Chapter 4: Analysis of Alternatives

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South Stream Offshore Pipeline ENERGISING EUROPE

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4 Analysis of Alternatives

4.1 Introduction

The Project is the Russian Sector of the South Stream Offshore Pipeline, which is the offshore component of the South Stream Pipeline System. The objective of the South Stream Pipeline System is to develop a new gas supply route via the Black Sea that provides a safe and reliable means to export Russian gas to the countries of Central and South-Eastern Europe.

This chapter examines the technically and financially feasible alternatives to achieve the Project objective, which, consistent with the objective of the overall South Stream Pipeline System, is to form a key part of the new supply route via the Black Sea. These alternatives were considered during the Feasibility and Development Phases of the Project and have led to the validation of the Project as it is described in **Chapter 5 Project Description**.

Alternatives to the overall South Stream Pipeline System have not been considered within this ESIA Report, although reference is made to decisions made for the South Stream Offshore Pipeline and the wider South Stream Pipeline System. Such reference is made to provide context, particularly where decisions were made by third parties that directly influence the Project's design, recognising that the Project is an integral part of the wider South Stream Pipeline System.

Alternatives that were considered and assessed during the Feasibility Phase of the Project are referenced to the source documentation in the text. As indicated above, not all alternatives that are described in this chapter were considered and assessed during the Feasibility Phase. Some were examined later during the Development Phase, which includes the ESIA process. The need to carry out further appraisal of alternatives as part of the ESIA process stemmed from a need to confirm that all routing and technical decisions did in fact result in the least possible environmental and social impact, prior to finalising the design of the Project. These further appraisals do not have separate references and the results of the appraisals are presented in this chapter as part of the ESIA documentation.

The objective of this chapter is to outline how the Project represents an optimised design that is technically and financially feasible whilst minimising overall environmental and social impacts. The assessment of impacts that will arise as the result of the Project, along with the identification of appropriate mitigation measures, is contained in Chapters 7 to 21 of this ESIA Report.

This chapter is structured to start with consideration of high level strategic options (e.g. the zero alternative) and progressively focuses in on the more detailed Project-specific alternatives considered as part of the Front-End Engineering and Design (FEED) process (e.g. shore crossing options and route refinement options) (Ref. 4.1 to Ref. 4.3). Routing and siting alternatives have been analysed in the context of the engineering, environmental, socio-economic and cultural heritage optimisations that have been carried out during both the Feasibility and Development Phases of the Project.

It is noted that there is a requirement to provide flexibility to construction contractors in determining the most efficient and cost-effective construction methodologies whilst ensuring compliance with Project standards and Project commitments. Specifically, it is recognised that, at the time of writing this ESIA Report, data gathering and detailed design are on-going. As a result, some detailed aspects of the Project design may be subject to change but these will not materially alter the findings of the ESIA or any associated mitigation measures. In such cases, rather than being discussed within this chapter, **Chapter 5 Project Description** provides an outline of the potential construction alternatives.

4.2 Approach to Analysis of Alternatives

As recommended in the International Finance Corporation (IFC) Performance Standards Guidance Note 1: Assessment and Management of Environmental and Social Risks and Impacts (Ref. 4.4), the ESIA Report includes *"an examination of technically and financially feasible alternatives to the source of such impacts, and documentation of the rationale for selecting the particular course of action proposed."*

It is important to recognise that the South Stream Offshore Pipeline (and therefore the Project) is the offshore components of a larger South Stream Pipeline System. Consequently, the South Stream Offshore Pipeline and the Project (Russia Sector), which forms part of it, are significantly influenced by the route selection for the broader South Stream Pipeline System. Alternatives to the South Stream Offshore Pipeline as a whole are briefly discussed in this document (Sections 4.3 and 4.4) followed by the more detailed discussion of alternatives to the Project (Russian Sector).

Decisions taken by Gazprom prior to the establishment of South Stream Transport B.V. for the wider South Stream Pipeline System have significantly influenced the route selection (Ref. 4.1). Accordingly, this chapter briefly refers to the consideration of alternatives and decisions taken by Gazprom that have to a some extent predefined the Project design i.e. the general location of Russian landfall facilities and the routing of the offshore section of pipeline. Consequently the Analysis of Alternatives described in this chapter is structured to follow a 'narrowing approach' involving a series of logical steps, starting with the high-level alternatives (including those determined by third parties) followed by descriptions of more detailed alternatives (under South Stream Transport's control). Using this commonly adopted narrowing approach, the Analysis of Alternatives considers alternatives in the following sequence:

- The 'Zero' Alternative;
- South Stream Offshore Pipeline alternatives:
  - Alternative means of gas transportation; and
  - Offshore (macro) routing.
- Project alternatives:
  - Landfall site selection;
  - Shoreline crossing technique (open cut vs. microtunnelling);
  - Onshore routing; and
  - The offshore route optimisation.

4.3 Zero Alternative

The zero alternative for the purposes of this ESIA Report is the situation where the Project (i.e. the Russian Sector of the South Stream Offshore Pipeline) does not proceed. Under the zero alternative for the Project there are no adverse environmental or social impacts in Russia, on land or in Russian waters, as there is no construction or operation of the pipeline in Russia. Any such option would imply that the Project does not impinge on Russian territory, Russian waters, or the Russian EEZ.

The need for the South Stream Pipeline System and therefore the Project is driven by Europe's long-term demand for natural gas; further details are provided in **Chapter 1 Introduction**.

Should the Project not proceed, the entire South Stream Pipeline System with an offshore pipeline through the Black Sea would not proceed and the objective to provide a new supply route to the countries of Central and South-Eastern Europe via the Black Sea would not be met. This would in turn mean that diversifying existing supply routes to Central and South-Eastern Europe and providing additional supplies of natural gas to meet its growing energy demand would not be possible.

At the same time, the zero alternative would also mean that the Russian Federation would not benefit economically at the national level from the export of gas and at regional and local levels from sourcing employment, goods and services for the construction of the Project.

4.4 South Stream Offshore Pipeline Alternatives

4.4.1 Alternative Means of Gas Transportation

Based on the premise that gas will be exported via a new route across the Black Sea, consideration can be given to offshore transportation of gas by means other than pipeline systems. The main alternative to pipelines for transporting natural gas from Russia to Central and Southern European countries by sea is the liquefaction of natural gas at a Black Sea port in Russia and transportation of Liquefied Natural Gas (LNG) using LNG carriers to either:

- A port on the Western Black Sea coast (Bulgaria or Romania); or
- A port in southern Europe beyond the Turkish Straits.

The following factors were considered in the assessment of these alternatives:

1. Liquefaction and transportation of LNG to gas markets is usually undertaken for 'stranded gas' deposits where the source of gas is so distant and isolated from its markets as to make transportation by pipeline uneconomic;
2. Liquefaction would require the construction of a liquefaction plant on the Russian coastline. The onshore environmental impacts associated with the construction and operation of an LNG plant would be greater than those of a pipeline and associated compressor station;
3. This alternative would require the presence of an unloading jetty or offshore buoy and a regasification plant on the shores of a South European receiving country. In view of the

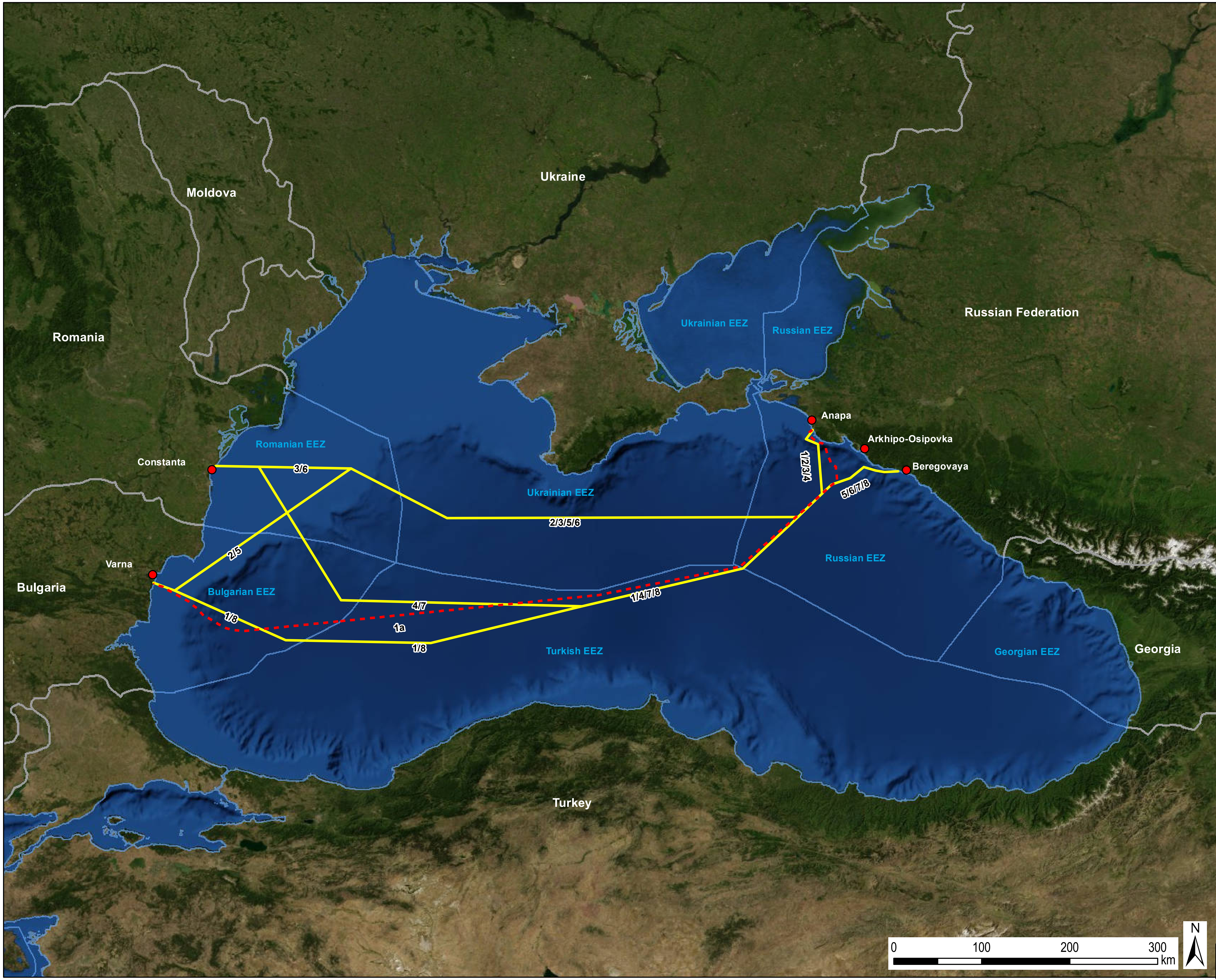
sensitivity and often designated protected status and recreational value of the Bulgarian and Romanian coastlines, it was considered undesirable to develop a large scale regasification plant on the coastal areas of Bulgaria or Romania. In order to avoid construction of a permanent regasification plant, export to an existing south European LNG regasification terminal could be considered; and

4. Transportation of LNG would require approximately 600 to 700 LNG carrier movements per year to export 63 bcm of natural gas per year. This would equate to approximately two full LNG carrier movements per day passing through the Turkish Straits, which include the densely populated areas adjacent to the Bosphorus Strait, Istanbul. In view of the hazardous nature of the cargo, the existing high density of maritime traffic through the Turkish Straits and the population density around the Bosphorus Strait, this number of vessels movements would introduce an additional and potentially unacceptable safety risk.

Based on the above, the LNG alternative is not considered further.

4.4.2 Offshore (Macro) Routing

Prior to selection of the site for the Russkaya Compressor Station (CS) to the south east of Anapa, eight potential offshore pipeline corridors were considered across the Black Sea; four offshore pipeline corridors from a shore crossing area near Beregovaya and four from a shore crossing area near Anapa, both located in the Russian Federation as shown in Figure 4.1.



LEGEND

Route alternatives

Option 1a

Exclusive Economic Zones

Offshore Pipeline Route Alternatives
Option 1 - Anapa to Varna (Turkish waters)
Option 1a - Anapa to Varna (Turkish waters)
Option 2 - Anapa to Varna (Ukrainian & Romanian waters)
Option 3 - Anapa to Constanta (Ukrainian waters)
Option 4 - Anapa to Constanta (Turkish & Bulgarian waters)

Discounted Offshore Pipeline Route Alternatives
Option 5 - Beregovaya to Varna (Ukrainian & Romanian waters)
Option 6 - Beregovaya to Constanta (Ukrainian waters)
Option 7 - Beregovaya to Constanta (Turkish & Bulgarian waters)
Option 8 - Beregovaya to Varna (Turkish waters)

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Purpose of Issue: For ESIA Report

Client: South Stream Offshore Pipeline – Energising Europe

Project Title: SOUTH STREAM OFFSHORE PIPELINE

Drawing Title: OFFSHORE PIPELINE CORRIDOR OPTIONS

Drawn	Checked	Approved	Date
DH	RW	MW	04/03/2014

URS Internal Project No.	Scale @ A3
46369082	1:4,000,000

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Drawing Number: Figure 4.1

Rev:

Plot Date: 04 Mar 2014
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The comparative assessment of these two locations, carried out by Gazprom (Ref. 4.2) as summarised in Section 4.5.1, showed that the location chosen for the Russkaya CS (near Anapa) had lower environmental impacts compared to the Beregovaya location.

As a result of the selection of Anapa as the proposed shore crossing location, route options 5, 6, 7 and 8 were discarded from further consideration. The four options taken forward for assessment (Options 1, 2, 3 and 4) are summarised in Table 4.1.

Table 4.1 Offshore Pipeline Route Alternatives

Option	Shore Crossing Location (Russia)	Shore Crossing Location (S. Europe)	Transit EEZs	Route Length (km)
1	Anapa	Varna	Russian, Turkish and Bulgarian	940.3
2	Anapa	Varna	Russian, Ukrainian, Romanian and Bulgarian	928.4
3	Anapa	Constanta	Russian, Ukrainian and Romanian	933.2
4	Anapa	Constanta	Russian, Turkish, Bulgarian and Romanian	931.3

Of these four corridors, two cross the Turkish EEZ (Options 1 and 4) and two cross the Ukrainian EEZ (Options 2 and 3). Options 2 and 3 could not be surveyed within the timeframe required and were therefore discarded from further consideration. Further technical investigations were performed for Option 1, landing in Bulgaria and Option 4, landing in Romania (Ref. 4.3).

Various landfall site alternatives were considered on the Black Sea coast of southern Europe, in Bulgaria and Romania. This process identified two preferred shore crossing areas: one near the Bulgarian port of Varna and one near the Romanian port of Constanta.

After Bulgaria and Russia signed an Intergovernmental Agreement on South Stream, the remaining Romanian landfall alternative (Option 4) was no longer considered, leaving Option 1 as the preferred option. Following this decision, shore crossing sites in the vicinity of Varna on the Bulgarian Black Sea coast were further considered.

Option 1 was subsequently subject to route optimisation with consideration of a direct route across the Turkish EEZ rather than the deviation to the south. Option 1 was originally proposed to avoid the potential impacts of the southern edge of the Danube Delta sediment fan. Following further engineering investigation, it was concluded that due to the relatively low relief and inactive depositional nature of the outer submarine fan, the effects associated with deposition of sediment in the Danube fan system were minor. The direct line approach shown as Option 1a on Figure 4.1 was therefore adopted and subjected to further consideration of environmental and cultural heritage sensitivities (see **Chapter 12 Marine Ecology** and **Chapter 16 Cultural Heritage**).

4.5 Project Alternatives

4.5.1 Landfall Site Selection

Following the decision to construct an offshore pipeline system across the Black Sea, landfall sites on the Russian Black Sea coast and on the Black Sea coast of Southern Europe were selected.

The selection of the landfall site on the Russian Black Sea coast first took into account the requirement for a Compressor Station (CS) close to the coast[1]. A large CS is necessary to increase gas pressure and pump the gas across the Black Sea. As mentioned in **Chapter 1 Introduction**, the CS will be designed and installed as part of the project known as "Expansion of the UGS (United Gas Supply System) to provide gas to South Stream pipeline" that is being developed by Gazprom.

The land-take requirements and environmental and safety considerations associated with the CS are more significant than those associated with the offshore pipelines. The site for a large gas compressor station requires gentle topography, safe and feasible connections with the onshore and offshore pipeline system and adequate distances from populated areas and from areas with special designation (e.g. nature reserves). Not many locations satisfied all these requirements and only two potential locations were identified by Gazprom on the Russian shores of the Black Sea:

- A location approximately 10 km southeast of the town of Anapa (the Russkaya CS); and
- Beregovaya CS, located approximately 5 km east of the town of Arkhipo-Osipovka.

The Russkaya CS location is a green field site in a relatively isolated location whereas the Beregovaya location is adjacent to the existing CS of the Blue Stream Pipeline[2].

The two locations were identified by Gazprom (Ref. 4.2) on the basis of available land of suitable morphology, existing land use, presence of transport infrastructure, distance from residential areas and other environmental and social constraints. The concept of bundling potential environmental and social impacts and thus confining such impacts to one location, with potential positive and adverse cumulative effects, was considered for the Beregovaya location, given its proximity to the CS of the Blue Stream Pipeline.

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[1] At this stage Gazprom divided pipeline into three distinct components: i) a pipeline system in Russia terminating at a Compressor Station (CS); ii) an offshore pipeline system (the South Stream Offshore Pipeline); and iii) an onshore distribution system in central and southern Europe. These three components became distinct projects with separate management companies, engineering and permitting history.

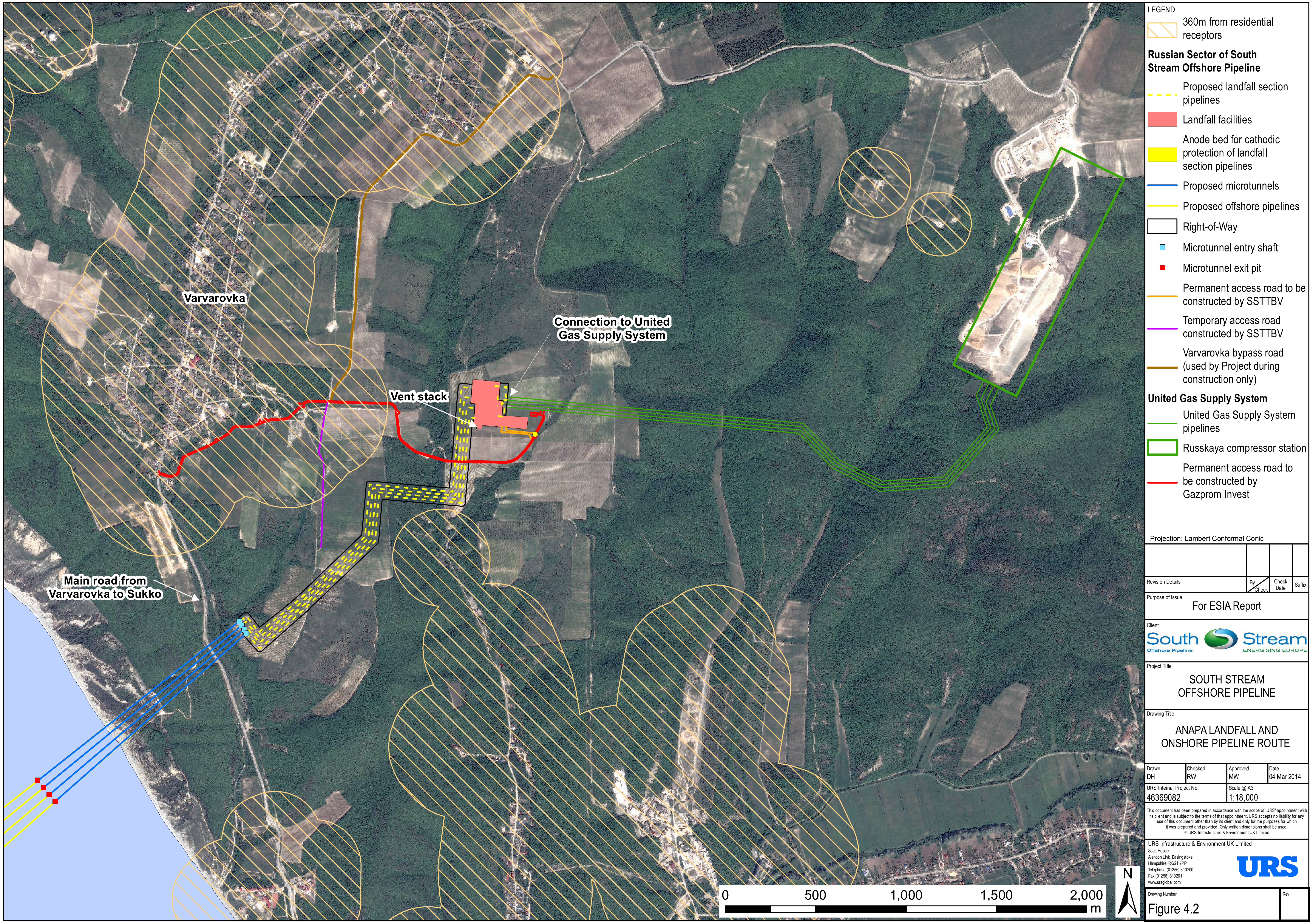
[2] The Blue Stream gas pipeline crosses the Black Sea delivering Russian natural gas to Turkey.

The comparative assessment of the two selected locations, carried out by Gazprom (Ref. 4.2), concluded that the location of the Russkaya CS had fewer environmental impacts compared to the Beregovaya location. This included lower impacts on air quality and noise, lower suspended solids in runoff, lower usage of petroleum products, lower impacts on marine biological resources and greater distances from protected areas (further details are provided in Appendix 20.1). Bundling impacts at Beregovaya was in this instance considered to be unacceptable because of the cumulative impacts associated with the contemporaneous operation of the two facilities. On this basis, the Russkaya CS site was selected and the decision was subsequently approved by Russian environmental agencies at both the Federal and Regional level during meetings held on the 22 to 29 September 2011.

As a result of the selection of the Russkaya CS site, the Anapa landfall was considered for further technical evaluation by Gazprom.

4.5.2 Shoreline Crossing

The selection of the shore crossing location was dictated by the requirement to keep the pipelines at a safe distance from residential and recreational areas (see Figure 4.2).



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File Name:I:\5004 - Information Systems\46369082_South_Stream\MXDs\Report Maps - Russia\Russian ESIA\Chapter 4 Analysis of Alternatives of the Russian ESIA\Figure 4.2 Anapa Landfall and Onshore Pipeline Route.mxd

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Based on this requirement, the only feasible shore crossing corridor for a trenched crossing required the pipelines to cross the main road from Anapa and Varvarovka to Sukko, climb up a steep coastal ridge (17% gradient), cross a coastal path and finally descend a steeper slope (37% gradient) to reach the Black Sea shore. Figure 4.2 shows the route of the pipelines.

A preliminary engineering and environmental analysis (Ref. 4.3) of the shore crossing feasibility indicated that in addition to significant engineering challenges, due to the steepness of the slope (Figure 4.3), an open cut approach to the shore crossing would have resulted in additional environmental impacts, including the need to remove larger areas of sensitive natural habitats, which would result in habitat loss and fragmentation[3].

Figure 4.3 Russia Shore Crossing Coastline

Alternative trenchless shore crossing techniques were therefore assessed. The chosen technique is based on the construction of a tunnel[4] for each pipeline from a location to the east of the Anapa-Sukko road to the seabed, at a water depth of approximately 23 m and a distance of 400 m from the shore. This option includes the additional benefit of removing the need to carry

[3] Natural habitats present comprise notable plant species, such as Juniperus excelsa and Juniperus foetidissima listed as species of concern on local, regional and international Red Data Books.
[4] Trenchless alternatives included Horizontal Direction Drilling (HDD) and Microtunnelling. Microtunnelling was selected over HDD because it allows greater flexibility and reliability in differing sub strata.

out dredging and pipeline construction activities in the most sensitive section of the marine environment (0 to 20 m water depth).

Following the Analysis of Alternatives, microtunnelling was selected on the grounds that a steep angled open cut method would present significant engineering challenges. This trenchless alternative would also result in fewer environmental impacts.

4.5.3 Onshore Routing

The route of the onshore sections of the Offshore Pipeline Project shown in Figure 4.2 was chosen to maximise the use of modified vineyards thereby minimising impacts on natural habitat whilst also considering mandatory exclusions zones for safety purposes. The onshore route is further described in **Chapter 5 Project Description.**

4.5.4 Offshore Route Optimisation

The route selection process progressed with the optimisation of the offshore route across Russian waters in the three main oceanographic units of the Project:

- The continental slope;
- The continental shelf; and
- The abyssal plain.

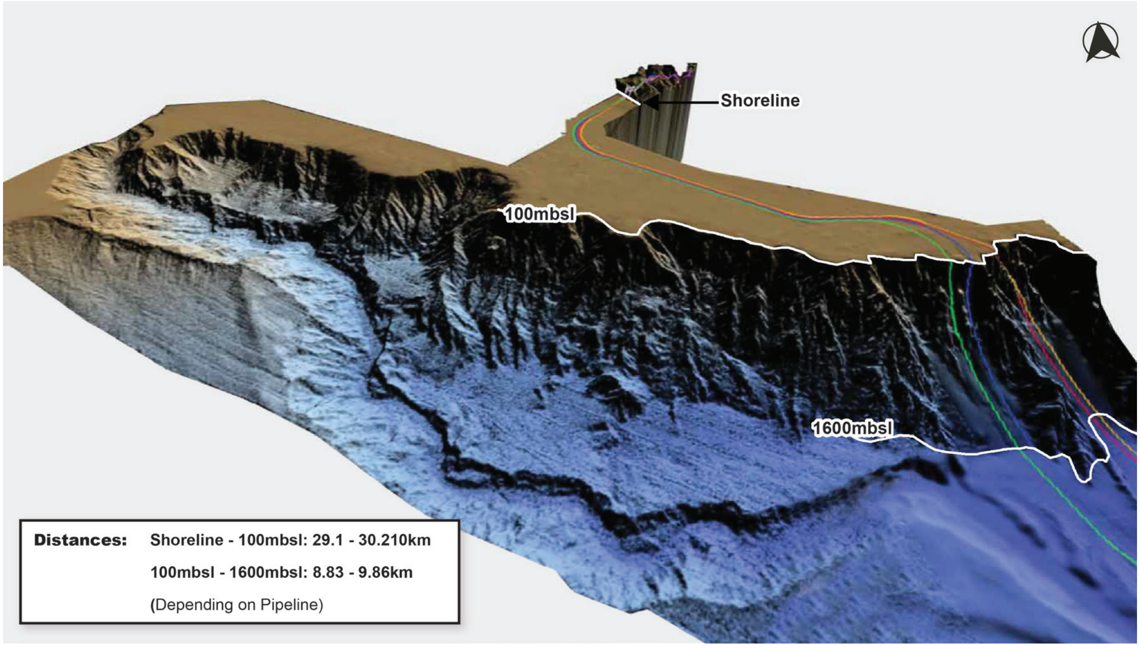
A corridor centred on a preliminary route alignment was surveyed between 2009 and 2011 to identify engineering and environmental constraints and marine archaeological features. The width of the corridor extended between 1.2 km and 2 km and up to 9 km in technically challenging areas such as the continental slope where the pipelines will be laid in separate canyons. Given the technical complexity associated with the identification of a continental slope crossing, this aspect was assessed first. After selecting a suitable continental slope crossing, the routes from the continental slope to the Anapa landfall (across the continental shelf and the shoreline) and the route across the abyssal plain to the border with the Turkish EEZ, were assessed.

4.5.4.1 Continental Slope Crossing

The continental slope is an unstable region where the depth of the sea rapidly changes and the seabed is generally characterised by unstable sediments, dynamic conditions (e.g. submarine slumps and sediment flows) and irregular morphology.

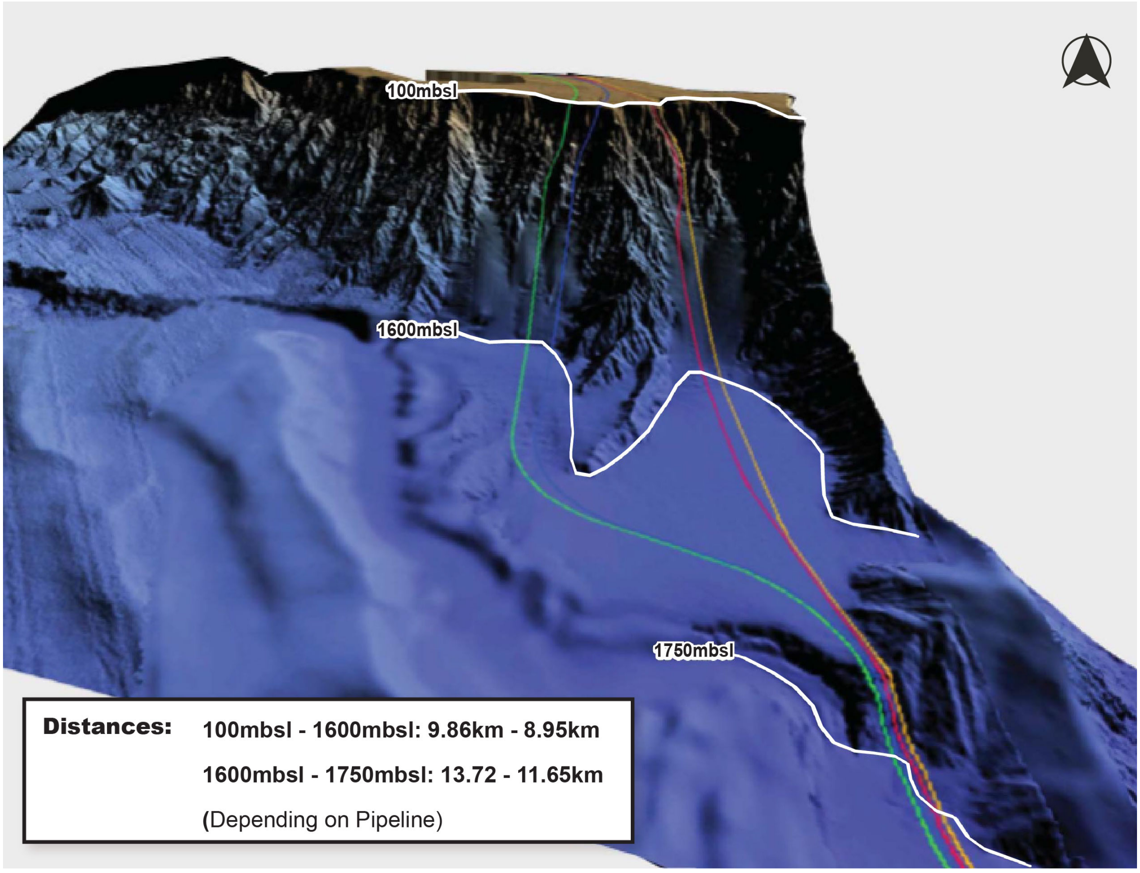
The continental slope near Anapa is characterised by an extensive network of canyons. The main canyon (known as the Anapa canyon) corresponds with the sediment transport path from the Sea of Azov to the Black Sea and is a relic feature of the estuaries of the Don and Kuban rivers. The Anapa canyon runs parallel to the Russian Black Sea coast. The northern slope of the Anapa canyon is steep and itself incised by smaller canyons. The floor of the canyon is further incised by a trough, which would have required a complex crossing. Throughout these morphological features of the seabed, sediment is unstable: massive sediment failures create turbid flows and submarine slumps, which could compromise the integrity of the pipeline. The rugged morphology associated with exposed rock outcrops and localised pockets of sediment also create stability and engineering challenges. For these reasons, extensive surveys were carried out to identify feasible crossing locations. Figure 4.4 shows the potential pipeline route through the Anapa Canyon.

Figure 4.4 Anapa Canyon Crossing



Two stable lateral canyons running down the continental slope were identified during the survey programme. On the basis of the width of the canyons, it was established that the best technical option included routing two pipelines in each canyon. Figure 4.5 shows the potential route of the four pipelines through these canyons diverging by up to approximately 4.8 km at the widest part.

Figure 4.5 Continental Slope Crossing



Having selected the preferred locations for crossing the continental slope, extensive geophysical and engineering surveys were carried out to identify both the safest routes across the continental slope and to determine if any environmental or cultural constraints were present along the preferred routes.

No significant environmental constraints that could influence the route selection were identified. The route selection process, therefore, progressed on the basis of technical feasibility and non-environmental sensitivities including a thorough review of the canyon's morphology and of the potential for the occurrence of geohazards and cultural heritage objects (CHO).

Three positively-identified CHOs are located on the continental slope. These three objects are not considered archaeological monuments, but are CHO ('science and technology objects') in accordance with Federal Law No.73-FZ dated June 25 2012. Furthermore, these objects were not in close proximity of the pipeline route and therefore did not influence the pipeline route selection. **Chapter 16 Cultural Heritage** provides further detail on these objects, their value and measures required to ensure their protection.

4.5.4.2 Continental Shelf Crossing

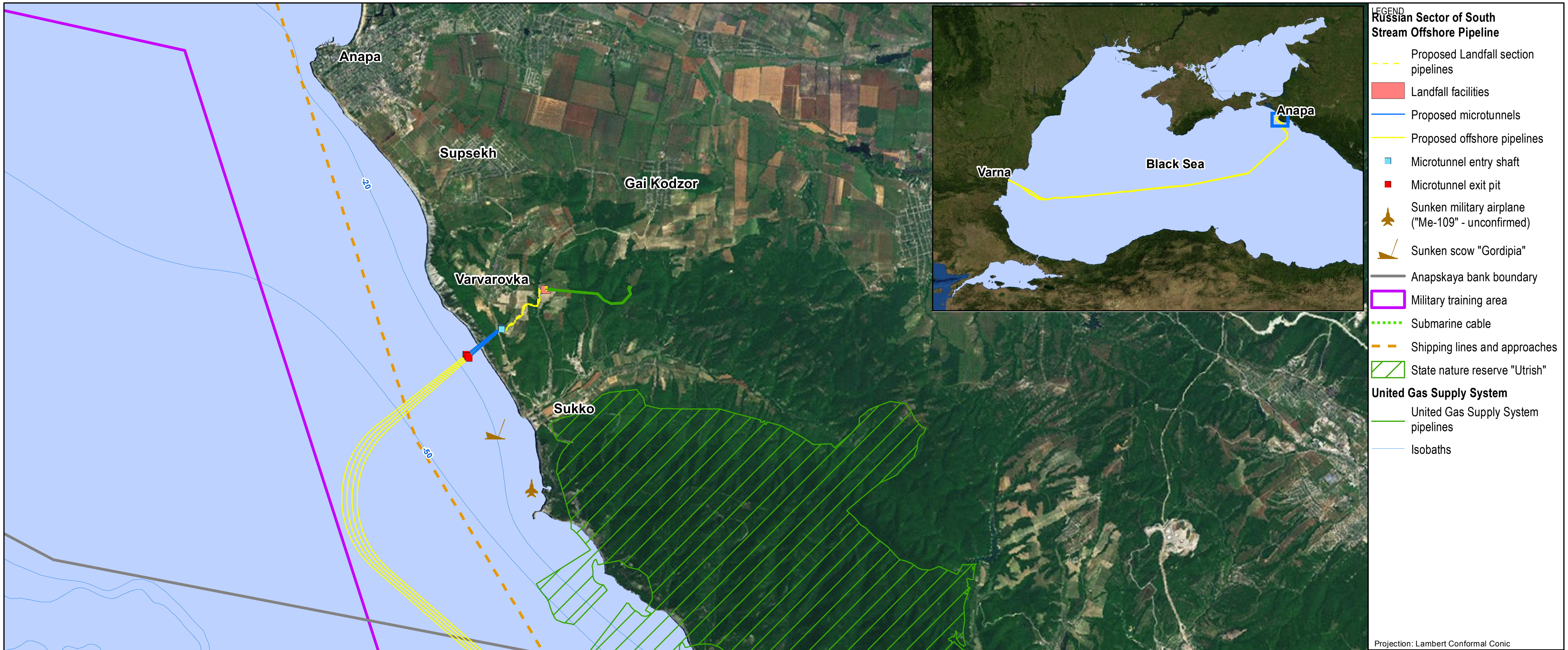
Currently known environmental, socio-economic and cultural heritage constraints on the continental shelf include environmental conservation areas in the shallow water environment (less than 20 m depth), military training areas, ammunition dumping grounds and shipping routes (Figure 4.6 and Figure 4.7). These areas were largely avoided during route selection.

Two further factors were considered in the assessment of alternative routes for crossing the Russian continental shelf:

1. The most sensitive marine habitats on the continental shelf are located at depths between 0 and 50 m; and
2. Below 30 m water depth, where conditions are stable, the risks from anchors and ships' hulls are minimal; and pipelines typically do not need to be buried. Consequently, trenching associated with the burial of pipeline is typically not required below 30 m water depth.

On the basis of the above considerations, the selected corridor runs parallel to the coast at a depth of more than 50 m for most of its length, therefore minimising any potential impacts on marine ecosystems from disturbance of water quality associated with dredging.

Marine habitat surveys were also carried out to validate the suitability of the chosen route (**Chapter 12 Marine Ecology**). These initial surveys, which have informed the assessment of impacts to the marine ecology, did not reveal any significant ecological sensitivities that warranted alteration of the route to minimise impacts.



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
NEARSHORE CONSTRAINTS MAP

Drawn	Checked	Approved	Date
DH	RW	MW	04/03/2014

URS Internal Project No.	Scale @ A3
46369082	1:125,000

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Drawing Number
Figure 4.6

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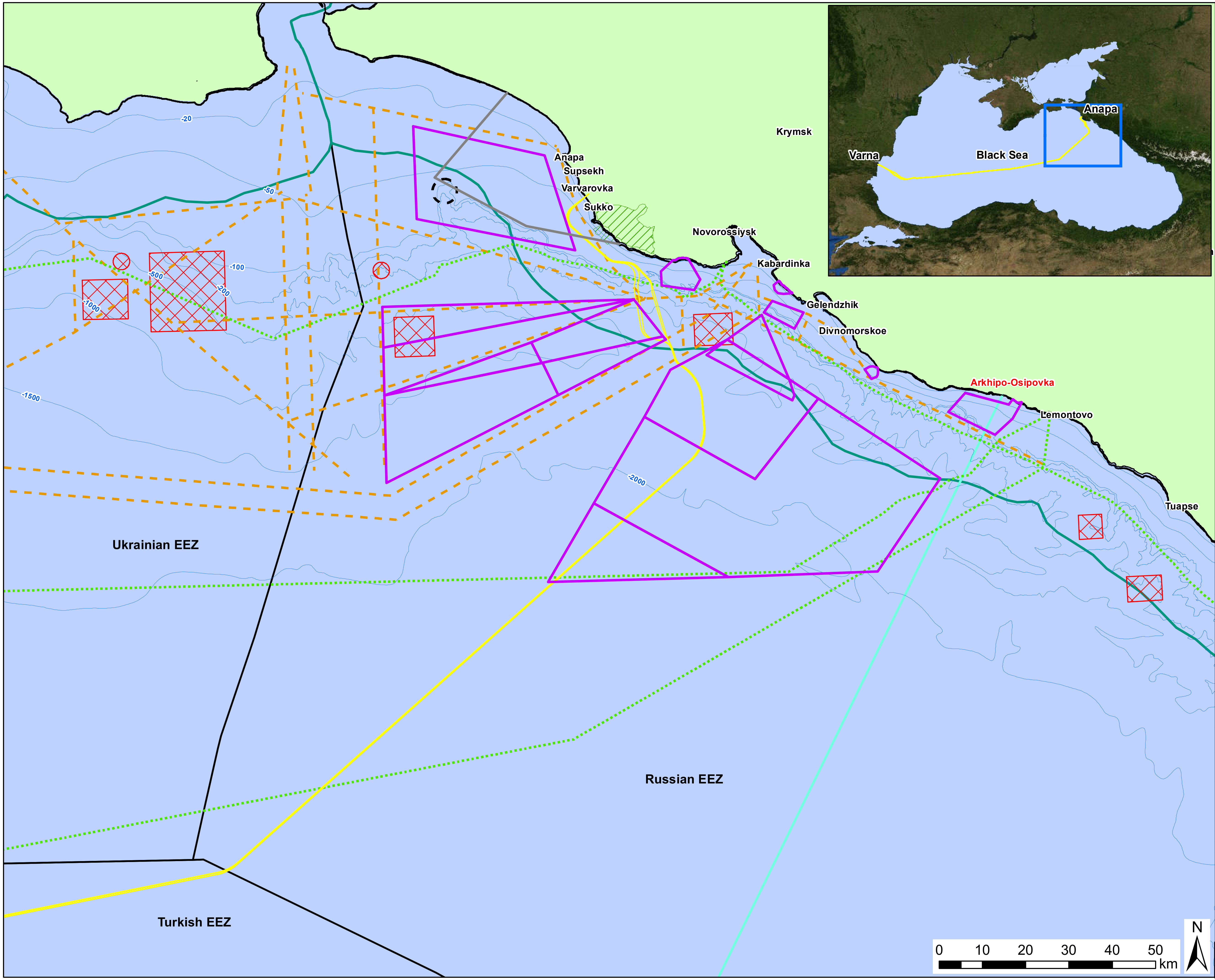
Plot Date: 04 Mar 2014
File Name:I:\5004 - Information Systems\46369082_South_Stream\MXDs\Report Maps - Russia\Russian ESIA\Chapter 4 Analysis of Alternatives of the Russian ESIA\Figure 4.6 Nearshore Constraints Map.mxd



LEGEND

Russian Sector of South Stream Offshore Pipeline

- Proposed offshore pipelines
- Anapskaya bank boundary
- Submarine cable
- Shipping lines and approaches
- Blue Stream pipeline (indicative)
- Territorial waters boundary
- Military training area
- Spoil deposit area
- Explosives dumping ground
- State nature reserve "Utrish"
- Exclusive Economic Zone boundary
- Isobaths

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: OFFSHORE CONSTRAINTS MAP

Drawn	Checked	Approved	Date
DH	RW	MW	04/03/2014

URS Internal Project No. 46369082

Scale @ A3 1:800,000

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Drawing Number: Figure 4.7

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Plot Date: 04 Mar 2014
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4.5.4.3 Abyssal Plain Crossing

Following selection of the continental slope crossing, a preliminary corridor was identified to route the pipelines across the abyssal plain to the border with the Turkish EEZ.

No significant engineering or social constraints were identified on the abyssal plain. In addition, there was very limited information available on the environmental constraints (e.g. marine ecosystems). Therefore, a straight line route was initially adopted.

The final route alignment was subsequently selected on the basis of further geophysical, environmental and cultural heritage surveys. The entire corridor was mapped and the geological, bathymetric and cultural features were recorded for further analysis.

Specifically, a thorough review of the seabed features was carried out to determine the presence of features of biological importance such as microbial mats and CHOs. The findings of this review are included in Appendix 7.1 Abyssal Plain Report.

Whereas no significant features of biological importance were identified, four potential CHOs have been identified on the abyssal plain within 150 m of the pipeline route and seabed intervention works[5]. These potential CHOs were first identified in side-scan sonar images and have been earmarked for visual inspection via submersible ROV to determine their identity and potential cultural significance, prior to construction of the pipeline (Ref. 4.4). A conservative approach has been taken to ensure that the objects are not impacted and route adjustments will therefore be made during the detailed design phase of the Project to maintain the 150 m buffer between the pipelines and the objects, regardless of their designation as CHOs. **Chapter 16 Cultural Heritage** discusses these objects, their potential value and measures required to ensure their protection in more detail.

4.6 Summary

This chapter summarises the Analysis of Alternatives performed initially by Gazprom during early feasibility studies and then by South Stream Transport as part of the South Stream Offshore Project, Russian Sector. To some extent, the nature and location of the Project was determined by factors beyond the control of South Stream Transport, particularly in respect of the location of the landfall section, which was constrained by the selection and siting of the Russkaya Compressor Station. Nevertheless, the Analysis of Alternatives has adopted a typical narrowing approach, starting with high level alternatives such as means of transporting gas across the Black Sea, honing in on more detailed consideration of alternatives, such as consideration of detailed pipeline routing. The flow diagram below summarises the analysis of alternatives process, including the rationale for discarding certain alternatives.

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[5] Seabed intervention works include all activities involving the disturbance of the seabed with the exception of pipe lay. For example, seabed intervention activities would include activities include rock placement to correct free span areas where the seabed is uneven, dredging, trenching, placement of support structures etc.

Figure 4.8 Summary Analysis of Alternatives (South Stream Offshore Project)

Options		Outcome and rationale
The 'no project' or Zero alternative (i.e. no transportation of gas via the Black Sea)	No Project vs **Project – gas export via the Black Sea**	Project Objective: as an integral part of the South Stream Offshore Pipeline to diversify supply routes for transportation of gas from Russia to Southern and Central Europe via the Black Sea, and to help meet projected increased demand for natural gas. If the Project does not proceed: • Impacts attributed to the Project would not occur, but other impacts associated with alternative transit routes would occur. • An opportunity to diversify gas supply routes will bemissed. • The risk of future gas supply interruptions and shortfalls in C&S Europe would be greater. **The 'No Project' option was dismissed**. Refer to Chapter 1 – the Project need.
Alternative means of gas transportation across the Black Sea	**Offshore Pipeline** vs LNG (LNG Plant, LNG carriers, regasification)	LNG could be exported to a new regasification facility in Romania, Bulgaria or beyond central and southern Europe, however: • Construction of unloading facilities and a regasification plant on the shore s of southern or central Europe is undesirable. • It is not the Project intent to export beyond central and southern Europe. • Transit through the Turkish Straits, for example to Italy, carries higher safety and environmental risks. **LNG dismissed on the grounds that a pipeline system was considered more safe and reliable avoiding the need for to construct a new regasification plant on the Black Sea coast/ship LNG through the Turkish Straits.**
Landfall – Russia (site selection)	**Anapa (greenfield site referred to as Russkaya CS)** vs Arkhipo-Osipovka (adjacent to the Blue Stream Beregovaya CS)	Driven by the need to have a large new build CS nearby – two sites identified by Gazprom were Anapa (Russkaya CS)and Arkhipo-Osipovka (close to Beregovaya CS) Studies performed by Gazprom concluded that a compressor station at the Anapa site would have less environmental impact. The cumulative impacts at Beregovaya were considered unacceptable. **Beregovaya was discarded due to concern over significant cumulative environmental impacts.**
Offshore routing (Macro alignment*)	**Option 1 - Anapa-Varna via Turkey EEZ** vs Option 2 - Anapa-Varna via Ukraine and Romania EEZ) Option 3 - Anapa-Constanta via Ukraine EEZ Option 4 - Anapa-Constanta via Turkey and Bulgaria EEZ	Option 2 and 3 were discarded because survey work would have resulted in schedule delays. Option 4, landing in Romania, was discarded after strategic transit agreements were made with Bulgarian entities. **Option 1 was the preferred alternative** selected for detailed route alignment studies after 1, 3 and 4 were discarded.
Shore crossing technique (Anapa, Russia)	Open cut trench vs **Microtunnel**	Open cut is typically less expensive, however open cut on a steep cliff face would be technically difficult and likely to result in environmental damage to a sensitive habitat. **Open cut discarded due to technical difficulties and risks to long term pipeline stability.**

References

Number	Reference
Ref. 4.1	Peter Gaz - A.V. Fedorenko Head of Safety and Environment Department et al., 2010. Social-Economical Feasibility Study for "South Stream" Gas Pipeline Project, Volume 17 - Environmental Impact Assessment. Russian Sector, Section 2 – Environmental Impacts Assessment on Alternative Options of Pipeline Route, Archive number: 6976.101.003.11.14.17.02-01(issued to replace 6976.101.003.11.14.17.02).
Ref. 4.2	Giprospetzgaz, 2010. Feasibility Study for the Offshore Section of the "South Stream" Project Pipeline, Volume 17 of the Environmental Impact Assessment (Russian Sector), Second Part of the Environmental Impact Assessment on Alternative Route Options for Pipeline (land area), Archive number: 6976.101.003.11.14.17.02-1 (replacement for 6976.101.003.11.14.17.02, St. Petersburg.
Ref. 4.3	Giprospetzgaz. 2010. Feasibility Study For Construction of South Stream Gas Pipeline, Volume 9: Route Evaluation. Part 3. Route Selection Manual. Archive No 6976.101.003.11.14.09.03-1 Instead of Archive No 6976.101.003.11.14.09.03
Ref. 4.4	Seascape Consultants Ltd. 2013. Interpretation of Seabed Survey Data for the South Stream Offshore Pipeline Project, Report No 2013/07.