated that during the cleaning, gauging and drying of the Pipeline between the Russian and Bulgarian landfall facilities (i.e. booster compressor spread operations) there is the potential for **High** impact significance to occur, and as such, mitigation measures need to be considered.

In order to reduce these noise levels by up to approximately 24 dB(A), it is expected that a combination of measures will need to be employed. These include the selection of inherently quiet plant with far lower sound power levels than used in the assessment; careful siting and orientation of the plant to minimise noise emissions at receptor locations; and the use of acoustic berms / barriers close to the pre-commissioning compound.

However, the degree of mitigation cannot be provided at this point in time, as the extent of mitigation will be dependent upon how great a reduction in noise levels can be achieved by the use of inherently quiet plant.

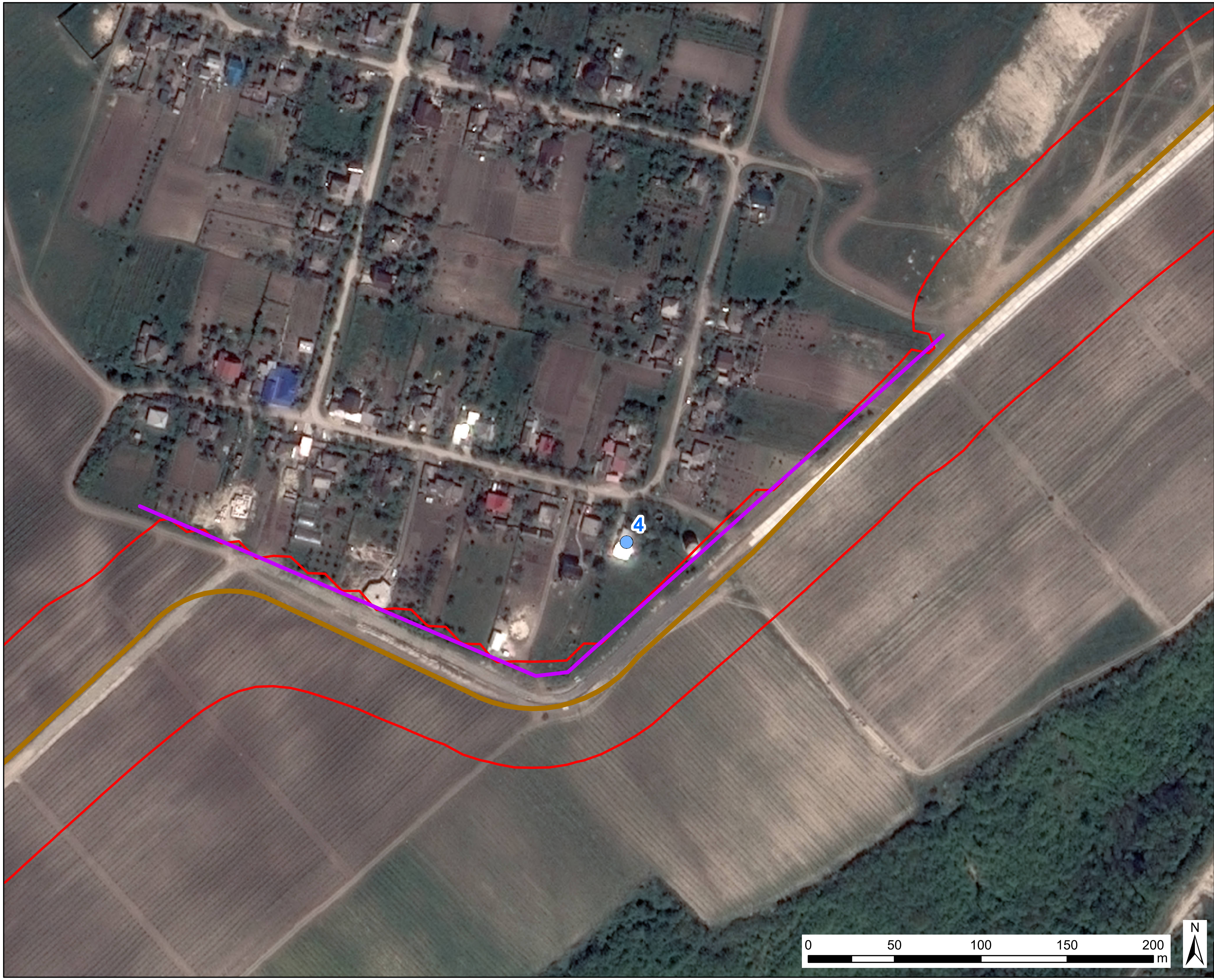
The predicted noise and vibration effects from the landfall and nearshore pre-commissioning cleaning and drying works have indicated that no mitigation measures need to be considered.

In addition to the above it is considered that the Project will adhere to GIIP in order to reduce the impact of construction noise and vibration upon all receptors. Mitigation measures will be documented within the Project Environmental and Social Management Plan (ESMP) (**Chapter 22 Environmental and Social Management**), and are described below:

- Equipment will be throttled to a minimum or switched off when not in use;
- Internal access roads will be kept well-maintained to minimise noise impacts generated by vehicles dealing with difficult terrain;
- Drop heights of materials will be minimised which will reduce the noise levels generated by the collision of materials with the ground or other materials;
- As far as reasonably practicable, sources of significant noise will be enclosed;
- Plant and equipment will be used and maintained regularly in accordance with manufacturers' instructions;
- Where possible, equipment and loading and unloading activities will be located away from noise-sensitive areas; and
- In consideration of the potential impacts arising from several noisy activities occurring at the same time, activities will be scheduled, where possible, to minimise overall noise levels.

Mitigation measures may need to be employed to reduce noise at Receptor 5 to acceptable levels; however, this is only in the event that this location is developed and occupied by residents during the Construction Phase. If this does occur, then consideration would be given to the following suitable measures:

- Selection of plant that gives rise to the lowest feasible noise emissions;
- Careful on-site location and orientation of plant; and
- The use of temporary soil screening bunds to reduce noise levels.



LEGEND

- 55dB(A)
- Varvarovka bypass noise barrier
- Noise survey locations
- Varvarovka bypass road (used by Project during construction only)

Projection: Lambert Conformal Conic

Revision Details	By / Check	Check Date	Suffix

Purpose of Issue

For Information

Client

South Stream
Offshore Pipeline
ENERGISING EUROPE

Project Title

SOUTH STREAM
OFFSHORE PIPELINE

Drawing Title

VARVAROVKA BYPASS
NOISE BARRIER

Drawn	Checked	Approved	Date
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Details of the compliance noise and vibration monitoring that will be undertaken are included in the overarching Environmental and Social Monitoring Programme (**Chapter 22 Environmental and Social Management**).

The document collates the assessments undertaken for both this ESIA Report and the in-country EIA Report, and the monitoring commitments made in each.

The in-country monitoring requirements are based on fixed timescales for sampling and do not provide flexibility to capture the start of specific activities. In addition, the in-country requirements for noise monitoring are based on both receptor locations, and points that are not representative of sensitive receptors.

Therefore, the monitoring programme has collated the commitments from both the ESIA Report and the EIA Report into a single working document that fulfils the requirements of both.

The committed monitoring regime goes beyond the in-country requirements in terms of both monitoring location numbers and frequency of monitoring.

This has been undertaken in order to capture the range of activities being undertaken, and a risk based approach has been adopted in order to target compliance noise monitoring at the starting time when specific activities which have the potential to exceed the noise limits occur.

With regard to the construction activities monitoring has been specified to occur at the start of the following activities:

- Daytime construction traffic during period of maximum movements (mid-June to November 2014);
- Daytime trenching, pipe fabrication, pipe laying and landfall facilities construction; and
- Night-time microtunnelling works.

Further to the above the assessment of the Pre-Commissioning Phase noise levels has highlighted that cleaning, gauging and drying of the pipelines between the Russian and Bulgarian landfall facilities is likely to be a key stage when compliance monitoring will be required. Given that this plant will operate on a 24 / 7 basis, and that the night time noise criteria is more stringent, compliance monitoring during the night time period will need to be scheduled during the first night of such plant operations. Compliance noise monitoring would be undertaken at the closest receptor locations to the pre-commissioning plant. Demonstrating compliance with the noise criteria at the closest receptors would ensure compliance with the criteria at all receptor locations.

10.6.2.4 Residual Impacts: Construction and Pre-Commissioning

The residual impact significance of both noise and ground borne vibration at sensitive receptors during the Construction and Pre-Commissioning Phases is summarised in Table 10.26.

For the majority of impacts are predicted to be **Not Significant** with the exception of two sub-phase scenarios.

During periods of the highest traffic flows there is predicted to be an impact on the boundary of the **Low** impact significance following the inclusion of a noise barrier to mitigate noise levels.

The activities associated with the use of the compressor booster spread for the cleaning, gauging and drying of the pipelines between the Russian and Bulgarian landfall facilities during Pre-Commissioning, which will result in an estimated **Low** impact significance at neighbouring receptors. It should be noted that the degree of mitigation feasible cannot be directly quantified at this point in time.

10.6.3 Assessment of Potential Impacts: Operational Phase

10.6.3.1 Introduction

The activities associated with the Operational Phase of the Project are:

- Operation of the pipeline inspection gauge (PIG) launching facility on an infrequent basis;
- Occasional vehicle movements and associated routine maintenance activities;
- Gas flow within the Pipeline; and
- Venting of gas from the landfall facilities during a shut down for maintenance or repairs.

10.6.3.2 Assessment of Potential Impacts (pre-mitigation)

The operation of the PIG launching facility will not involve any significant noise generating plant or machinery. The closest residential receptor is at a distance of over 1 km from the facility. As receptor sensitivity is high and the impact magnitude is negligible, the resulting noise impact significance is **Not Significant**.

Noise impacts resulting from infrequent routine maintenance and associated vehicle movements to the facility are considered to be of negligible magnitude given the large distances to the nearest noise sensitive receptors. As receptor sensitivity is high and the impact magnitude is negligible, the resulting noise impact significance is **Not Significant**.

Gas flow within the Pipeline has the potential to generate relatively low levels of sound. However, as the Pipeline will be buried below a minimum of 1.5 m of backfill, the resulting sound levels above ground level are anticipated to be inaudible. The resulting noise impact at sensitive residential receptors at considerable distance from the Pipeline corridor is therefore considered to be of negligible impact magnitude. As receptor sensitivity is high and the impact magnitude is negligible, the resulting noise impact significance is **Not Significant**.

Table 10.26 Assessment of Potential Impacts: Construction and Pre-Commissioning Phases

Activity	Potential Impact	Receptor(s)	Receptor Sensitivity	Impact Magnitude / Likelihood	Pre-Mitigation Impact Significance	Mitigation Measures	Residual Impact Significance
Operation of Construction Plant	Noise	Residential Dwellings, Cemeteries and Places of Worship	High	Negligible	Not Significant	None Required*	Not Significant
Varvarovka Bypass Access Road Traffic	Noise	Residential Dwellings	High	Moderate at Receptor 4	High at Receptor 4	Noise Barrier to protect properties	Low
Operation of Construction Plant	Vibration	Residential Dwellings, Cemeteries and Places of Worship	High	Negligible	Not Significant	None Required	Not Significant
Construction Traffic on Public Highways	Noise	Residential Dwellings, Cemeteries and Places of Worship	High	Negligible	Not Significant	None Required*	Not Significant
Pre-Commissioning – landfall and nearshore section pipelines	Noise	Residential Dwellings, Cemeteries and Places of Worship	Negligible	Not Significant	Not Significant	None Required	Not Significant
Pre-Commissioning – landfall and nearshore section pipelines	Vibration	Residential Dwellings, Cemeteries and Places of Worship	High	Negligible	Not Significant	None Required	Not Significant

Continued…

Activity	Potential Impact	Receptor(s)	Receptor Sensitivity	Impact Magnitude / Likelihood	Pre-Mitigation Impact Significance	Mitigation Measures	Residual Impact Significance
Pre-Commissioning – whole Pipeline (Russia to Bulgaria)	Noise	Residential Dwellings, Cemeteries and Places of Worship	High	High	High	Selection of inherently quiet plant; careful siting and orientation of plant; use of earth berms and temporary acoustic barriers.	Estimated as Low
Pre-Commissioning – whole Pipeline (Russia to Bulgaria)	Vibration	Residential Dwellings, Cemeteries and Places of Worship	High	Negligible	Not Significant	None Required	Not Significant

*Note – if Receptor 5 is constructed and becomes occupied during the Construction Phase, mitigation measures may need to be implemented.

Complete.

The impact of operational noise on ecological receptors is addressed within **Chapter 11 Terrestrial Ecology**.

The landfall facility will house a vent stack for the venting of gas from the pipelines during maintenance activities. The venting of gas from the Pipeline has the potential to generate jet noise. The resulting noise that may be generated has therefore been assessed using the procedures for estimating gas jet noise given within Engineering Noise Control (Ref. 10.11). The resulting overall acoustic power is determined to be $5.7*10^{-9}$ Watts, which equates to a sound power level (Lw) of 37.6 dB. The sound power level is further corrected to account for the directivity of the noise and the number of the pipes within the stack (eight), each of which will vent to atmosphere.

The predicted impact magnitude at all receptor locations is shown to be negligible. Though the sensitivity is high the resulting impact significance at all receptors is **Not Significant**.

10.6.3.3 Mitigation and Monitoring

No mitigation of noise or vibration from the Operational Phase is required.

The compliance noise and vibration monitoring is detailed in the overarching Environmental and Social Monitoring Programme (**Chapter 22 Environmental and Social Management**).

The document collates the assessments undertaken for both this ESIA Report and the in-country EIA Report, and the monitoring commitments made in each.

The Russian National EIA Report has committed to undertaking noise monitoring once per year during the Operational Phase.

Given that this ESIA Report has not identified any significant noise impacts, and no requirement for mitigation during the Operational Phase, it is concluded that noise monitoring at a greater frequency that the in-country commitment is not required.

10.6.3.4 Residual Impacts: Operational Phase

The noise and vibration impacts associated with the Operational Phase are not anticipated to require any form of mitigation. The resulting impact magnitudes for both noise and vibration are considered to be negligible, and noise and vibration levels are expected to be compliant with Russian Regulations; as the receptor sensitivity is high, the resulting impact significance is **Not Significant**, as summarised in Table 10.27.

Table 10.27 Assessment of Potential Impacts: Operational Phase

Activity	Potential Impact	Receptor(s)	Receptor Sensitivity	Impact Magnitude / Likelihood	Pre-Mitigation Impact Significance	Mitigation Measures	Residual Impact Significance
PIG launching facility	Noise and Vibration	Residential Dwellings, Cemeteries and Places of Worship	High	Negligible	Not Significant	None Required	Not Significant
Routine maintenance and associated vehicle movements	Noise and Vibration	Residential Dwellings, Cemeteries and Places of Worship	High	Negligible	Not Significant	None Required	Not Significant
Gas flow within the Pipeline	Noise and Vibration	Residential Dwellings, Cemeteries and Places of Worship	High	Negligible	Not Significant	None Required	Not Significant
Venting of gas within the landfall facilities during a planned shutdown for maintenance / repairs	Noise and Vibration	Residential Dwellings, Cemeteries and Places of Worship	High	Negligible	Not Significant	None Required	Not Significant

10.6.4 Assessment of Potential Impacts: Decommissioning Phase

10.6.4.1 Introduction

A decommissioning programme will be developed during the Operational Phase. The South Stream Pipeline System has a design life of 50 years, although this may be extended subject to close monitoring.

The decommissioning of onshore facilities has the potential to result in noise impacts at sensitive receptor locations, including human and ecological receptors. Offshore decommissioning of the Pipeline is considered to be at suitably large distances from terrestrial receptors and, therefore, there would be no impact.

10.6.4.2 Assessment of Potential Impacts (pre-mitigation)

The anticipated onshore noise and vibration impacts are expected to arise from the following activities;

- The demolition of facilities and infrastructure;
- Equipment and vehicle movements; and
- Earthworks.

The intensity and duration of works associated with the Decommissioning Phase are expected to be no greater than the Construction Phase. Given that the noise and vibration impacts associated with the non-construction traffic related activities, and excluding pre-commissioning activities which would not be undertaken, have been shown to be **Not Significant** for human receptors, it is considered that decommissioning activities would be likely to give rise to similar insignificant impacts, subject to no further residential buildings being built closer to the Pipeline over the course of the Operational Phase, and selection of appropriate routes for traffic away from habitable areas.

However, it is likely that Receptor 5 would be occupied during the Decommissioning Phase of the Project. As this receptor is located closer to the Pipeline corridor, there is the potential for elevated noise levels at this location during decommissioning. If noise levels equivalent to those generated during construction are received at this location, the impact at Receptor 5 could be of **High** significance, prior to the implementation of mitigation measures.

Given that the Decommissioning Phase will be undertaken a considerable time in the future, a re-appraisal of the following would be undertaken:

- A review of prevailing international and national legislation, regulations and GIIP;
- An assessment of new receptors that may have been introduced into the immediate vicinity; and
- An assessment of potential noise and vibration impacts once a detailed methodology and programme has been developed for the Decommissioning Phase.

Assessments will be undertaken during the Operational Phase to confirm that the planned decommissioning activities are the most appropriate to the prevailing circumstances and proposed future land use.

10.6.4.3 Mitigation and Monitoring

The requirements for mitigation and monitoring will be identified as part of the assessment to decommission the Project. As noise levels equivalent to those generated during the Construction Phase are expected, and that Receptor 5 is occupied, it is considered that by careful selection and orientation of plant, combined with the implementation of noise barriers, it is feasible to reduce noise impact from **High** to **Low** significance.

10.6.4.4 Residual Impacts: Decommissioning Phase

It is anticipated that the resulting impacts from decommissioning are likely to be of **Low** impact significance. However, this will be assessed in full as part of once a decommissioning methodology has been developed.

10.7 Unplanned Events

There are no significant sources of noise that will occur in the event of an unplanned event. Hence the significance of the impact of the noise generated by unplanned events will be **Not Significant**. Further details on unplanned events relevant to the Project are detailed in **Chapter 19 Unplanned Events**.

10.8 Cumulative Impact Assessment

The cumulative impacts associated with the Project relating to noise and vibration are assessed in **Chapter 20 Cumulative Impact Assessment**.

Table 10.28 Assessment of Potential Impacts: Decommissioning Phase

Activity	Potential Impact	Receptor(s)	Receptor Sensitivity	Impact Magnitude / Likelihood	Pre-Mitigation Impact Significance	Mitigation Measures	Residual Impact Significance
Decommissioning	Noise and Vibration	Occupants of Residential Dwellings	High	Negligible to Moderate	Not Significant to High	To be determined when decommissioning methodology is finalised	Expected to be Not Significant to Low

10.9 Conclusions

An assessment of the worst case noise and vibration impacts associated with construction and pre-commissioning has been undertaken. The results predict that the majority of noise and vibration impacts will be **Not Significant** at existing sensitive receptors neighbouring the Project, with a number of exceptions.

At Receptor 4 a **High** impact is predicted. The Receptor 4 location is mainly effected by road traffic noise using the Varvarovka bypass road, and the **High** impact significance is only predicted to occur during periods when the greatest vehicle movements will occur. Mitigation in the way of a noise barrier is proposed along the boundary of the Varvarovka bypass road. Post mitigation noise impacts are predicted to be of **Low** impact significance.

The pre-commissioning stage that utilises the booster compressor plant is predicted to give rise to a **High** impact at the majority of neighbouring receptors. By selection of inherently quiet plant, careful siting, and the use of acoustic bunds / barriers it is potentially feasible to reduce noise impacts to **Low** significance. This would however, be dependent on being able to source inherently quieter plant than the type used in the assessment. Vibration impacts are classified as being **Not Significant**.

The assessment at a proposed residential site (Receptor 5) has indicated that the impact significance at this location is also considered to be **Not Significant/Low** during all construction and pre-commissioning scenarios considered. This is based upon the receptor having a negligible sensitivity through the Construction and Pre-Commissioning phases, as the development is not anticipated to be complete for occupation during this period.

The assessment of the Operational Phase has also concluded that noise and vibration impacts will be **Not Significant**.

The assessment of decommissioning activities will be undertaken during the Operations Phase of the Project. However, it is anticipated that decommissioning works can be suitably mitigated so that the majority of impacts are considered likely to be **Not Significant** to **Low** significance. An assessment of potential impacts will be undertaken prior to decommissioning.

References

Number	Reference
Ref. 10.1	World Health Organisation (WHO) (1999), Guidelines for Community Noise.
Ref. 10.2	Peter Gaz (2011), 'Complex Engineering Surveys at the Phase 'Design Documentation' within the Framework of the South Stream Gas Pipeline Marine Sector Project Implementation. Volume 5 Environmental Survey and Archaeological Studies. Part 1 Environmental survey. The Russian sector. Book 4 Technical report. Technical appendices. P. 1-796, 'LLC PGAZ', 2011 (Ref. No. 6976.101.004.21.14.05.01.04-02).
Ref. 10.3	Peter Gaz (2013) 'Report on additional land studies of noise and vibration on the landfall section in the area of the resort town of Anapa, on access roads and the temporary materials and equipment warehouse site in the port of Temryuk as part of the South Stream Offshore Pipeline section (Russian sector) project'.
Ref. 10.4	Sanitary Norms (CH 2.2.4 / 2.1.8.562-96) – Noise at the working places in rooms of residential and public buildings and in residential areas.
Ref. 10.5	Russian Regulation SanPin 2.1.2.2645-10.
Ref. 10.6	IFC General EHS Guidelines (2012): Environmental – Section 1.7 Noise.
Ref. 10.7	British Standard Institution (2009) 5228-1 Code of practice for noise and vibration control on construction and open sites – Part 1 and 2.
Ref. 10.8	The International Organisation for Standardisation (ISO) (1996), 9613 Acoustics – Attenuation of sound during propagation outdoors – Part: 2 General method of calculation.
Ref. 10.9	Datakustik Cadna, A noise modelling software Version 3.72.131
Ref. 10.10	Department of Transport, Welsh Office, (1988) Calculation of Road Traffic Noise (CRTN).
Ref. 10.11	Engineering Noise Control Second Edition (2002), Bies and Hansen, Jet Noise, General Estimation Procedures, pages 444-447.