Chapter 5: Project Description

URS-EIA-REP-204635

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5 Project Description

5.1 Introduction

This chapter of the Environmental and Social Impact Assessment (ESIA) Report describes the technical components of the Project and forms the basis for the assessment of impacts undertaken in the technical studies found in Chapters 8 to 21 of this ESIA Report. The physical aspects of the Project are set out in terms of the Construction, Pre-Commissioning, Operational, and Decommissioning Phases of the Project.

As described in Section 1.2 of **Chapter 1 Introduction**, the Project is the Russian Sector of the South Stream Offshore Pipeline, which itself, is the offshore component of the South Stream Pipeline System that will deliver natural gas from Russia to the countries of central and south-eastern Europe.

The Project commences at a pipeline tie-in (where two pipeline ends are welded together) approximately 100 m upstream of the landfall facilities, which connects the Project pipelines to the project known as "Expansion of the United Gas Supply System" that is being developed by Gazprom Invest. The landfall facilities will be connected to the Russkaya Compressor Station (CS) via four 3.2 kilometres (km) long onshore pipelines. The Russkaya CS, and the four connecting pipelines (upstream of the aforementioned tie-in location), are being developed by Gazprom Invest and are not part of the Project. The tie-ins to the "Expansion of the United Gas Supply System" are located approximately 10 km south of the town of Anapa, in the Krasnodar Krai (or region). See Section 5.2.1 for illustrative figures.

From the landfall facilities, the Project pipelines will extend in a generally south-westerly direction for approximately 2.4 km to four microtunnel entry shafts. The pipelines will continue in a south-westerly direction through microtunnels for approximately 1.4 km where they will emerge from the tunnels approximately 400 m offshore. Microtunnelling has been selected for the shore crossing predominantly due to the technical difficulties associated with the crossing of the high cliffs at the shore crossing location. Due to the steepness of the slope and the presence of rock, open-cut installation of the onshore pipeline across the sea cliffs is not feasible. The pipelines will then extend through Russian Territorial Waters and the Russian Exclusive Economic Zone (EEZ) for approximately 225 km in a generally south and south-westerly direction to the EEZ boundary of Russia and Turkey (the downstream boundary of the Project). From here, the South Stream Offshore Pipeline will continue across the Black Sea, via the Turkey and Bulgaria EEZ towards Varna in Bulgaria where it will make landfall.

The proposed route of the Pipeline was selected following an extensive analysis of alternatives as described in **Chapter 4 Analysis of Alternatives**. Final pipeline route alignments may be further optimised during the detailed design phase; however any such changes are not anticipated to result in changes to the impact assessments presented in technical Chapters 8-21 of this ESIA Report. Should any major changes to the pipeline routing be required, which may affect the results of the ESIA, the management of change process described in Section 5.11 will be followed.

As part of the Project design process, measures to avoid or minimise impacts were identified and incorporated into the design. These are referred to as design controls and include physical design features and management measures. They are based on Good International Industry Practice (GIIP) and are intended to avoid or control unacceptable impacts. Specific design controls are described in this Project Description. Their role in controlling impacts on environmental, social and cultural heritage impacts is further discussed in **Chapter 3 Impact Assessment Methodology**. Where the outcome of the ESIA indicates that design controls are insufficient to manage an impact to an acceptable level, further measures have been identified. These measures have been termed "mitigation measures" and are described in respective chapters and detailed in Environmental and Social Management Plans.

5.2 Project Components

The permanent Project components comprise of the following main elements:

- Four 32-inch (813 millimetre (mm)) diameter buried onshore steel pipelines approximately 100 metres (m) long from the tie-in to the "Expansion of the United Gas Supply System" to the landfall facilities;
- Four 32-inch (813 mm) diameter buried onshore steel pipelines approximately 2.4 km long from the landfall facilities to the microtunnel entry shafts;
- Four 2.5 m diameter, 1.4 km long microtunnels each housing one 32 inch (813 mm) steel pipeline from the microtunnel entry shafts to the offshore microtunnel exit pits;
- Four 32-inch (813 mm) diameter subsea steel pipelines, approximately 225 km in length, from the microtunnel exit pits to the border of the Russian and Turkish EEZ;
- Fenced landfall facilities (approximately 4.85 hectares (ha) in area), which will primarily consist of:
    - Metrology equipment;
    - Four Pipeline Inspection Gauge (PIG) trap facilities (one per pipeline);
    - Eight Emergency Shutdown (ESD) valves (two per pipeline);
    - Eight block valves (two per pipeline);
    - Other valve systems including ball line valves, and temperature control valves (TCV);
    - A gas heating system;
    - Four 24-inch (610 mm) diameter steel pipelines, each approximately 106 m long;
    - Pre-fabricated containers to provide office and storage space, sanitary facilities and house electrical and instrumentation (E&I) equipment;
    - A 21 m high vent stack and associated piping;
    - Isolations joints;
    - Two 10 kilovolt (kV) buried power cables connecting to the Russkaya CS;
    - Two buried fibre optic communication cables connecting to the Russkaya CS;
    - Rainwater drainage system;
- An area of cut and fill slopes (approximately 4.83 ha in area) surrounding the landfall facilities;
- Access road and car parking;

- Cathodic protection system, including an onshore anode bed;
- A permanent Right of Way (RoW) approximately 95 m wide above the landfall section trenched onshore pipelines;
- Exclusion zones extending to 410 m from the outermost landfall section pipelines and landfall facilities for the protection of public health and infrastructure; and
- A 0.5 km exclusion zone (either side of the centreline of the outermost pipelines - except for a section on the Russian continental slope where the pipelines diverge into two groups of two), extending from the seabed to the surface of the sea, and from the microtunnel exit pits to the Russian and Turkish EEZ boundary.

Further details on the permanent Project components are provided in Sections 5.2.4 and 5.2.5 and information on the Operational Phase safety exclusion zones are provided in Section 5.6.6 and 5.6.7. Information on the temporary facilities required for the construction of the permanent Project components is provided in Section 5.3.4.1.

5.2.1 Project Area

The Project Area (defined in Section 1.2.1 and illustrated in Figure 1.5) is subdivided into the following sections: landfall, nearshore and offshore, primarily in relation to the different construction activities employed in each section. The landfall, nearshore and offshore sections of the Project Area are shown in Figure 5.1 and Figure 5.2 respectively and are described below. Note that the Project Area sections are associated with the construction activities and have no ecological meaning.

5.2.1.1 Landfall Section

The landfall section of the Project Area, including the landfall facilities, is approximately 4 km in length. Within this section the pipelines will be buried for the first 100 m upstream of the landfall facilities and for 2.4 km downstream of the landfall facilities using open-cut construction techniques. For safety reasons the buried landfall section pipelines will have a minimum soil cover of 1.5 m. For the remaining 1.4 km each pipeline will be housed in a microtunnel which will terminate approximately 400 m from the coast in water depth of approximately 23 m. The permanent onshore landfall facilities (approximately 142 m wide) are also included within the landfall section.

The area of the landfall section is primarily defined by the maximum operational safety exclusion zone of 410 m width surrounding the Pipeline and the landfall facilities. While the entirety of this area may not experience physical impacts, there will be restrictions on future land use and development within the exclusion zone. Within this area, a 95 m operational pipeline RoW will be permanently established above the pipelines. Outside of the operational safety exclusion zone, the landfall section of the Project Area also includes a temporary construction access road, a bypass road that will be constructed for permanent use, but only used by the Project during the Construction Phase and potential temporary transfer site (if required by contractor). The temporary road will link the microtunnel construction site to a permanent access road being constructed by Gazprom Invest as part of the "Expansion of the United Gas Supply System".

The bypass road will link the Varvarovka – Gai Kodzor public road to Gazprom Invests' permanent access road, in order to provide an access road to the landfall facilities construction site. Refer to Section 5.3.3 and Figure 5.8 for further information on the permanent and temporary access roads required to support the Project.

5.2.1.2 Nearshore Section

The nearshore section of the Project Area commences at the exit point of the microtunnels, located approximately 400 m from the coast at a water depth of approximately 23 m and extends approximately 425 m out to a water depth of 30 m where an above water tie-in will be made following the completion of pre-commissioning activities of the landfall and nearshore section pipelines. From the microtunnel exit point the pipelines will be buried in trenches to a depth of approximately 2.5 - 3 m for a distance of approximately 170 m. From here, out to the edge of the nearshore section (30 m water depth), the pipelines will be coated in concrete and laid directly on the seabed. Concrete coating is to provide protection from third party activities and stability from sea currents. The pipelines are pre-coated before delivery to South Stream Transport.

5.2.1.3 Offshore Section

The offshore section of the Project Area extends from the edge of nearshore section at 30 m water depth (where an above water tie-in will be made) to the border of the Russian and Turkish EEZs in the Black Sea, passing through approximately 225 km of Russian waters, of which 50 km lie within Russian territorial waters and 175 km lie in the Russian EEZ. In the offshore section, the pipelines will be laid directly on the seabed. In the offshore section, the pipelines will be coated in concrete out to a water depth of approximately 88 m.

5.2.2 Associated Facilities

As described in **Chapter 1 Introduction**, the Project will rely on other facilities that are not under the direct control of South Stream Transport and typically located outside of the Project Area. In line with the OECD Common Approaches [1] definition for associated facilities these include *"facilities that are not a component of the project but that would not be constructed or expanded if the project did not exist and on whose existence the viability of the project depends; such facilities may be funded, owned, managed, constructed and operated by the buyer and/or project sponsor or separately from the project."* (Ref. 5.1). The Project associated facilities are consistent with this definition and include:

- The Russkaya Compressor Station (CS) located immediately upstream of the Project in Russia being developed and managed by Gazprom Invest; and
- Designated existing quarries for sourcing material / aggregates, where those existing quarries would require significant expansion for the sole purpose of supplying the Project.

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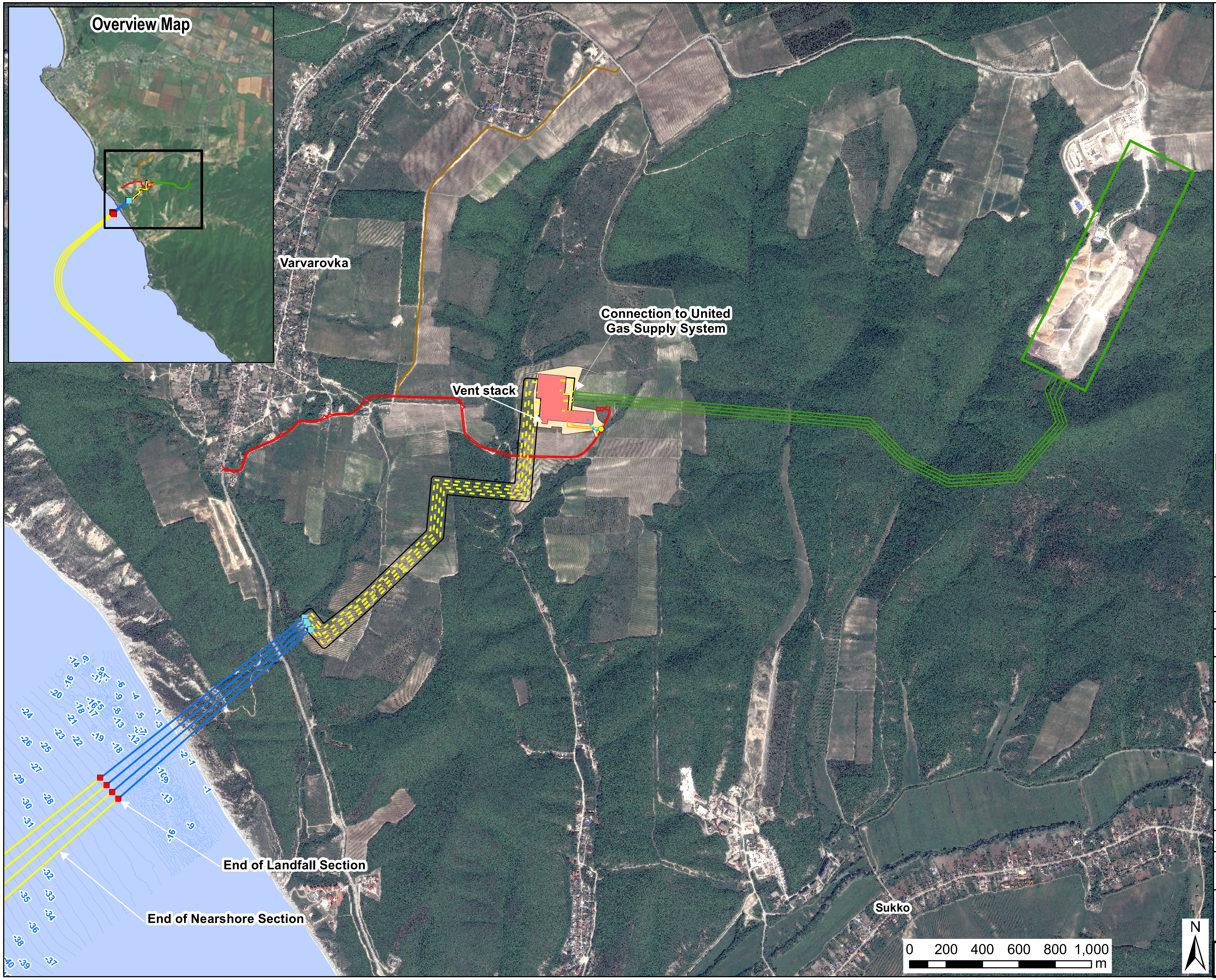
[1] OECD Common Approaches are the primary Environmental and Social Standards applicable to the Project. Further details are provided in **Chapter 2 Policy Regulatory and Administrative Framework**.



LEGEND

Russian Sector of South Stream Offshore Pipeline

- Proposed landfall section pipelines
- Landfall facilities
- Anode ground bed for cathodic protection of pipelines (indicative)
- Proposed microtunnels
- Proposed offshore pipelines
- Microtunnel entry shaft
- Microtunnel exit pit
- Right-of-Way
- Cut and fill side slopes
- Anode ground bed connection to landfall facilities (indicative)
- Permanent access road to be constructed by SSTTBV
- Varvarovka bypass road (used by Project during construction only)

United Gas Supply System

- United Gas Supply System pipelines
- Russkaya compressor station
- Permanent access road to be constructed by Gazprom Invest
- 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: LANDFALL AND NEARSHORE SECTIONS PIPELINE ROUTE

Drawn	Checked	Approved	Date
DH	RW	MW	28 Feb 2014

URS Internal Project No.	Scale @ A3
46369082	1:20,000

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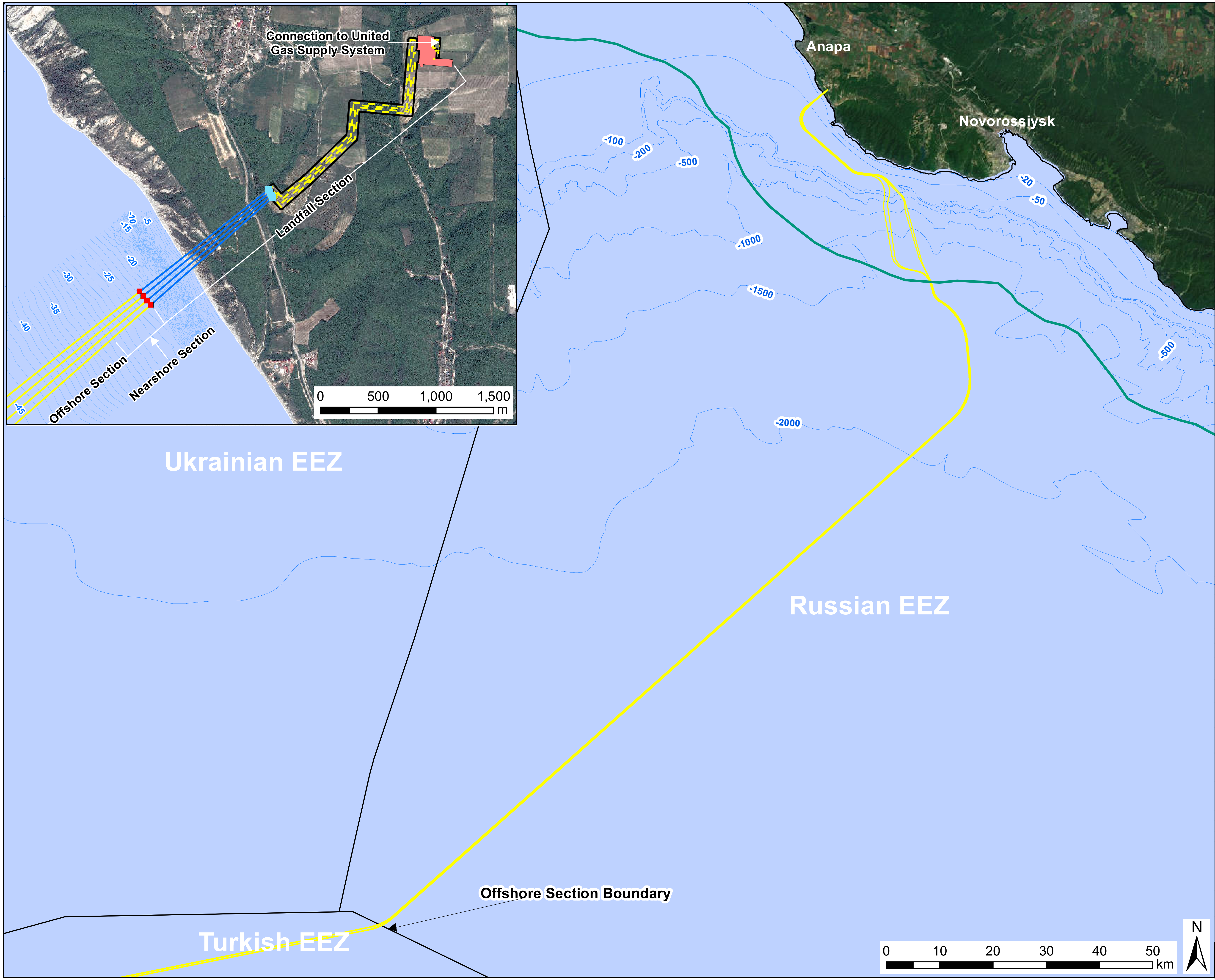
Drawing Number: Figure 5.1

Rev

Plot Date: 28 Feb 2014
File Name:I:\5004 - Information Systems\46369082_South_Stream\MXDs\Report Maps - Russia\Russian ESIA v2\Chapter 5 Project Description\Figure 5-1 Landfall and Nearshore Sections Pipeline Route.mxd



LEGEND

Russian Sector of South Stream Offshore Pipeline

- Proposed landfall section pipelines
- Landfall facilities
- Proposed microtunnels
- Proposed offshore pipelines
- Right-of-Way
- Microtunnel entry shaft
- Microtunnel exit pit
- Russian Territorial Waters boundary
- 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 — South Stream ENERGISING EUROPE

Project Title: SOUTH STREAM OFFSHORE PIPELINE

Drawing Title: OFFSHORE SECTION PIPELINE ROUTE

Drawn	Checked	Approved	Date
DH	RW	MW	18 Feb 2014

URS Internal Project No.	Scale @ A3
46369082	1:650,000

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Drawing Number: Figure 5.2

Rev

Plot Date: 18 Feb 2014
File Name:I:\5004 - Information Systems\46369082_South_Stream\MXDs\Report Maps - Russia\Russian ESIA v2\Chapter 5 Project Description\Figure 5-2 Offshore Section Pipeline Route.mxd

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There are existing Ports in Bulgaria that will be upgraded as part of the Project in order that they can be used as Marshalling Yards for the Project. Use of the Marshalling Yards is described further in Section 5.3.2.1.

5.2.3 The Russkaya Compressor Station

As described in **Chapter 1 Introduction**, the landfall facilities will be connected to the Russkaya CS via four 3.2 km onshore pipelines (Figure 5.1). The four 3.2 km connecting pipelines, and the Russkaya CS are not part of the Project, but will be designed and installed as part of a separate project known as the "Expansion of the United Gas Supply System", which is being constructed by Gazprom Invest. However, the CS provides the pressure necessary to drive gas through the Project pipelines across the Black Sea, and therefore it is considered to be an associated facility. The main elements of the Russkaya CS and its construction and operation are summarised briefly in this Section. The CS is described in more detail in Appendix 20.1.

According to the Russkaya EIA (Ref. 5.2), the Russkaya CS includes approximately 50 ha of permanent landtake for the CS facilities, and comprises the following main elements:

- Input pipelines and gas inlet unit that will connect the main gas pipeline with the gas treatment unit;
- Gas treatment unit that will treat gas by removing contaminants, such as solids, water and hydrocarbon condensate;
- Compressor works, that will comprise the gas pumping units (GPUs) with individual gas air cooling units;
- Gas flow-rate metering unit that will measure the commercial gas flow-rate and determine the chemical composition of the transported gas;
- Supporting facilities and utilities, such as access roads, a gas processing unit for internal power needs, power stations, a boiler unit for heat supply, water supply and treatment facilities, wastewater drainage and treatment facilities; and
- Materials and equipment depot (MED) to provide for storage of materials and equipment. The MED will include an entry area with changing rooms, heated warehouse, cooled warehouse, open storage area, automatic diesel power station, diesel storage tank and local treatment facilities for rainwater.

5.2.3.1 Inlet Unit

The inlet unit will connect the Russkaya CS to the upstream gas pipeline. A control unit will provide for safe operation of CS inlet unit and pipelines, protecting them from pressure fluctuations.

5.2.3.2 Gas Treatment Unit

The gas treatment unit will remove solids, water and hydrocarbon condensate in order to prevent contamination and erosion of the CS equipment and pipelines. Products of treatment will be transported for recycling / disposal at licensed facilities.

5.2.3.3 Gas Compressor Works

The compressor works will comprise 32 megawatt (MW) unit capacity gas pumping units (GPUs) equipped with full pressure turbo-compressors (Ref. 5.2). During Stage 1, the works will consist of seven GPUs. This will be expanded during Stage 2 to consist 14 GPUs which will increase the maximum total capacity to 448 MW, and the maximum processing capacity to 63 billion m^3/year (Ref. 5.3). Gas will be compressed at the CS for 24 hours a day, 7 days a week. The schedule for these two stages is summarised in Section 5.2.3.8.

5.2.3.4 Access Roads

A permanent access road will be constructed by Gazprom Invest to the Russkaya CS site. It is understood that this access road will have a permanent width of approximately 25 m (including shoulders) and will be hard surfaced. The construction corridor width for the road will be approximately 41 m wide. Temporary access roads will be constructed to the construction site and site accommodation, with temporary road surfacing of precast concrete slabs (Ref. 5.2).

5.2.3.5 Power Supply

The main power supply to the Russkaya CS will be a natural gas power plant, consisting of seven 1.5 MW gas turbines (five in duty, one reserve, one repair). An emergency automatic diesel power station will be used as a reserve source of power in case of a power cut (Ref. 5.2).

5.2.3.6 Water Demand and Supply

Construction

During construction, 7 m^3 per day of water will be required for production and engineering needs (Ref. 5.2). Water will be delivered from the existing water supply systems of nearby settlements and stored in a tanker.

Pre-Commissioning

The total demand for water for hydrotesting is estimated to be 3,000 m^3 (Ref. 5.2). To accumulate this volume, a temporary earthen insulated settling pit will be constructed near the Russkaya CS site. Water will be delivered to the site from existing supply systems in nearby settlements via trucks (Ref. 5.2).

Operation

During operations at the Russkaya CS it is estimated that approximately 152 m^3 per day of water will be required for use in the CS plant, household and potable needs, and for watering the area (Ref. 5.2). Water will not be used in the main technical processes at the CS.

5.2.3.7 Landfill and Waste Facilities

According to the Russkaya EIA (Ref. 5.2), contracts will be signed with licensed organisations for waste recycling, disposal, and reprocessing prior to the commencement of construction and operation of the Russkaya CS.

Construction

Construction waste will comprise solid refuse waste, vegetation and mineral soil surplus, stumps and cutting debris, and will be transported to approved sites. The total amount of construction waste generated is predicted to be approximately 502,484.5 tons (Ref. 5.2).

Operation

All industrial and domestic wastes produced during CS operation will be incinerated at the station site or transferred to licensed facilities. The annual amount of waste generated at the site is predicted to be approximately 164.6 tons (Ref. 5.2).

5.2.3.8 Construction Phase

Indicative Construction Schedule

The main construction period for Stage 1 of the Russkaya CS is estimated to be 34 months, from early 2013 until approximately October 2015. Stage 2 of the construction is estimated at 34 months, with completion in 2018 (Ref. 5.2).

Construction Works

Construction Materials

During the preparatory period, quarry soil will be transported to site via trucks and used to install temporary platforms and roads, and to maintain roads used during the construction phase (Ref. 5.2). Industrial equipment, pipes, soil, construction cargo, and labourers will all be transported to site by vehicles.

5.2.3.9 Pre-Commissioning, Commissioning and Operation

The Pre-Commissioning phase will involve testing the pipelines for durability and checking for leaks using the hydraulic method.

Process discharge of gas will be performed during the commissioning stage.

During operation, gas will be transported through the Russkaya CS via the following sequence: supply, treatment, compression, cooling and metering. Operational procedures centre on monitoring and maintenance of the CS facilities.

5.2.4 Pipeline Routing, Spacing and Operational Exclusion Zones

In general the four pipelines shall be laid parallel to each other in such a fashion that minimises the overall pipeline length and extent of the onshore RoW and offshore exclusion zones. However, detailed design engineering may require some final deviations to the design should any changes be required they are anticipated to be minor and are not anticipated to alter the results of this ESIA Report. Should any major changes to the pipeline routing be required, which may affect the results of the ESIA Report, the management of change process described in Section 5.11 will be followed.

In the landfall section of the Project Area, the distance between the pipelines in open-cut trenches is approximately 19 m. However, the spacing between the pipelines housed in the microtunnels increases from 26 m at the entry shafts to approximately 50 m at the exit pits located approximately 400 m from the coast. Throughout the nearshore and offshore sections, the pipeline spacing will range between 50 and 4,300 m (where the pipelines diverge down two canyons on the continental slope) measured from the centreline of the pipelines, although in general they are approximately 100 m apart.

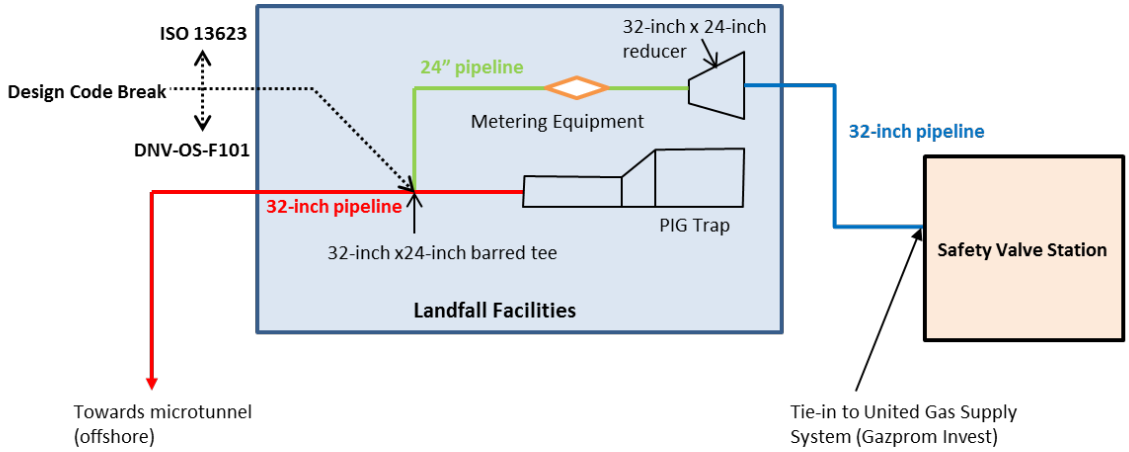
Operational Phase exclusion zones and permanent land take is required to ensure the safety of the landfall section pipelines. The permanent RoW will be approximately 95 m wide (19 m either side of the centreline of the two outside pipelines and 19 m between the centreline of each pipeline). In addition to the permanent RoW there will be three Safety Exclusion Zones for the protection of public health and infrastructure, which go out to a maximum distance of 410 m from the outermost pipelines and landfall facilities. Further information on permanent land use and onshore exclusion zones are provided in Section 5.6.6.

During the Operational Phase of the Project an exclusion zone of 0.5 km either side of the outermost pipelines will be put in place above the offshore and nearshore section pipelines for the entire length of the pipelines within the Russian EEZ (except for a section on the Russian continental slope where the pipelines diverge into two groups of two). This will restrict activities that may damage the pipelines. Further information on the offshore exclusion zones is provided in Section 5.6.7.

5.2.5 Permanent Landfall Facilities

The landfall facilities will occupy an area of approximately 4.85 hectares (ha). The areas of cut and fill side slopes surrounding the landfall facilities are approximately 4.83 ha. The location of the landfall facilities is shown in Figure 5.2 and the indicative layout of the equipment is shown in Figure 5.3 and Figure 5.4.

Figure 5.3 Landfall Facilities 32-Inch and 24-Inch Pipelines Design Break



Within the landfall facilities there will be pipe and equipment installed both above and below ground as illustrated in Figure 5.5.

The main components of the landfall facilities are the metrology equipment for monitoring the operations at the landfall facilities (gas temperatures, pressures etc.), PIG traps, electrical heating system, a venting system for pipeline depressurisation and customised pre-fabricated containers, that will serve various purposes including providing office space, sanitary facilities and housing E&I equipment to monitor the operating conditions of the pipelines. The final number and dimensions of the containers will be confirmed during the detailed design phase. However, this is not anticipated to affect the result of the impact assessments reported in Chapters 8-21 of this ESIA Report.

The landfall facilities will also include a number of valve systems including ESD valves, block valves, ball line valves, temperature control valves (TCV) and flow control valves (FCV).

Within the landfall facilities, each 32-inch pipeline will pass through a reducer (32-inch x 24-inch) which decreases the pipeline diameter to 24-inch, leading to a 32-inch x 24-inch barred tee (a type of T-shaped pipe fitting) upstream of the PIG traps. The 24-inch pipeline is required in order to connect to the metrology equipment. From the barred tee, the 32-inch pipeline diverges. In one direction the pipeline leads to a PIG trap and in the other direction the pipeline continues downstream through the landfall facilities as can be seen in Figure 5.4. A schematic of this process is shown in Figure 5.3.

The landfall facilities will be provided with power by buried cables which will run from the Russkaya CS to the landfall facilities. A fire and gas detection system will also be installed at the landfall facilities. The landfall facilities will be unmanned, except during maintenance activities, and will be controlled from a Central Control Room (CCR) and a Back Up Control Room (BUCR) located in Amsterdam.

The main elements of the landfall facilities are described in the following sections and permanent access routes to the landfall facilities are described in Section 5.3.3. Further information on permanent land take requirements for the Pipeline is provided in Section 5.6.6.

5.2.5.1 Monitoring Equipment

The E&I equipment required to monitor the operation of the South Stream Offshore Pipeline will be housed in customised pre-fabricated containers located with the landfall facilities. The monitoring equipment will continuously measure the gas composition (including water and hydrocarbon dew point), temperature, flow rate and pressure of the gas being transported. It is anticipated that approximately five containers may be required to house the necessary E&I equipment.

5.2.5.2 Emergency Shutdown Valves

Consistent with GIIP, the landfall facilities in Russia will have local ESD valves installed for each pipeline. An ESD valve is a hydraulic actuated and spring return valve designed to stop the flow of a hazardous substance (i.e. the gas) upon the detection of a potentially dangerous event or non-standard operating conditions. The ESD valves will quickly enable the offshore section pipeline to be isolated from the landfall facilities in case of a rupture or leak. This minimises risk of possible harm to people, equipment or the environment. The ESD valves will be located in below ground concrete pits and are designed to operate in the event of plant malfunction or fire. The location of the inlet and outlet ESD valves are shown in Figure 5.4.

5.2.5.3 Block Valves

Each pipeline within the landfall facilities will be equipped with block valves. The block valves enable a segment of the pipeline to be isolated for maintenance work. Block valves are not as quickly operated (opened / closed) as the ESD valves described above, which are used in response to an emergency situation.

5.2.5.4 Pipeline Inspection Gauge Trap Facilities

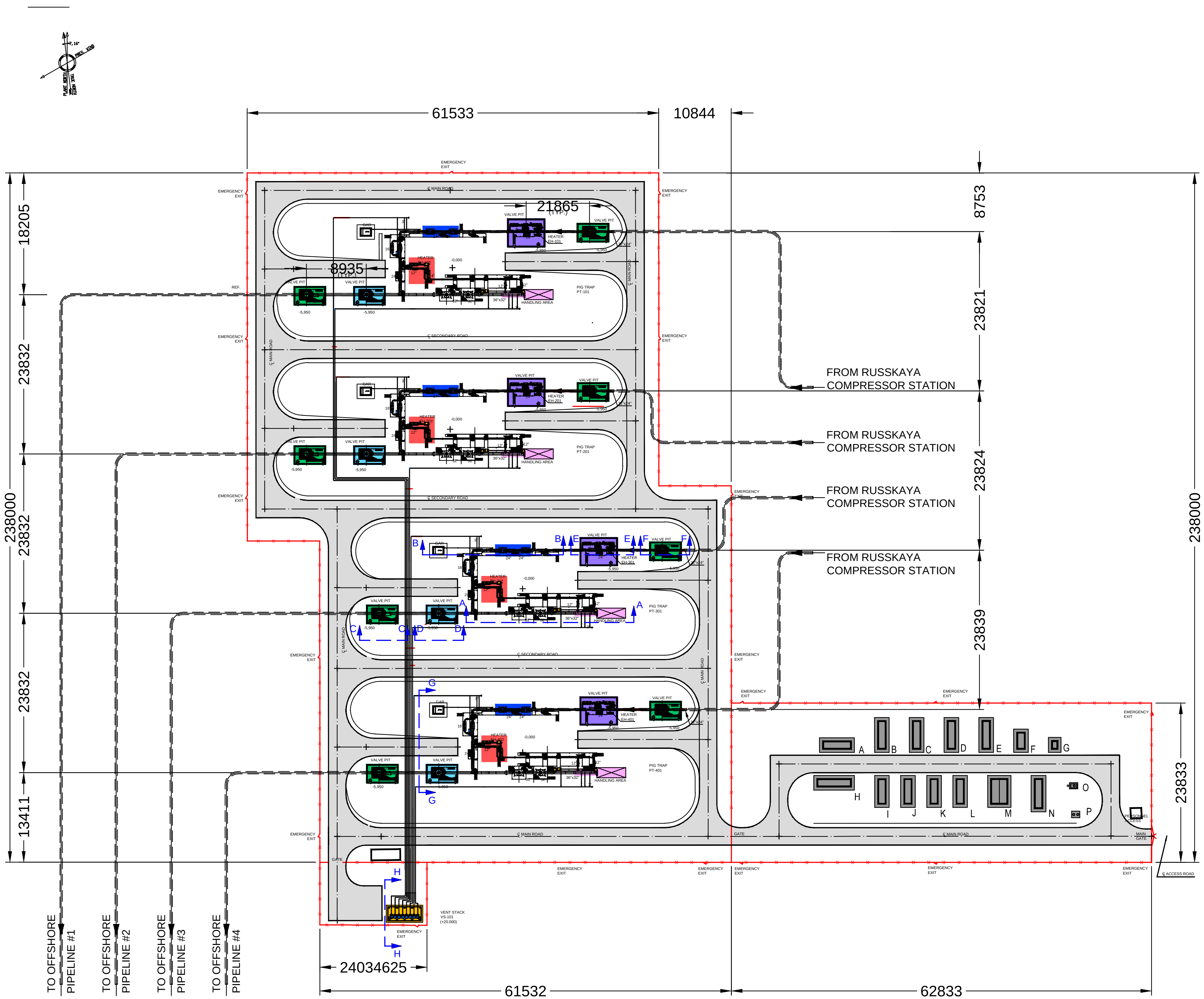
A bidirectional PIG trap will be constructed for each 32-inch pipeline. PIG traps are used for inserting PIGs into a pipeline then launching, receiving, and finally removing them without flow interruption. The PIG trap will be used to send and receive PIGs during pre-commissioning tests and to receive PIGs during maintenance activities in the Operational Phase. PIGs are used for activities such as checking for defects (gauging), cleaning, drying and inspection of the inside of the pipeline.

5.2.5.5 Gas Heating System

A gas heating system will be employed to heat the gas to maintain the temperature of the gas above the minimum design requirements of -10°C. This heating system will not be required on a continuous basis and will only be employed during start-up operations following a planned or emergency shutdown event and at certain gas throughput quantities. It is estimated that the heaters will be required to operate for between one and three days during start-up operations depending on the size of heater used and length of shutdown period.

5.2.5.6 Vent System

The venting system is designed for venting the gaseous inventory of the pipework within the landfall facilities to the atmosphere (to depressurise) via eight 3-inch vent pipes in cases of planned shutdown of the pipelines. Each of the vent pipes will be mounted to a single 21 m high vent stack. For safety purposes, the location of the vent stack structure is chosen such that the prevailing wind blows gas away from the landfall facilities. Consequently the vent stack will be located approximately 70 m from the nearest pipework within the landfall facilities. Flow of gas to the vent stack is controlled by blow down valves (BDV). The BDV is a fail-safe actuated valve with downstream piping leading to a local vent pipe. During normal operations, the vent stack will not emit any gas. Venting will only take place during planned maintenance or shutdown activities that may require gas within certain areas of the landfall facilities to be released to atmosphere. The vent stack will be fitted with appropriately designed silencers to reduce the noise associated with the venting process. There will be no flaring from the vent stack.



RUSSIAN SECTOR OF THE SOUTH STREAM OFFSHORE PIPELINE

LEGEND:

GAR = GAS ANALYZING ROOM

SECURITY FENCING

CONCRETE VALVE PIT. CONTAINS:
- EMERGENCY SHUT DOWN VALVE
- ELECTRICAL CASTLINE HEATER
- TEMPERATURE CONTROL VALVE

EMERGENCY SHUTDOWN VALVE (IN CONCRETE PIT)

BLOCK VALVE (IN CONCRETE PIT)

GAS HEATING BYPASS SYSTEM. CONTAINS:
- ELECTRICAL CASTLINE HEATER
- TEMPERATURE CONTROL VALVE

METROLOGY EQUIPMENT

PIPELINE INSPECTION GAUGE (PIG) TRAP

VENT STACK

PRE-FABRICATED CONTAINERS AND PORTAKABINS

A. COMMON ELECTRICAL AND INSTRUMENTATION ROOM
B. ELECTRICAL AND INSTRUMENTATION ROOM PIPELINE 1
C. ELECTRICAL AND INSTRUMENTATION ROOM PIPELINE 2
D. ELECTRICAL AND INSTRUMENTATION ROOM PIPELINE 3
E. ELECTRICAL AND INSTRUMENTATION ROOM PIPELINE 4
F. MEASURING ROOM
G. CP CONTAINER
H. COMMON LOCAL CONTROL ROOM
I. MEETING / STAFF ROOM
J. MEETING / STAFF ROOM
K. OPERATORS ROOM
L. STORAGE FOR SPARE PARTS
M. TRANSFORMERS
N. DIESEL GENERATOR
O. DIESEL STORAGE TANK (9 m³)
P. DIESEL DISCHARGE TANK (1 m³)

ROADS

NOTES

1. ALL DIMENSIONS ARE IN mm.
2. VALVE PITS ARE PROVIDED FOR ISOLATION AND ESD-VALVES.
3. PIPELINE CONSTRUCTION SEQUENCE: #1, #2, #3, #4.

Projection: Lambert Conformal Conic

Revision Details	By / Check	Date	Suffix

Purpose of issue: For Information

Client: South Stream Offshore Pipeline — ENERGISING EUROPE

Project Title: SOUTH STREAM OFFSHORE PIPELINE

Drawing Title: Indicative Landfall Facilities Layout

Designed	Drawn	Checked	Approved	Date
RW	OAS	MJW		20/11/13

URS Internal Project No. 46369078 — Scale @ A3 1:1500

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Drawing Number: Figure 5.4 — Rev

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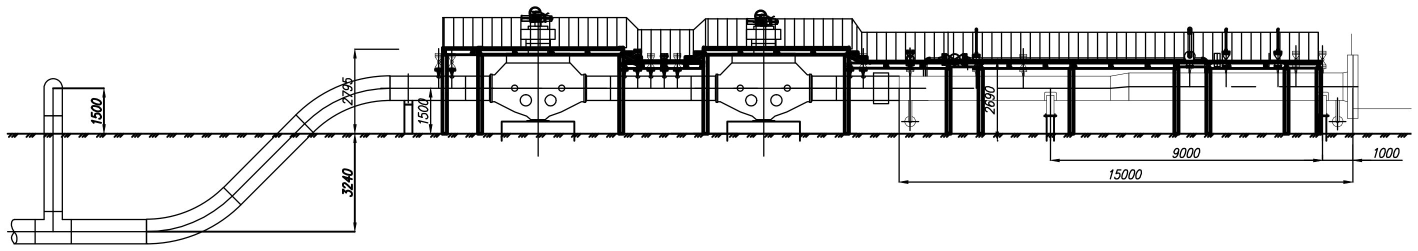
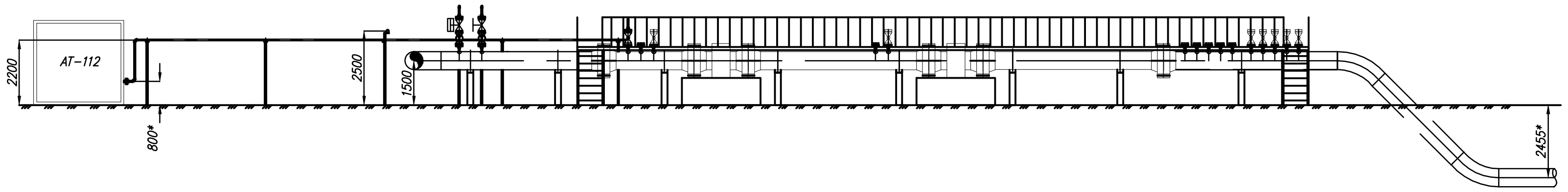


SECTION A-A

Scale 1:250



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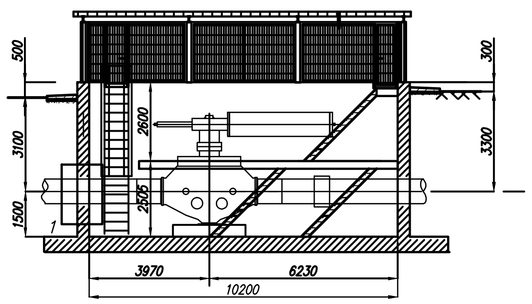

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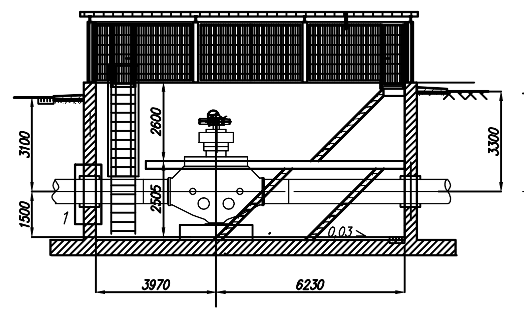

SECTION D-D

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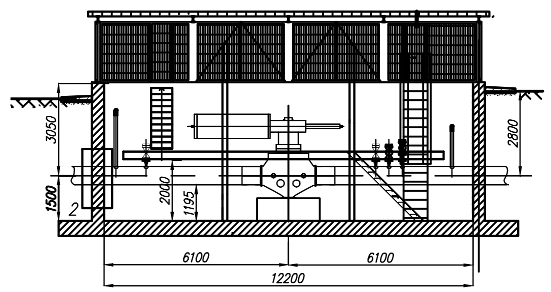

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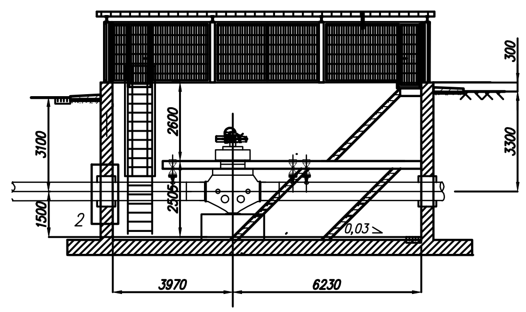

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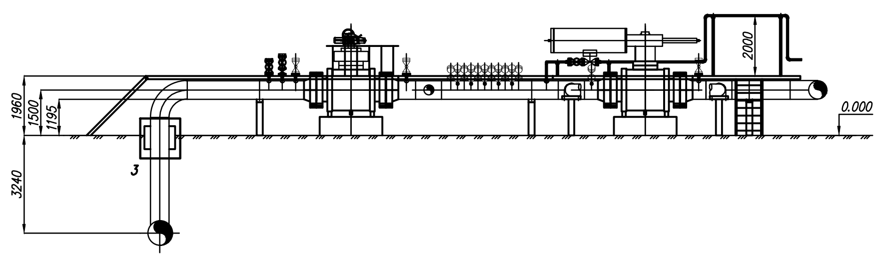
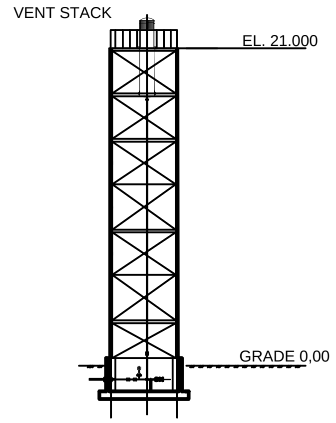


SECTION G-G

Scale 1:250



SECTION H-H

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RUSSIAN SECTOR OF THE SOUTH STREAM OFFSHORE PIPELINE

NOTES

1. ALL DIMENSIONS ARE IN mm.
2. VALVE PITS ARE PROVIDED FOR ISOLATION AND ESD-VALVES.

Projection: Lambert Conformal Conic

Revision Details	By / Check	Date	Suffix

Purpose of issue

For Information

Client

South Stream Offshore Pipeline — Energising Europe

Project Title

SOUTH STREAM OFFSHORE PIPELINE

Drawing Title

Indicative Landfall Facilities Elevations

Designed	Drawn	Checked	Approved	Date
RW	OAS	MJW		19/03/14

URS Internal Project No. 46369078

Scale @ A3 As Shown

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Drawing Number: Figure 5.5

Rev

5.2.5.7 Auxiliary Facilities

Fire and Gas Detection System

The purpose of the Fire and Gas (F&G) detection system is to protect and alert personnel and assets from the consequences of a fire and/or gas release. The F&G detection system is a safeguarding system which acts completely autonomously from other safety systems. The landfall facilities F&G detection system will include a number of strategically placed gas, flame and smoke detectors. The containers housing the E&I equipment will also be fitted with gas, flame and smoke detection systems as appropriate.

In an emergency case the landfall facilities will be isolated from the offshore pipeline and Russkaya CS in Russia and the Receiving Terminal in Bulgaria. There is no requirement for emergency venting (i.e. venting is not part of the ESD logic). However, provisions exist to enable a manual depressurisation of the landfall facilities, if required.

Provisions for active firefighting activities exposing personnel are not foreseen for fire protection of the equipment within the landfall facilities as water based extinguishing systems are not considered an effective measure to extinguish or even mitigate the effects of gas fires on gas containing equipment. Main piping will be installed underground as much as possible and ESD valves will be installed in pits to minimise exposure to fire and explosion events, and therefore minimise the potential for escalation. The containers housing the E&I equipment will be provided with automated gaseous extinguishing systems in accordance with applicable fire protection codes and standards. As the rooms in the containers will be occasionally occupied by electrical/instrumentation personnel, signs and warning systems shall be in place to ensure personnel do not enter or get trapped in the rooms when the system is activated upon fire detection. The containers Heating Ventilation Air Conditioning (HVAC) system will be provided with fire dampers, to be closed prior to activation of the extinguishing system. This will ensure the effectiveness of the extinguishing system and prevent migration of inert gas to other areas.

During a gas venting event (for example during a process shut down for maintenance) there is a risk that the gas cloud could ignite at the vent stack. If this occurs, the gas supply to the vent stack will be stopped.

Security Systems

The perimeter of the landfall facilities will be secured by chain-link fencing. An intrusion detection system with Closed-Circuit Television (CCTV) and presence detection will also be installed at the landfall facilities. The CCTV and presence detection will be monitored from the CCR. The CCR will also have a constant and secure communication link with operational staff located at the Russkaya CS (operated by Gazprom Invest) who will be alerted to an incident if necessary.

A Security Plan is currently being developed by South Stream Transport as part of the Health, Safety, Security and Environmental Integrated Management System (HSSE-IMS). The Security Plan will define the detailed management and security measures to be employed for the Project. Further information on the management plans that will be produced for the Project is provided in **Chapter 22 Environmental and Social Management.**

5.2.5.8 Utilities

Electrical Power Supply

During operation, the landfall facilities will be provided with 400 kW of electrical power, provided via two 10 kV buried cables which will run from the Russkaya CS to the landfall facilities. Transformers will be provided within the landfall facilities to adjust the electricity supply as required for the operation of systems and equipment.

In addition, emergency power supply provisions are provided at the landfall facilities to support critical electrical systems following the loss of normal power supplies. It will be supplied by an emergency power generator and batteries (uninterruptible power supply). The emergency power generator is a diesel generator with integrated diesel storage for several days of power supply.

Emergency power is provided so that essential safety systems can still function and maintain safe conditions following the loss of normal power supplies. These systems are primarily those associated with control and monitoring, emergency shutdown, F&G detection systems and communication.

Water

There is no process water demand at the landfall facilities and there will be no service water connection to a mains supply. Potable water for domestic consumption will be provided through a drinking water dispenser or bottled water that will be brought in when required for personnel. Water is not required for firefighting.

Wastewater

No sewerage connection is required for the landfall facilities as chemical toilets will be used. Proprietary service will be contracted for toilet emptying for disposal off-site, and maintenance of chemical toilets. The only water collected during the Operational Phase will be rain water run-off from hardstanding areas.

The run-off will be guided via engineered sloped surfaces and a system of drainage channels which will flow towards the south-eastern corner of the landfall facilities. The collected water will be filtered by sand traps and pass through an oil-water separator before being discharged into the nearby gully, Graphova Gap, which is a tributary of the Sukko River.

Systems and equipment using liquid fuels or chemicals, for example the emergency back-up diesel generator, will be provided with impermeable bunding to contain any leaks/spills as an integral part of the design. Any rainwater drainage from these areas will be directed through an oil-water separator prior to being discharged.

Any waste water arising from operational maintenance activities (e.g. pigging of pipelines) will be collected on site in tanks and transported from site by an appropriately licensed waste hauler to an appropriate waste treatment site in accordance with current waste management regulations.

Waste

No waste will be produced at the landfall facilities during normal operating conditions as the landfall facilities will be unmanned. Low volumes of waste will be generated during maintenance activities (for example during pigging of the pipelines). This will be collected and taken-off site and disposed of at an appropriately licensed waste treatment site in accordance with current waste management regulations. A description of potential waste streams generated during the Operational Phase is provided in **Chapter 18 Waste Management.**

5.2.5.9 Telecommunication System

The landfall facilities will be equipped with a Telecommunication System (TCS). The TCS will be designed to operate under normal conditions with minimum operator actions required. As the distance between the landfall facilities in Bulgaria and the landfall facilities in Russia is in excess of 900 km, and the location of the CCR and BUCR in Amsterdam is also a significant distance from the landfall facilities, a dedicated South Stream Offshore Pipeline telecommunication network infrastructure (e.g. use of fibre optic cables) is not considered feasible.

It is proposed that a service with high availability in combination with high bandwidth is used. Thus a broadband internet connection (Digital Subscriber Line (DSL)) will be used as the primary transmission technique and data path for the TCS. A satellite connection (Very Small Aperture Terminal (VSAT)) will provide a backup transmission technique. The TCS will automatically switch back and forth between data paths, based on failure and recovery from failure of data paths. The landfall facilities will also be equipped with an Ultra High Frequency (UHF) radio system to enable two-way indoor and outdoor communication at the landfall facilities where no fixed telephone system is available. The mobile network (Global System for Mobile Communications (GSM)) will be used to supplement the telephone network but is not part of the TCS due to limited bandwidth.

Telecommunication links between the Project and the "Expansion of the United Gas Supply System" will be made via two buried fibre optic cables connecting the landfall facilities and Russkaya CS. The connection between the fibre optic cables installed by South Stream Transport and Gazprom Invest will be made at the Telemechanic Valve Station being developed by Gazprom Invest approximately 300 m upstream from the landfall facilities. The fibre optic cables will allow bi-directional information exchange to take place between the landfall facilities and Russkaya CS and wider South Stream Offshore Pipeline facilities such as the CCR in Amsterdam. Information to be exchanged includes safeguarding signals (e.g. if a shutdown is taking place), process control data (e.g. changes in flow rates, valves opening/closing) and security information (e.g. a security alert as a result of a security breach).

5.2.6 Design Philosophy

The South Stream Offshore Pipeline (including the Project) has a design life of 50 years. The overall design philosophy is to ensure that the South Stream Offshore Pipeline is in compliance with internationally recognised standards for the design, material use, fabrication, installation, testing, commissioning, operation and maintenance of pipeline systems. Furthermore, the design aims to minimise impacts to the environment and communities.

5.2.6.1 Pipeline System Design Codes and Standards

The Project will be undertaken in compliance with national and internationally recognised standards for the design, material use, fabrication, installation, testing, commissioning, operation and maintenance of pipeline systems. The Project will comply with Russian Federation national legislation, spatial planning (detailed development plans), investment design, construction permit and other related permits.

The Project will be designed in accordance with recognised and respected pipeline industry standards.

In addition, a Project Specific Design Code (PSDC) will be prepared for the Project, which is intended to reconcile the design with Russian requirements. The PSDC for the Project will be developed during the detailed design stage and will be primarily based on DNV-OS-F101 (2010).

DNV will certify that the offshore gas pipeline is compliant with its internationally-recognised offshore design code Offshore Standard DNV-OS-F101, which is harmonised with ISO 13623:2009 and other relevant ISO standards. This design code has been used for 65% of offshore pipelines worldwide, including Blue Stream, which connects Russia with Turkey across the Black Sea, and Nord Stream, which is the only high pressure offshore pipeline constructed in the Baltic Sea.

5.2.6.2 Pipeline Design Parameters and Gas Properties

System Export Capacity

When fully operational the Project will have a design export capacity of 63 Billion Cubic Meters (BCM) per year. Each of the four pipelines will have an export capacity of 15.75 BCM and a daily flow rate of approximately 47.9 Million Standard Cubic Metres (MMSCM) per day.

The entire South Stream Offshore Pipeline, including the Russian sector, will have a design pressure of 300 bar, although the expected maximum operating pressure is anticipated to be approximately 284 bar. The operating pressure of the South Stream Offshore Pipeline will vary across its length, particularly in relation to friction inside the pipelines and ambient temperature conditions surrounding the pipelines. The operating temperature of the gas will be approximately 50°C at the upstream end of the Project pipelines and will gradually fall as the gas moves further offshore through the pipeline. By the time the gas makes landfall in Bulgaria the arrival operating pressure will have fallen to between 65 and 87 bar (if the South Stream Offshore Pipeline is operating at maximum flow rate).

The operating temperature of the gas on arrival in Bulgaria will normally be approximately -5°C. However, during extreme winter conditions there is potential for the gas temperature to fall to -8°C and as such, the pipelines have been designed to a minimum temperature of -10°C.

The South Stream Offshore Pipeline operating data is summarised in Table 5.1.

Table 5.1 Summary of System Pressures and Temperatures

Parameter	Value
Design Pressure (in Russia)	300 bar at +180 m reference elevation
Maximum operating pressure (inlet)	284.5 bar
Minimum operating delivery pressure (in Bulgaria)	65 bar at +100 m reference elevation
Maximum operating delivery pressure (in Bulgaria)	87 bar at +100 m reference elevation
Design Temperature - minimum / maximum	
- main 32-inch pipeline	-10°C / + 55°C
- landfall facilities 32-inch pipeline	-30°C / + 55°C
- main landfall facilities piping	-40°C / + 55°C
- bypass heaters / piping	-40°C / + 93°C
- venting piping	-120°C / + 55°C
- vent stack	-150°C / + 55°C
Operating Temperature	
- maximum (compressor outlet in Russia)	50°C
- minimum (requirement at landfall in Bulgaria)	-5°C (normal) - 8°C (in extreme winter conditions)

Safety protection facilities will be provided so that the pipelines at the landfall facilities in Russia will not be subject to temperatures higher than the maximum design temperature. This is described in more detail in Section 5.6.1.

Gas Composition and Properties

The gas to be transported by the South Stream Offshore Pipeline will be treated to a dry condition (i.e. having a water and hydrocarbon dewpoint of -22°C at 65 bar). Dry gas means water, liquefiable hydrocarbons and other impurities have been removed from the gas to make it suitable for sale to gas customers. The gas will consist of approximately 97 mol% [2] of methane and the maximum carbon dioxide (CO_2) content will be 0.41 mol%. The gas density is anticipated to vary between approximately 60 and 250 kilograms per cubic metre (kg/m^3).

[2] Mol% describes the percentage of moles (or molecules) within a given mixture.

Table 5.2 provides a summary of the likely composition of the gas. These gas properties apply as design values only and the properties of the processed natural gas provided to the South Stream Offshore Pipeline may vary slightly from those identified in the table. However, any changes will be very small deviations around the design natural gas parameters and will not result in changes to the size and design of the main Project components.

Table 5.2 Gas Composition

Component	Mole %	Component	Mole %
Methane	97.5389	n-pentane	0.0171
Nitrogen (N_2)	0.9305	Hexane	0.0205
CO_2	0.4101	Heptane	0.0033
Ethane	0.8800	Octane	0.0004
Propane	0.1399	Nonane	0.0001
i-butane	0.0150	Water	0.0014
n-butane	0.0249	Methanol	0.0005
i-pentane	0.0171	Hydrogen sulphide (H_2S)	0.0003

5.2.6.3 Pipeline Design Data

Pipeline Overview

The pipelines will be constructed of steel line pipes made of 12 m long sections, which will be welded together. The pipe sections will be coated both inside and outside prior to delivery to the marshalling yards. The internal coating will be an epoxy paint which improves internal cleanliness and the operational gas flow rate, whilst the external coating will be made of three-layer-polypropylene (3LPP) to protect the pipelines from corrosion.

Shallow water sections of the subsea pipelines (for water depths of less than approximately 88 m, including buried pipelines) will be additionally coated with reinforced concrete to increase their weight to improve stability against sea currents and provide additional protection from external damage due to third party activities. The concrete coated pipelines will be delivered to the marshalling yards pre-coated ready for installation. In addition, the pipelines will be protected against corrosion by a cathodic protection system consisting of sacrificial anodes for the nearshore and offshore sections and an Impressed Current Cathodic Protection (ICCP) system for the landfall section.

Pipe Dimensional Data

The steel pipe properties and dimensional data of the 32-inch pipes to be used for the South Stream Offshore Pipeline (including the Project) are summarised in Table 5.3 and Table 5.4, respectively.

Table 5.3 Steel Properties of 32-inch Pipes

Parameter	32-inch Pipe
Steel density	7,850 kg/m^3
Young's Modulus	207 megapascal (MPa)
Poisson's ratio	0.3
Material grade (per DNV-OS-F101)	SAWL 450
Specified Minimum Yield Stress, SMYS	450 MPa
Yield stress to be used in design	447 MPa

Table 5.4 Pipeline Dimensional Data of 32-inch Pipes

Parameter	32-inch Pipe
Pipe nominal outside diameter	812.8 mm
Pipe nominal inside diameter	734.8 mm
Wall thickness	39 mm
Internal or external corrosion allowance	0 mm
Wall thickness fabrication tolerance	±1 mm

The pipe used for the landfall, nearshore and offshore sections will have the same dimensions and steel properties, with the exception of a short section within the landfall facilities. Within the landfall facilities, 24-inch (609.6 mm) outside diameter steel pipes will transport the gas from a 32-inch x 24-inch reducer to a 32-inch x 24-inch barred tee as described in Section 5.2.5 and illustrated in Figure 5.5.

5.2.6.4 Buckle Arrestors

Buckle arrestors (pipe reinforcement) are used in the pipeline to avoid buckle propagation in the event of local buckling by placing arrestors at regular intervals and/or in susceptible areas along the length of the pipeline. The buckle arrestors will be welded into the pipelines in those areas that are susceptible to collapse, local buckling or propagation buckling.

Buckle arrestors are manufactured from the same steel grade as the pipes and basically act as a reinforcing ring placed around the outside of the pipe.

An integral ring buckle arrestor is considered to be the most effective type of arrestor for deep water pipeline projects. As such, an integral ring buckle arrestor approximately 4.1 m long with wall thickness of 74 mm (tapering down to 39 mm) is proposed. Buckle arrestors will be required in water depths in excess of approximately 650 m and it is proposed that a buckle arrestor spacing of 2,000 m is used. As the exact spacing of arrestors will depend on the pipe-lay installation methodology, the final spacing of the arrestors will be determined in consultation with the appointed installation contractor.

5.2.6.5 Welding

The line pipe sections will be welded together to form the four pipelines. Welding consumables (e.g. electrodes, wires and fluxes) that are similar and compatible to the composition of the line-pipe material will be used. The weld properties will have a minimum steel grade equal to that of the pipe. No other materials will be added during welding.

Each weld will be subject to visual inspection and non-destructive examination (NDE) to ensure the weld meets the required specification. The weld specification will be agreed with the installation contractor prior to construction and supported by an Engineering Critical Assessment. The weld specification will be produced to complement the NDE procedures.

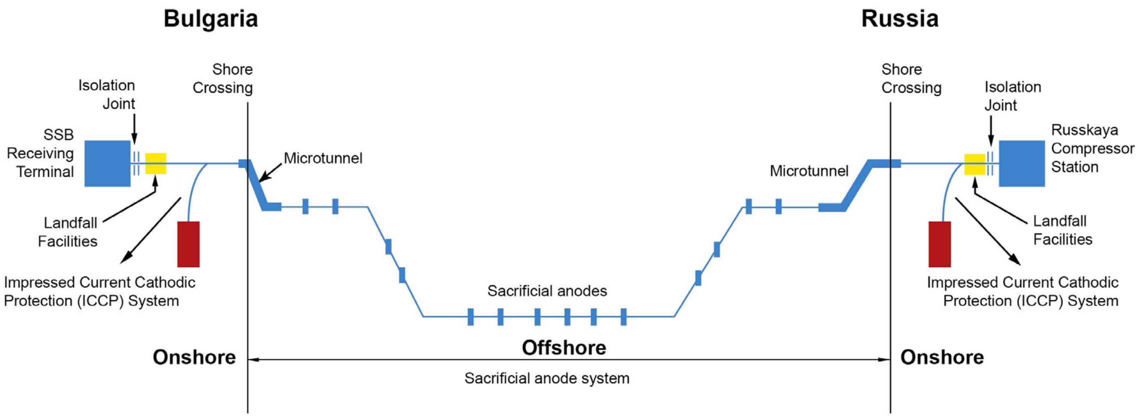
Critical processes such as welding will be inspected by the contractor’s quality assurance crew, and thereafter inspected by representatives of the certification company and South Stream Transport.

Corrosion Protection, Internal and External Coatings Corrosion Protection System

The corrosion protection system of the pipelines is important to ensure pipeline integrity during installation and during its operational life. The principle of cathodic protection is to prevent anodic sites occurring on the structure under protection by allowing the anodic reactions to occur on specially designed and installed anodes.

An indicative schematic diagram of the onshore and offshore corrosion protection system is shown in Figure 5.6.

Figure 5.6 Schematic Layout of the Cathodic Protection System



Cathodic Protection

Landfall Section Pipelines

An ICCP system will be installed to provide cathodic protection of the landfall section pipelines. With an ICCP system the current flow is "impressed" or forced by a power supply. The power source will deliver a direct current (DC) through the groundbed to provide the cathodic protection.

Nearshore and Offshore Section Pipelines

To ensure the integrity of the nearshore and offshore (subsea) pipelines over their operational life, secondary anticorrosion protection will be provided by sacrificial anodes. The cathodic protection design of the offshore pipeline is performed in accordance with the recommended practice design code DNV-RP-F103.

Applying the recommended practice design code (DNV-RP-F103) for the selected zinc anodes, results in the following anode requirement per pipeline in Russian waters as provided in Table 5.5. This assumes a maximum spacing of up to 300 m between anodes.

Table 5.5 Estimated Number of Anodes Required per Offshore Pipeline (in Russian Waters)

Number of Anodes	Total Anode Mass (kg)
736	301,998

5.2.7 Resource Efficiency

Resource efficiency measures are included in the Construction Management Plans which will form part of South Stream Transport's Environmental and Social Management Plan (ESMP). Examples of such measures in Russia include:

- Minimisation of plant, equipment and vehicle noise and air emissions;
- Contractor shall ensure that all vehicle engines are turned off when the vehicle is not in use. Where possible, equipment with engines shall not be left running at night;
- Minimisation of the volume of water generated by trench dewatering, the contractor shall minimise the time that trenches and pits are open;
- The contractor shall actively seek and implement opportunities to avoid, minimise, reuse or recycle waste materials;
- Surplus excavated spoil shall be used for landscaping purposes within the construction corridor or will be used for site engineering or restoration purposes at a local landfill site, or as inert backfill at identified quarries;
- Appropriate vessels will be chosen and maintained correctly; and
- Systematic monitoring of the condition and the adjustment of the fuel systems of ship equipment to ensure efficient use of fuel.

5.3 Construction Phase

This section describes the activities that will take place during construction of the Project. Activities are described for each section of the Project: offshore, nearshore and landfall.

5.3.1 Indicative Construction Schedule

The overall South Stream Offshore Pipeline phases and timeline is provided in **Chapter 1 Introduction**, and the construction schedule for the Project is summarised in Figure 5.7. The schedule presented in Figure 5.7 is the base case estimate that has been used for the planning of the Construction Phase and Pre-Commissioning Phase of the Project. Construction is scheduled to begin in 2014, with first gas from Pipeline #1 scheduled for late 2015, and all four pipelines fully operational by the end of 2017.

As with all large construction projects, there may be some changes made to the schedule during the Construction and Pre-Commissioning Phase as a result of unforeseen delays such as weather conditions, logistics problems, geological conditions/seabed intervention issues or administrative procedures with national Governments. Should there be any major change to the construction schedule, which may affect the results of the ESIA Report the management of change process described in Section 5.11 will be followed.

Each of the pipelines in the landfall section from the landfall facilities to the microtunnel entry shaft will be installed consecutively in a single construction period to minimise the length of disturbance. Restoration of the landfall and nearshore sections will not commence until successful pre-commissioning tests of these sections have been concluded.

Figure 5.7 Indicative Construction Schedule (all four pipelines)

		2013	2014				2015				2016				2017			
	Operations	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Landfall Section	Landfall Section Pipelines & Microtunnel - site establishment, offices and access road preparation and mobilisation of equipment																	
	Landfall Section Pipeline Construction																	
	Landfall Facilities - site establishment, offices and access road preparation and mobilisation of equipment																	
	Landfall Facilities Enabling / Early Civil Works																	
	Landfall Facilities Pipework & Instrumentation Installation																	
	Excavation of Microtunnel Entry Shaft																	
	Construction of Microtunnel																	
	Installation of Pipeline in Microtunnel (pull-in from pipe-lay vessel)																	
	Grouting of Microtunnel																	
	Tie-in to Expansion of the United Gas Supply System (Gazprom Invest)																	
	Land Clean-Up & Installation of Pipeline Markers																	
Nearshore Section	Mobilise Shallow Water Pipe-Lay Vessel to Microtunnel Exit Pit and Survey Area																	
	Dredging of Microtunnel Exit Pit and Transition Trench & recovery of TBM																	
	Installation of Pipeline in Microtunnel (pull-in from pipe-lay vessel)																	
	Pipe-Lay from 26m to 30 m WD																	
	Backfilling of Microtunnel Exit Pit and Transition Trench																	
Offshore Section	Pre-lay Rock Dumping and Cable Crossings																	
	Pipeline Route Pre-lay Survey (max of 45 days in advance of pipe-lay)																	
	S-Lay Pipe-lay - 30m to 600 m WD																	
	J-Lay Pipe-lay - 600 m WD to Russia / Turkey EEZ Boundary																	
	Above Water Pipeline Tie-in at 30 m WD																	
	Post-Lay Seabed Intervention (including surveys)																	
	Pre-Commissioning of Landfall & Nearshore Pipelines																	
	Pre-Commissioning of Landfall Facilities																	
	Pre-Commissioning of South Stream Offshore Pipeline (Russia to Bulgaria)																	
	Commissioning Of South Stream Offshore Pipeline (Russia to Bulgaria)																	
	South Stream Offshore Pipeline Russia to Bulgaria) Operational																	

The construction schedule presented in Figure 5.7 assumes the deep water part of the pipeline (water depth greater than 600 m) is laid by J-Lay method. However, S-Lay methods could also be used. Further information on J-Lay and S-Lay pipe-lay methods is provided in Section 5.3.5.5 and 5.3.6.4. The use of J-Lay provides a more conservative approach in terms of scheduling, as the J-Lay pipe-lay rate is typically slower than the S-Lay method.

The construction schedule assumes the installation of two or more of the pipelines in the deep water section (water depth >600 m) will overlap. To achieve this strategy, multiple pipe-lay vessels must be utilised during the course of the installation. Following this phasing concept, pipeline #1 and pipeline #2 are installed using the first pipe-lay vessel. Approximately midway through the pipe-lay of pipeline #2, a second pipe-lay vessel then commences with pipeline #3. Once the first pipe-lay vessel completes pipeline #2, it then commences with the pipe-lay of pipeline #4.

Installation of one pipeline (pipeline #3) is removed from the critical path installation sequence thus reducing the completion time of the offshore pipe-lay process by approximately one year. The use of a second pipe-lay vessel to perform simultaneous work can be introduced at various other points in the schedule to achieve the same results.

5.3.2 Logistics and Material Supply

The Project will require the procurement of materials, equipment and labour from locations in Russia, the EU and outside the EU. Established road, rail and sea transportation routes will be utilised during the Project. Preference will be given to source equipment (such as plant and construction vehicles) and materials which meet the required project specifications from Russia wherever possible. The pipe to be used for the installation of the Project pipelines is anticipated to come from pipe mills located in Europe, Russia, Japan, and/or India.

At the time of preparing this ESIA Report it is anticipated that all of the pipe required to construct the Project will arrive at marshalling yards in Bulgaria via sea.

5.3.2.1 Marshalling Yards in Bulgaria

Large scale pipeline construction work requires considerable support from onshore support facilities, known as marshalling yards, for the delivery, storage and load out of pipe, plant and equipment. The marshalling yards will also provide support facilities, which will provide general storage for supply of consumables to the offshore fleet, and managerial support for South Stream Transport and its contractors.

Marshalling yards for the Project will be located at the ports of Varna East, Varna West and Burgas in Bulgaria. The impacts of the development and use of these marshalling yards are assessed in the Bulgarian ESIA. The Project is committed to using these marshalling yards for construction of pipelines 1 and 2, including construction of the landfall (onshore) components in Russia and in Bulgaria. Once future construction contracts for pipelines 3 and 4 are signed, it will be known if the marshalling yards will remain in Bulgaria, or be moved to Russia. If the latter, then the management of change process, as described in Section 5.11, will be invoked and an impact assessment prepared if required.

5.3.2.2 Ports

Although it is anticipated that there will be no marshalling yards located on the Russian coast, it is likely that the contractor will use the Port of Novorossiysk for some of the activities listed below during the Construction Phase of the Project:

- Temporary storage of pipe;
- Load out of pipe to the landfall section construction spread via road transport;
- Receipt, temporary storage and load out of plant, equipment and supplies to the landfall section construction spread;
- Receipt of wastes from vessels generated during construction of the nearshore and offshore section construction spreads prior to onward transport to suitably licensed waste handling facilities;
- Base for the supply vessels necessary to deliver construction materials;
- Re-fuelling and maintenance of construction vessels and bilge-water disposal; and
- Base for crew-change vessels travelling to the nearshore and offshore construction spread.

Although the use of other Russian ports is possible, only Novorossiysk has been included in the assessment as it was not known at the time this ESIA report was prepared which other ports could be used, or which activities could be involved. If there is a need to examine the impacts of activities taking place at an alternative port, they will be considered by the management of change process described in Section 5.11.

5.3.3 Onshore Access Routes

5.3.3.1 Transport Routes from Novorossiysk Port

Pipe sections and other materials that are required for the installation of the landfall section of the Project will be delivered from the port of Novorossiysk to the landfall section construction sites by road. The proposed road delivery route from Novorossiysk will utilise the M25, as summarised below.

The delivery route from Novorossiysk will utilise the M25 and the Rassvet to Gai Kodzor Road. Construction traffic will then use a temporary road being constructed by Gazprom Invest to bypass Gai Kodzor before joining the Gai Kodzor to Varvarovka road briefly, and then turning off onto a new Varvarovka bypass road being constructed by South Stream Transport for use during the Construction Phase of the Project.

Permanent Access Roads

From the Varvarovka to Sukko Road, a new permanent access road (shown in red in Figure 5.8) will be constructed by Gazprom Invest, to support the development of the "Expansion of the United Gas Supply System".

This permanent access road will be approximately 2.7 km in length, and only the last spur (of approximately 200 m shown in orange in Figure 5.8) will be constructed by South Stream

Transport. This road will be utilised throughout the Operational Phase of the Project to provide access to the landfall facilities and pipeline RoWs.

A 2.6 km bypass road (referred to as the Varvarovka bypass road, shown in brown in Figure 5.8) will be constructed by South Stream Transport to bypass the town of Varvarovka and prevent construction traffic from passing through those residential settlements during the Construction Phase of the Project. Although the Project will make only temporary use of it, the road will be a permanent structure as local residents / motorists will continue to use it after construction is complete.

Temporary Access Roads

Temporary access roads will also be required during the Construction and Pre-Commissioning Phase of the Project.

Temporary Bypass Road

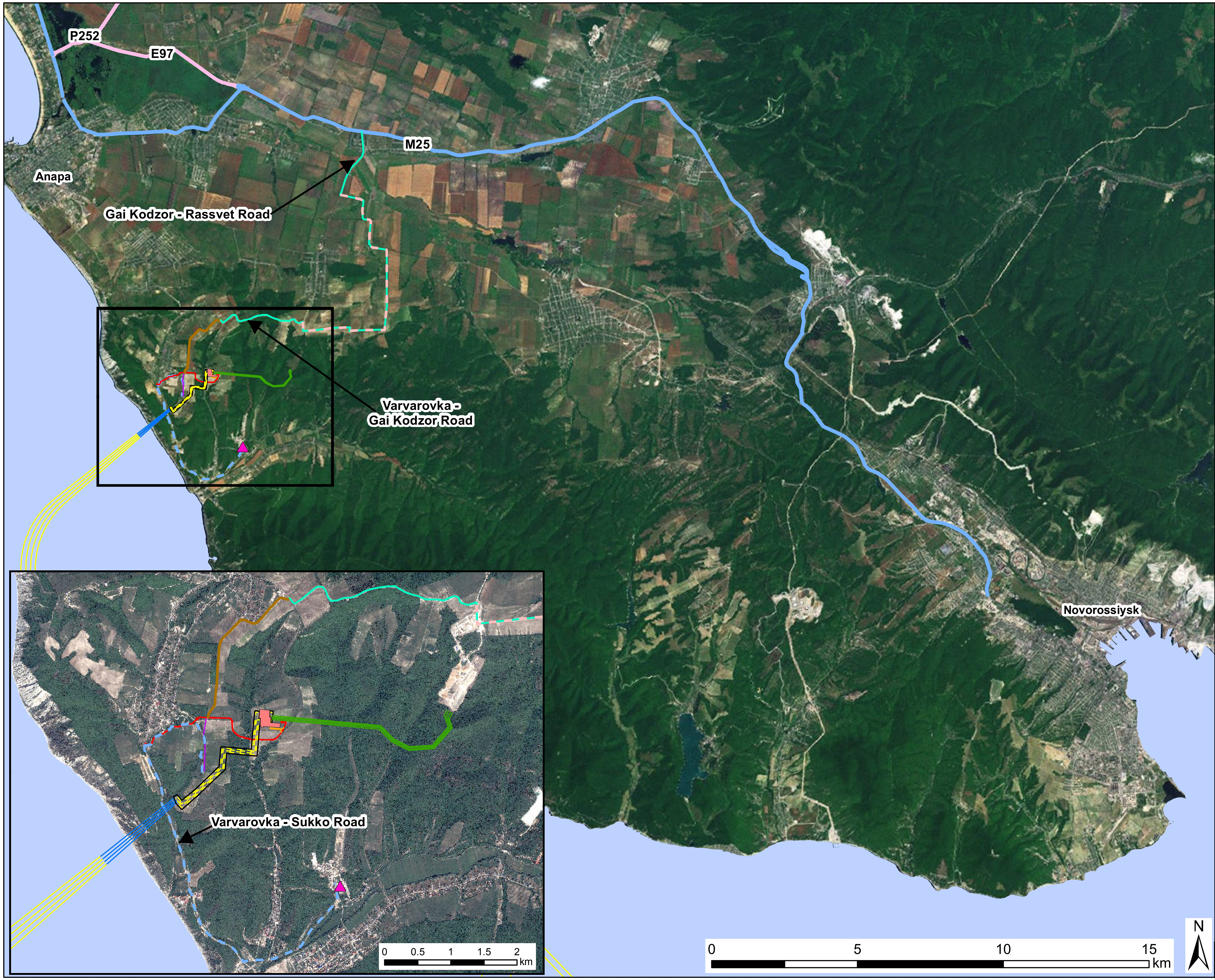
A temporary bypass road (shown by dashed pink lines in Figure 5.8) has been constructed by Gazprom Invest to avoid their construction traffic passing through residential settlements in Gai Kodzor. Although this bypass road is part of the "Expansion of the United Gas Supply System", South Stream Transport will use the same temporary bypass road for construction of the Project.

Other Temporary Access Roads

A 0.8 km temporary access road (shown in purple in Figure 5.8) will be installed by South Stream Transport from the point where the Varvarovka bypass road meets the permanent access road being constructed by Gazprom Invest, and will travel south to the temporary Pipeline String Preparation Area (Site B). A temporary access road will also be established within the construction corridor shown in (Figure 5.8) to allow the movement of heavy equipment and materials. The temporary access roads will be removed following the completion of the Construction Phase. Access along the permanent RoW for inspection and maintenance activities will be via a minor track which will be accessible by 4x4 vehicles only. Further information on the construction of the access road and construction corridor road is provided in Section 5.3.4.2.

5.3.3.2 Freshwater Supply

Freshwater is required for the microtunnel construction process (approximately 37,000 m^3 in total) and the hydrotesting of the landfall facilities (approximately 500 m^3). In addition there will be an average usage of approximate 10 m^3 of water per day for general construction activities (domestic usages, dust suppression, wheel washing etc.) at the landfall section construction sites.



LEGEND

Russian Sector of South Stream Offshore Pipeline

- Proposed landfall section pipelines
- Landfall facilities
- Proposed microtunnels
- Proposed offshore pipelines
- Right-of-Way

Access Roads

- Proposed delivery route
- Permanent access road to be constructed by SSTTBV
- Temporary access road constructed by SSTTBV
- Varvarovka bypass road (used by Project during construction only)
- Gazprom Invest temporary bypass road to be utilised by SSTTBV
- Route from freshwater supply well
- Ministry of Defence freshwater well

United Gas Supply System

- United Gas Supply System pipelines
- Permanent access road to be constructed by Gazprom Invest
- Federal road
- Regional road

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
TRANSPORT ROUTE TO LANDFALL SECTION

Drawn	Checked	Approved	Date
AH	RW	MW	11 Apr 2014

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Drawing Number	Rev
Figure 5.8	

Plot Date: 11 Apr 2014
File Name:I:\5004 - Information Systems\46369082_South_Stream\MXDs\Report Maps - Russia\Russian ESIA v2\Chapter 5 Project Description\Figure 5-8 Transport Route to Landfall Section.mxd

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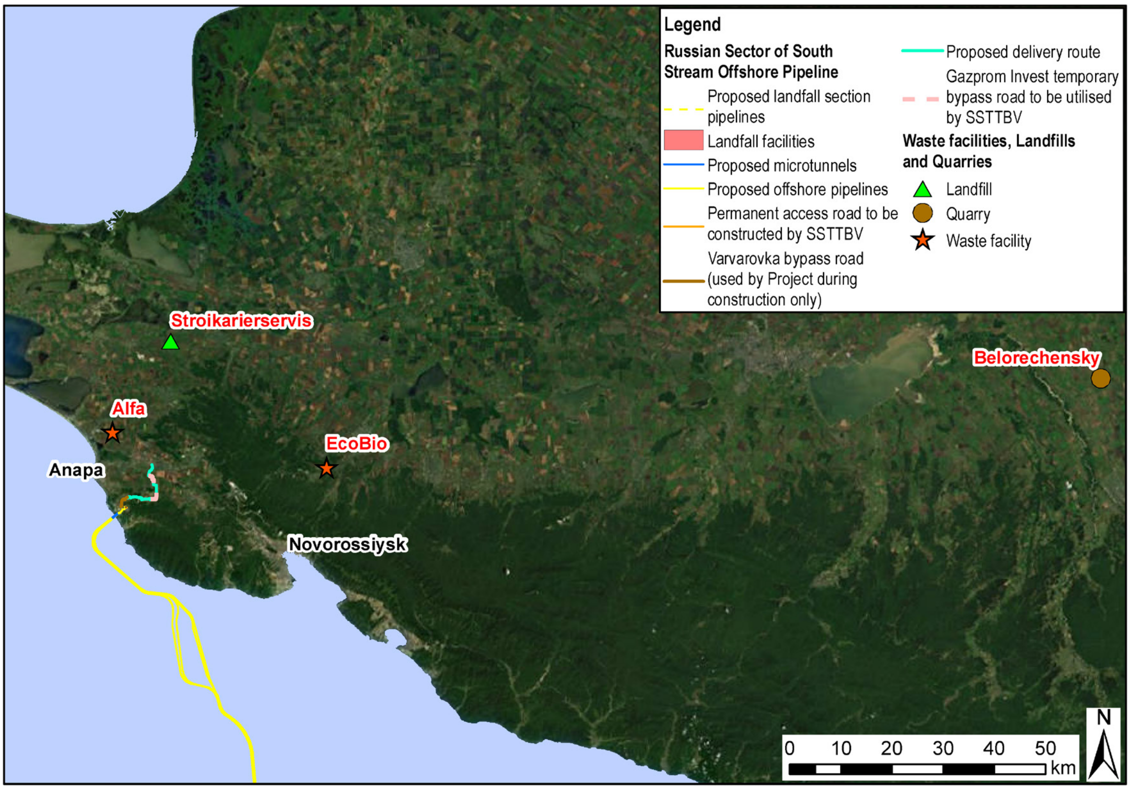
Water will be obtained from an existing well located on the northern side of Sukko. The route from the northern edge of Sukko to the landfall section is shown in Figure 5.8. However, water cannot be sourced from here between May and September (inclusive). Therefore, a large volume of water (up to 10,800 m^3) may need to be stored within the landfall section construction sites during this period. Further information on water use and storage requirements is provided in Section 5.3.4.1.

5.3.3.3 Landfill, Waste Facility and Quarry Locations

Potential waste facilities, landfill sites and quarries to support the construction of the Project have been identified (see Figure 5.9). However, it should be noted that no agreements with these sites has been put in place and alternative sites may be identified during the detailed design phase of the Project. When suitable sites are confirmed, the potential impacts of traffic travelling between these sites and the landfall section construction site will be managed through the Russian Landfall Construction Management Plan (CMP), which will form part of South Stream Transport's ESMP. The CMP will contain activity-specific requirements, to be met by both South Stream Transport and the appointed contractors (and sub-contractors). Further information on the Russian Landfall CMP and South Stream Transport's ESMP are described in **Chapter 22 Environmental and Social Management**.

Figure 5.9 Locations of Potential Waste Facilities, Landfill Sites and Quarries



5.3.4 Construction of Landfall Section

The landfall section is approximately 4 km in length. Within this section, the pipelines will be buried using both open-cut and trenchless construction techniques and will pass through the landfall facilities. The pipelines will be buried using open-cut techniques for approximately 100 m from the connection to the "Expansion of the United Gas Supply System" to the landfall facilities and for approximately 2.4 km from the landfall facilities to the microtunnel entry shafts. Due to the presence of a steep sea cliff at the shore crossing, for the remaining 1.4 km the pipelines will be housed in microtunnels (2.5 m in diameter), which will terminate approximately 400 m from the coast in a water depth of approximately 23 m. The equipment within the landfall facilities is listed in Section 5.2 and illustrated in Figure 5.4.

Prior to construction, the appointed contractor will perform a pre-entry survey, including topographic and photographic records at all construction sites, and will prepare a Record of Condition in agreement with landowners, tenants and South Stream Transport. This record will be used as the standard against which the quality of the restoration work will be judged at any time during the construction works and upon completion of the works. Restoration of the land required for the temporary facilities during the Construction and Pre-Commissioning Phase is estimated to take approximately 17 months.

5.3.4.1 Temporary Facilities

A number of onshore temporary facilities will be required throughout the Construction and Pre-Commissioning Phase for the storage of pipe, equipment, materials, spoil storage areas, parking space and mess and welfare facilities for workers. Pipe will be temporarily stacked within the construction sites prior to transport to the construction spread for installation. A summary of the estimated areas of land required for these temporary facilities is shown in Table 5.6 and illustrated in Figure 5.10. It should be noted that these are the maximum extents of land anticipated as being required. During construction, the actual footprint of these areas will be reviewed by the contractors and South Stream Transport to ascertain if the footprints can be reduced to minimise the areas of land clearance required. Further information on the microtunnel construction site is provided in Section 5.3.4.5. The majority of this land will be rehabilitated following completion of construction.

Table 5.6 Estimated Area Requirements for Onshore Temporary Facilities

Temporary Site	Area (ha)
Landfall Section Pipeline Construction Corridor	27.43*
Microtunnel Construction Site (Site A)	8.76†
Pipeline String Preparation Area (Site B)	4.61
Landfall Pipeline Construction Site (Site C)	2.24

Continued…

Temporary Site	Area (ha)
Temporary Storage Area (Site D)	0.50
Landfall Facilities Construction Site and Pre-Commissioning/Commissioning Spread (Site E)	5.19
Access Road Construction Areas (including temporary access roads in their entirety)	8.54
Potential Transfer Site (only if required by the contractor)	5.38

* 21.72 ha of the Permanent RoW is located within the Landfall Section Pipeline Construction Corridor, therefore the temporary landtake requirement outside the RoW is 5.71 ha.
† 4.93 ha of Site A is located within the Landfall Section Pipeline Construction Corridor, therefore the temporary landtake outside the Landfall Section Pipeline Construction Corridor is 3.83 ha.

Complete.

The Microtunnel Construction Site (Site A), Pipeline String Preparation Area (Site B), Landfall Pipeline Construction Site (Site C), the Landfall Facilities Construction Site and Pre-Commissioning/Commissioning Spread (Site E), and the optional Transfer Site will have approximately 50% of their surface area to be reinforced with small stones/rock to prepare areas of hardstanding. This land will be re-instated following completion of construction.

A Transfer Site (shown indicatively in Figure 5.10) may be required as a temporary laydown area for equipment and materials required for the Project between the construction sites and the public highway. It may also be used to temporarily store soils excavated for the Project that cannot be re-used on site before they are taken away for disposal. Deliveries of materials and equipment to the temporary facilities will be made via the temporary and permanent access roads described in Section 5.3.3 and shown in Figure 5.8.

The layout of equipment within each construction site will be subject to the preference of the appointed contractor. However, it is anticipated that a number of pre-fabricated cabins and/or containers will be required to provide office space, mess and welfare facilities etc. in the Microtunnel Construction Site (Site A), the Landfall Pipeline Construction Site (Site C) and the Landfall Facilities Construction Site and Pre-Commissioning/Commissioning Spread (Site E). Pipe will be temporarily stacked within the Landfall Pipeline Construction Site (Site C), and potentially at the optional Transfer Site, prior to transport to the construction spread for installation. Due to the source of freshwater near Sukko being unavailable for supply during May to September (inclusive), a large volume of water (up to 10,000 m^3) may need to be stored in large water tanks. This water is required for the microtunnelling process, but it is assumed that it would be stored in the Pipeline String Preparation Area (Site B), so that it is adjacent to the Microtunnel Construction Site (Site A). Approximately 1,000 m^3 may also need to be stored at the Landfall Facilities Construction Site and Pre-Commissioning/Commissioning Spread (Site E). This water is required for general construction activities at the various onshore construction sites. The exact location and dimensions of the storage tanks will be finalised during the detailed design and will be agreed between the Contractor, South Stream Transport and the relevant Local Authorities.

It is anticipated that during March and April 2014 seven months' supply of water (approximately 1,400 m^3) will be delivered to site for general construction activities. Between October 2014 and April 2015 (inclusive), approximately 28,500 m^3 of water will be delivered to the Pipeline String

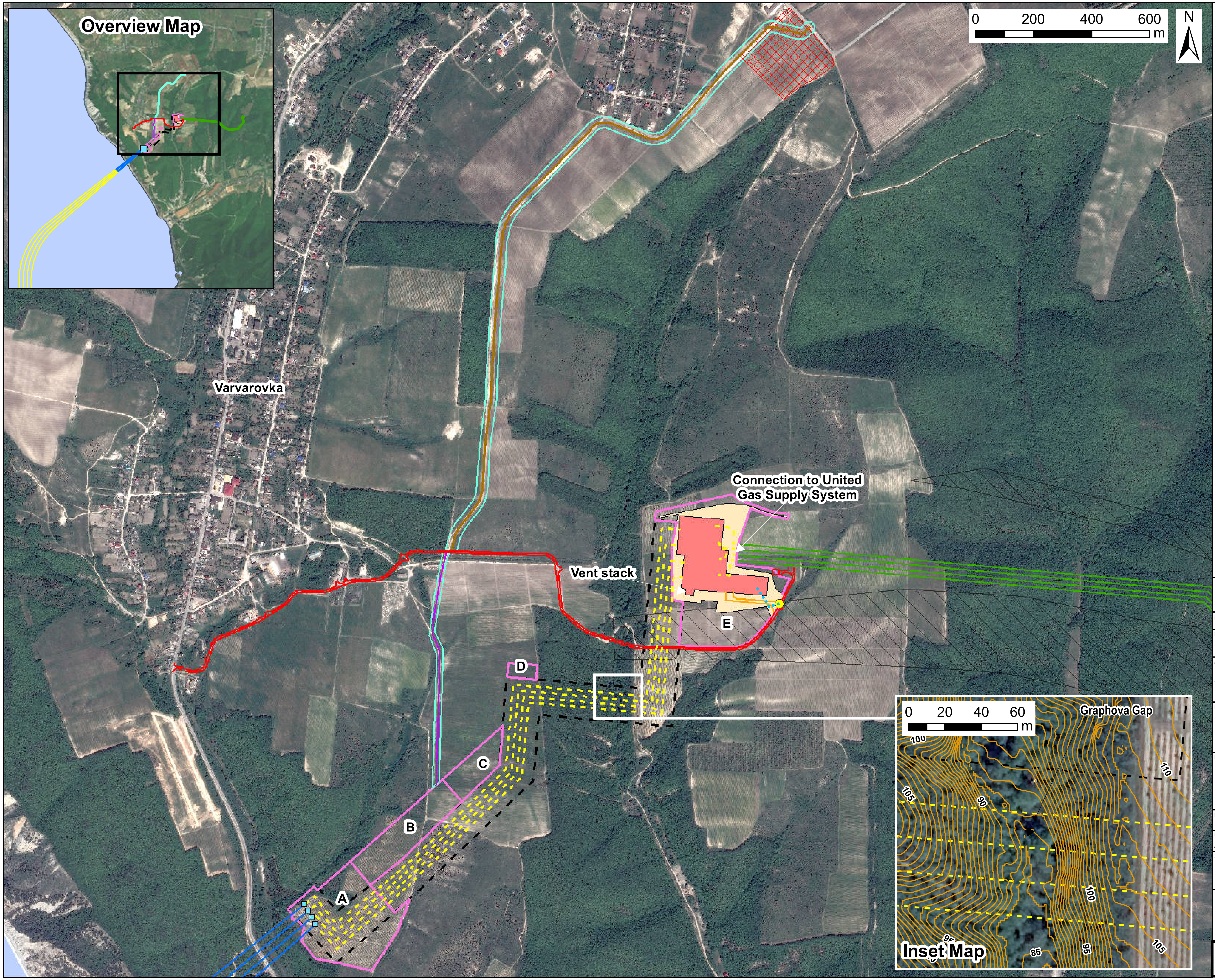
Preparation Area (Site B) and 2,900 m^3 (2,400 m^3 for general construction activities and 500 m^3 for hydrotesting) to the Landfall Facilities Construction Site and Pre-Commissioning/ Commissioning Spread (Site E). Between October 2015 and mid-February 2016 (inclusive) a further 8,500 m^3 will be delivered to the Pipeline String Preparation Area (Site B) and 900 m^3 will be delivered to the Landfall Facilities Construction Site and Pre-Commissioning/Commissioning Spread (Site E). It is considered that the amounts of water required at the construction sites after mid-February 2016 will be sufficiently low that associated truck movements will be negligible and do not need to be considered. The only activity after this date is site reinstatement. The estimated truck movements to bring freshwater to the site have been included in Table 5.13 These numbers are also specified in **Appendix 9.1 Traffic and Transport Study**.

A temporary construction corridor will be required along the length of the landfall section pipelines route from the tie-in location with the project "Expansion of the United Gas Supply System" to the landfall facilities, and from the landfall facilities to the microtunnel entry shaft.

It should be noted that some of the permanent facilities described in Section 5.6.6 and shown in Table 5.4 are located within the footprint of the boundary of the temporary facilities shown in Table 5.7. This includes the permanent RoW which is located within the construction corridor.

A temporary security fence will be installed around the perimeter of the temporary facilities, and the landfall facilities site during construction to prevent the entry of unauthorised persons. Signs will be erected to raise awareness of the hazards. Fencing may also be provided where necessary to prevent the entry of animals. Further information on requirements for fencing along the construction corridor is provided in Section 5.3.4.5 and fencing in relation to the prevention of injury to animals is provided in **Chapter 11 Terrestrial Ecology**.

All open-cut pipeline construction activities will be undertaken within a temporary construction corridor. The construction corridor will nominally be 120 m wide. A typical cross-section of the construction corridor is shown in Figure 5.11.



LEGEND

Russian Sector of South Stream Offshore Pipeline

- Proposed landfall section pipelines
- Landfall facilities
- Anode ground bed for cathodic protection of pipelines
- Proposed microtunnels
- Microtunnel entry shaft
- Construction corridor
- Cut and fill side slopes
- Temporary construction area for road construction
- Construction sites
- Anode ground bed connection to landfall facilities
- Permanent access road to be constructed by SSTTBV
- Temporary access road constructed by SSTTBV
- Varvarovka bypass road (used by Project during construction only)
- Optional transfer site

A - Microtunnel construction site
B - Pipeline string preparation area
C - Landfall section pipelines construction site
D - Temporary storage area
E - Construction site for landfall facilities and offshore pre-commissioning and commissioning spread and site preparation

United Gas Supply System

- United Gas Supply System pipelines
- Permanent access road to be constructed by Gazprom Invest
- Marfovsky fault (indicative location)

Projection: Lambert Conformal Conic

Revision Details	By / Check	Check Date	Suffix

Purpose of Issue: For Information

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Project Title: SOUTH STREAM OFFSHORE PIPELINE

Drawing Title: LOCATION OF TEMPORARY FACILITIES

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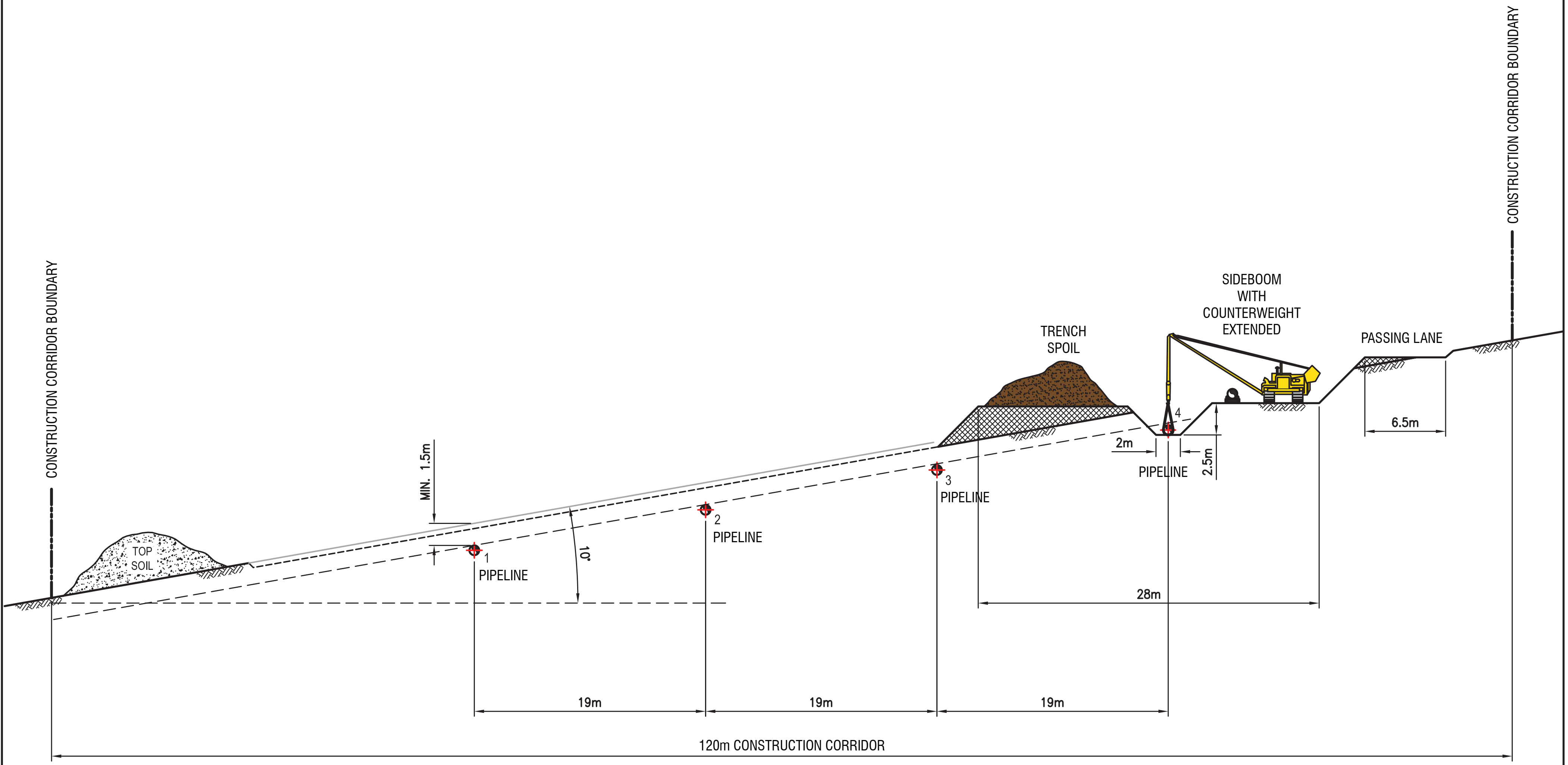
Plot Date: 18 Feb 2014
File Name:I:\5004 - Information Systems\46369082_South_Stream\MXDs\Report Maps - Russia\Russian ESIA v2\Chapter 5 Project Description\Figure 5-10 Location of Temporary Facilities.mxd

Figure 5.11 Typical Construction Corridor



5.3.4.2 Construction of Permanent and Temporary Access Roads

The Project will require the construction of the following roads, as shown in Figure 5.10 to provide access to all aspects of the Project during construction of the pipelines, microtunnels and landfall facilities:

- Approximately 200 m of permanent access road that will branch off the permanent access road being constructed by Gazprom Invest (shown in red in Figure 5.10) to meet the southern edge of the landfall facilities (shown in orange in Figure 5.10). This road will have a running surface approximately 7 m wide with 1.5 m wide shoulders on either side of the road, and will require an additional 3.5 m either side of the road edge during construction of the road only. This entire road will be contained within the area designated for cut and fill slopes, therefore the road does not add to the total permanent or temporary land take of the Project;
- Approximately 0.8 km of temporary access road from the permanent access road being constructed by Gazprom Invest to the temporary Pipeline String Preparation Area (Site B) (shown in purple in Figure 5.10). This road will have a running surface approximately 7 m wide with 1.5 m wide shoulders on either side of the road, and will require an additional 3.5 m either side of the road edge during construction;
- Approximately 2.6 km of access road (shown in brown in Figure 5.10 from the Gai Kodzor - Varvarovka Road to the permanent access road being constructed by Gazprom Invest. This permanent road is referred to as the Varvarovka bypass road and will be used by the Project during the Construction Phase only. This road will have a running surface approximately 8 m wide and 1 m wide shoulders on either side of the road. Due to the road being constructed on a slope, it is assumed that this road will require construction areas ranging from approximately 5 - 14 m at the road edges in some sections during construction to form safe slopes and the construction of retaining walls where required; and

Approximately 2.5 km of temporary access road (shown in Figure 5.10) within the temporary construction areas and along the construction corridor, which runs from the landfall facilities to the microtunnel construction site. This road will have a running surface approximately 4 - 5 m wide.

Road Construction Techniques

Where possible, a ‘cut-track’ design will be used for the construction of the permanent access road and temporary access roads, in which the topsoil will be stripped to expose a suitable rock or sub-soil horizon on which to build the track. The upper soil horizon will be suitably stored on the site for later reinstatement, as appropriate. Where practicable, a geotextile material such as a geogrid (grid-like mesh formed of plastics which provide ground stabilisation and reduce aggregate requirements) will then be placed to provide separation between the fill material and the founding strata. The road will then be built up on the geogrid by laying and compacting crushed rock. The actual depth will be dependent on ground conditions and topography and confirmed during the detailed design stage.

The temporary Varvarovka Bypass Road will be constructed on a hill slope and will require cuts and fills of soils in various sections of the road to form a suitable road surface. The road will also require a number of engineered slopes and retaining walls to ensure the integrity of the road is protected during its use throughout the Construction Phase.

In areas of very poor soil conditions, (i.e. boggy or wet ground) along the route of the temporary access road within the construction corridor, topsoil stripping may be omitted in favour of the geotextile material being laid directly over the ground. Alternatively, there may be sections which are constructed with timber crane / bog mats which can be easily removed following the completion of the construction process. Timber crane / bog mats provide stable access over boggy and wet ground conditions, reducing permanent damage to existing surfaces by spreading heavy loading, increasing stability and minimising hard surface damage.

As far as possible, the access roads will be constructed of material from locally sourced imported graded stone and geotextiles. The source of this material is yet to be confirmed but a potential suitable quarry source has been identified (see Figure 5.9).

However, it should be noted that no supply agreement with this source has been put in place and alternative sources may be identified during the detailed design phase of the Project. When a suitable source is confirmed, the potential impacts of traffic travelling between the quarry and the landfall section construction site will be managed through the Russian Landfall CMP, which will form part of South Stream Transport's ESMP. The CMP will contain activity-specific requirements, to be met by both South Stream Transport and the appointed contractors (and sub-contractors). Further information on the Russian Landfall CMP and South Stream Transport's ESMP are described in **Chapter 22 Environmental and Social Management**.

The materials imported from quarries will be chemically checked to ensure their inertness and to prevent any potential adverse effect on groundwater. The permanent access road leading to the landfall facilities will be finished with an asphalt concrete or tarmac surface approximately 80 mm thick.

For the purposes of the ESIA it has been assumed that the entire length of the temporary access road from the junction with the permanent access road to the temporary Pipeline String Preparation Area (Site B) and the temporary road within the construction corridor will be constructed with rock, although some sections may use timber crane/bog mats.

Road Drainage

The general approach to road drainage is described below, along with measures specific to the Varvarovka Bypass Road.

Road edge drains will be led away by ditches into drainage swales (a shaped and sloped depression in the soil surface) via settlement lagoons and small ponds away from the road edges so that runoff is controlled to prevent sediment entering local surface waters. Swales are shallow channels that are used to collect and/or move water and also remove pollution from it (see **Chapter 8 Soils, Groundwater and Surface Waters**). They can be covered by grass or other vegetation and have shallow side slopes. Swales allow the water to infiltrate into the ground resulting in less water run-off. The road will have adequate cross-fall to allow rainwater to be shed and, where gradients are present, lateral drains will intercept flow along the road. A drainage ditch may be formed on the upslope side of the road where required to collect runoff from the upper slopes, dependent on detailed drainage design.

Cross pipes will be laid as required to permit good road drainage and introduced where the position of the road may cause ponding to one side. As far as possible, these will coincide with naturally occurring drainage channels. Where the road slopes downhill, 'waterbars' will be placed to divert the flow into naturally occurring channels. The key function of a waterbar is to divert running surface water off a sloping road surface to prevent the road surface from being scoured by the water flow and becoming rough and gullied and unsuitable for construction traffic.

Due to the steepness of the slope on which the Varvarovka bypass road will be constructed, this road will include some additional rainwater drainage features to those described above to ensure safe driving conditions during rainfall. The drainage features for this road consists mainly of ditches situated at the bottom of the road embankment (road edge) or at the head of surrounding slopes to collect water coming from the road itself and/or surrounding areas. In addition, in cut sections of the road a concrete lined ditch will be located at each side of the road to collect the water coming from the road surface and surrounding slopes. Where retaining walls are provided, to avoid water (from the surrounding slopes) flowing down the wall into the road, a concrete channel will be formed above the wall to collect the water. To avoid scouring of the concrete lined ditch, due to high flow velocity of water in areas of slopes greater than 5%, the lined concrete ditches will be provided with features to slow down the conveyed water.

Road Crossings

The permanent access road to the landfall facilities and temporary access road within the construction corridor will cross the unnamed tributary of the Sukko River which is located in the Graphova Gap (illustrated in Figure 5.10). This unnamed tributary has no or low flow during the summer months and more significant flow during the winter months.

A road crossing of the Graphova Gap within the construction corridor is necessary to allow the movement of construction vehicles and equipment. This crossing will remain in place to allow 4x4 vehicles to access along the permanent RoW during the operational phase of the project to allow for inspections of the pipelines. The design of the crossing will be finalised during the detailed design stage and will ensure that water flow is not impeded.

At the time of preparing this ESIA Report, the actual location of the temporary access road within the construction corridor is unknown and will be subject to the detailed design of the appointed installation contractor and approvals from South Stream Transport and/or the Russian Federation regulatory authorities.

During construction of the landfall section, the movements of construction vehicles will be restricted to the temporary construction yards, the construction corridor and the access roads constructed as part of the Project.

Landfall Section Construction Plant, Vehicles and Equipment

Table 5.7 presents a preliminary list of typical construction equipment that may be used during the construction of the landfall facilities and the installation of the open-cut pipelines.

Table 5.7 Numbers of Plant / Equipment Expected for Construction of the Open-Cut Pipelines and Landfall Facilities

Construction Equipment			Number of Plant / Equipment per Phase				
Equipment	**Power Rating**	**Activity dB Laeq,T @ 10 m**	**Site Preparation (inc. access roads and equipment mobilisation)**	**Landfall Facilities (4 pipelines)**	**Trench Excavation (4 pipelines)**	**Pipeline Installation (4 pipelines)**	**Demobilisation/ Reinstatement**
Bulldozer	250 kW - 35 t	86	4	2	1	1	1
Grader	87 kW	77	2	1	1	1	1
Tracked Excavator	102 kW - 22 t	78	4	2	4	2	2
Tipper Lorry	75 kW - 25 t	85	6	2	2	1	2
Shovel	74 kW - 19 t	76	2	1	2	1	2
Tracked Side Boom	230 kW - 50 t	77	0	0	0	6	0
Tracked Crawler Crane	250 kW -120 t	75	0	2	0	1	0
Welding Machines	20 kW - 0.6 t	65	0	0	0	10	0
Pipe Bending Machine	129 kW - 25 t	66	0	0	0	1	0
Generators	250 kW	98	2	4	2	4	2

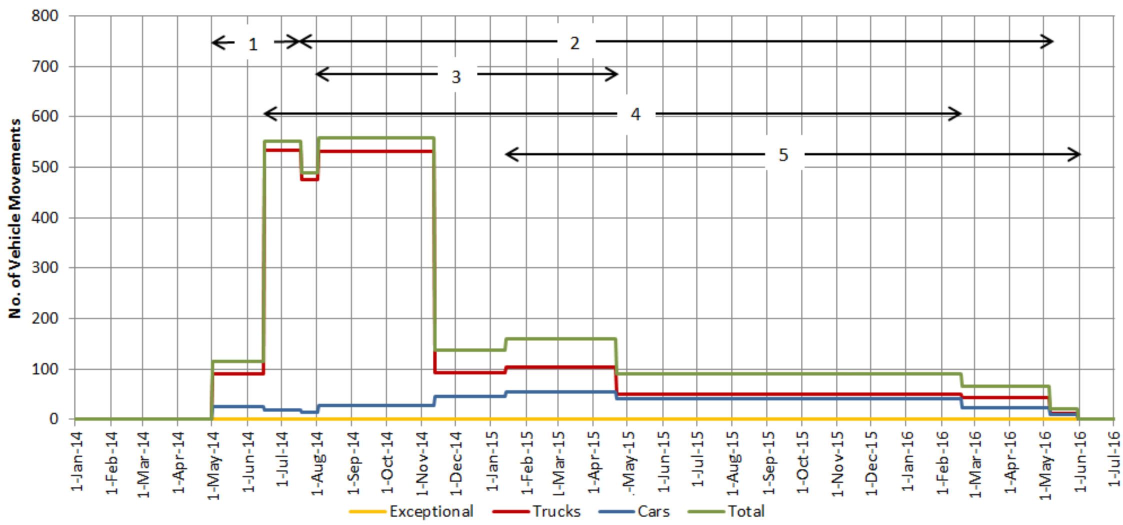
Equipment specific to the construction of the microtunnels is provided in Table 5.9. There will be considerable transportation of labour, heavy equipment and materials on local roads for the delivery of pipe and heavy equipment from the supply port. The delivery route to the landfall section is described in Section 5.3.3.

The estimated total number of vehicle movements associated with the construction of the landfall section on the public road network is presented in Table 5.8.

Table 5.8 Predicted Total Number of 2-Way Construction Phase Traffic Generation by Offsite Vehicles

Vehicle Type	Estimated Total Number of Vehicle Trips Movements by Activity				
	1. Site Preparation and Access Roads	**2. Micro-tunnelling**	**3. Pipeline Construction**	**4. Landfall Facilities**	**5. Demobilisation /Reinstatement**
Special Transport	12	33	68	50	8
Trucks	5,481	16,505	11,144	54,129	4,647
Cars / Minibus	1,811	7,029	2,796	6,600	3,586
Total per Phase	*7,304*	*23,567*	*14,008*	*60,779*	*8,241*

Figure 5.12 Average Daily Vehicle 2-Way Trips Movements to/from the Landfall Section during Construction



The table presents total 2-way vehicle trips. A 2-way trip is defined as both the arrival and departure of vehicles to and from the site and therefore comprises two additional traffic flow movements over a day (inbound and outbound direction). Weekly construction traffic movements are anticipated to peak in the second half of 2014 (Figure 5.12). Existing traffic flows on the local road network are described within Appendix 9.1 Traffic and Transport Study.

It is anticipated that the Project will share this delivery route with construction traffic associated with the construction of the Russkaya CS. The potential cumulative impacts generated by both projects are described **in Chapter 20 Cumulative Impact Assessment**, including traffic generated impacts.

5.3.4.3 Landfall Facilities Construction

The construction of the landfall facilities is expected to last approximately 19 months (May 2014 to December 2015). The equipment, materials and offices, etc. required for the construction of the landfall facilities will be located in the Landfall Facilities Construction Site and Pre-Commissioning Spread/Commissioning Spread (Site E) shown in Figure 5.10 and Table 5.7 and described in Section 5.3.4.1.

The following works will be undertaken during construction of the landfall facilities:

- Preparatory works, including surveying, site clearance and earthworks;
- Construction of internal roads;
- Preparation of foundations;
- Erection of equipment;
- Piping and mechanical works, including NDE of all welds;
- Laying of cables and electrical works;
- Installation of operational and instrumentation control systems;
- Connection to utilities (electricity); and
- Reinstatement of temporary areas that are not part of the permanent project footprint.

Preparatory works will include preparation of access to the landfall facilities site, site clearing, site levelling (including cut and fill of the site) and erection of perimeter fencing and access gates.

The preparation of the site for the construction of the landfall facilities will require extensive earthworks in order to prepare a level area and to stabilise the slopes surrounding the landfall facilities. It is estimated that approximately 257,000 m^3 of material will be cut from the site and 134,000 m^3 of fill material will be required to form a level site for the landfall facilities. Due to the structural properties of the soils at the landfall facilities not being suitable for engineering purposes, it is anticipated that all of the cut material will be taken offsite for disposal and the entire quantity of fill materials will be imported to the site.

The levelled platform area will have both upward and downward slopes. Engineered slopes are required to stabilise the platform and ensure that the landfall facilities will not be at risk from landslides from the surrounding hill slopes during its operational life. The design of the slope stabilisation techniques will be undertaken during detailed design, however the methods that may be considered to provide the necessary stabilisation include:

- Engineered structures;
- Vegetation stabilisation; and
- Soil bio-engineering systems.

In addition to earthwork, civil and structural engineering activities include excavation of foundations, surfacing of internal roads, car parking and paths, pouring of concrete foundations and slabs for pre-fabricated containers, foundations for equipment, vent stack, valve pits, erection of steel structures in the form of pipe bearings, supporting structures etc.

Fitting and connection of all communication equipment will allow the landfall facilities to be controlled locally from the containers containing the E&I equipment, and remotely from the CCR and BUCR in Amsterdam.

5.3.4.4 Pipeline Construction

General Overview

The landfall section of the Project will use a combination of open-cut and trenchless techniques for pipeline construction.

Conventional open-cut trenching techniques will be adopted for the installation of the four pipelines from the tie-in to the "Expansion of the United Gas Supply System" to the landfall facilities and from the landfall facilities to the microtunnel entry shafts. The four pipelines will be constructed one pipe at a time, although all four pipelines will be laid in one continuous construction period over a period of approximately six months to avoid the impacts associated with four separate construction periods. There will be a separation distance of approximately 19 m between the centreline of each pipeline.

Where the pipeline alignment will cross the shore there is a sea cliff with an average slope of approximately 43%, starting at sea level and rising to a height of approximately 150 m. The landward side of the coastal ridge has with an average slope of approximately 20% and drops down to a height of approximately 40 m above sea level at the microtunnel entry shaft location. Due to the steepness of the slope and the presence of rock, open-cut installation of the onshore pipeline across the sea cliffs is not feasible. The trenchless technique of microtunnelling has therefore been selected as the construction technique in this area. Each pipeline will be housed within one of four microtunnels each approximately 1.4 km long, which extend from an onshore entry shaft to approximately 400 m offshore at a microtunnel exit pit located within the nearshore section.

The alignment of the landfall section pipelines crosses one major road and two watercourses. The Varvarovka to Sukko road and the Shingar River are both crossed only by the surface trace of the microtunnels and thus impacts and disruptions are not anticipated during construction. The pipelines will directly intersect an unnamed tributary of the Sukko River that is located in the Graphova Gap (illustrated in Figure 5.10). This watercourse will be crossed using open-cut techniques as described below.

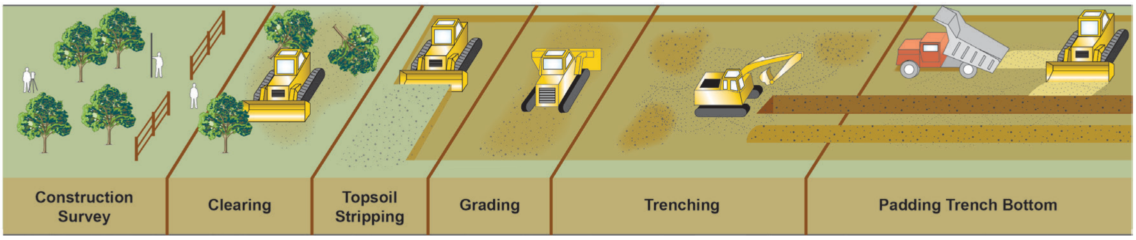
The landfall section pipelines will also pass through the southern branch of the Marfovsky Fault. The exact location of the fault is subject to further geophysical survey, however the anticipated location based on survey work carried out to date is shown in Figure 5.10. The fault will be crossed using traditional open-cut techniques as described below and further information on the characteristics of the fault are provided in **Chapter 7 Physical and Geophysical Environment**.

Open-Cut Pipeline Construction

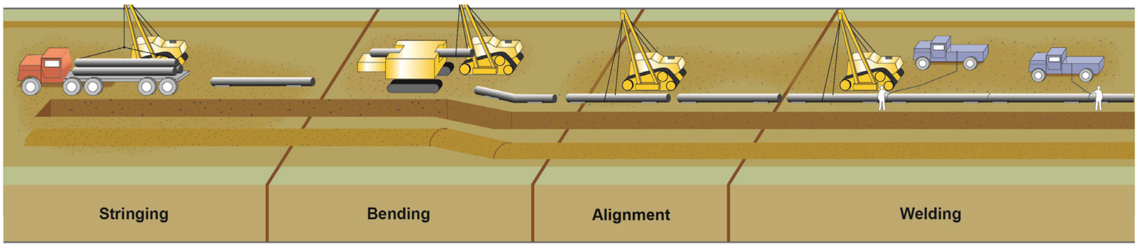
The general process for open-cut technique is shown in Figure 5.13 Typical Open-Cut Pipeline Construction Technique and summarised in the following sections.

Figure 5.13 Typical Open-Cut Pipeline Construction Technique

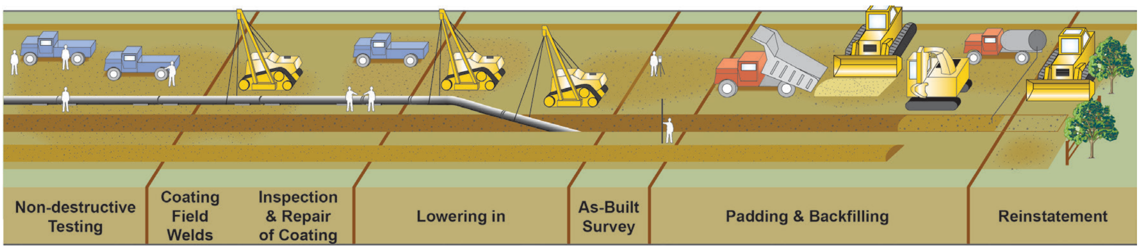
Part 1



Part 2



Part 3



Construction Corridor Preparation

The exact route of each pipeline will be surveyed and the centreline will be marked out. The temporary 120 m wide construction corridor will be clearly marked using wooden pegs. The edge of the construction corridor will require temporary fencing to prevent injury to animals, in particular the tortoise (*Testudo graeca nikolskii*), which is listed as critically endangered in both the International United Conservation Network (IUCN) Red Data List (Ref. 5.4) and Russian Federation Red Data Book (Ref. 5.5), and as Vulnerable in the Red Data Book of the Krasnodar Krai region (Ref. 5.6). Further information on methods to mitigate impacts on tortoises is provided in **Chapter 11 Terrestrial Ecology**. Environmental and archaeological specialists (appointed by the contractor) will accompany the survey crews to clearly mark sensitive environmental and archaeological sites.

Existing infrastructure that intersects the Pipeline route, such as walls, fences and paths, will be disturbed as little as possible. Existing third party services will be located, marked, and either safeguarded or diverted in accordance with owners agreements and relevant permits. It is known that the pipelines will cross beneath an underground communication cable and below a 10 kV overhead power line suspended on poles, approximately 850 m downstream from the landfall facilities.

For buried services, at the time of setting out the works, the contractor shall locate them and record depth, type and size through the use of hand excavation. All services will be adequately protected from damage by the laying of excavator mats, or geotextile membrane and hardcore and by maintaining a minimum separation distance of 1.5 m between the pipeline and existing services. Supporting spans will also be implemented to support the services if necessary. Alternatively, in agreement with the cable owner, it may be decided to cut and reroute the cable. The final decision will be subject to consultation with the cable owner and detailed design studies.

Due to the height the overhead power line is suspended over the access road and construction corridor it is possible that this may restrict certain types of vehicle from accessing the route. In order to overcome this and to maintain a safe working environment, the power will need to be cut (temporarily) and either an alternative power system provided or the power lines rerouted so that the construction equipment can travel safely along the route. A decision on which option will be selected will be based on consultation and agreement with the owners, local authorities and any other effected parties. South Stream Transport will put in place measures to ensure that disruptions to power supply are kept to a minimum.

During any works near the overhead power line, the contractor shall use extreme care to prevent contact between personnel and equipment and the power line. Clear warning signs detailing the working height and nature of the danger will be displayed either side of the overhead power line and the danger will also be explained to workers on site during safety toolbox talks.

In the event that unknown services are encountered, work will stop in this area until the nature of the services and owners have been established. Where diversions are necessary, works will be carried out in consultation with the owners. Clear warning signs will be erected for overhead cables, and temporary crossing points will be clearly marked.

Topsoil Stripping and Vegetation Removal

Prior to topsoil removal, any rare plant species (for example juniper (*Juniperus sp.*), a species listed in the IUCN Red Data List (Ref. 5.4), Red Data Book of the Russian Federation (Ref. 5.5) and Krasnodar Krai region (Ref. 5.6) will be translocated to suitable alternative habitat outside the construction corridor. Other notable species will be gathered in sufficient numbers to be used for the reinstatement work after the pipeline has been laid. In addition, the construction corridor includes areas of protected forests under the Forest Code of the Russian Federation. Tree species which are not to be translocated, and are of commercial value, will be harvested and extracted by conventional methods and standard forestry equipment. Clearance of immature or unmerchantable crops will be by use of scrub cutters or chainsaws with the resulting material being stored on site. South Stream Transport will consult with relevant land owners and the Russian Federation State Forestry Fund on the potential uses for the timber. During the Construction Phase, the requirement to strip the entire construction corridor will be reviewed by the contractor and South Stream Transport to ascertain if the area of topsoil stripping can be reduced. Further information on the habitats along the construction corridor and which species will be translocated is provided in **Chapter 11 Terrestrial Ecology**.

The topsoil will generally be stripped across the construction corridor and then stored to be used when reinstating the construction corridor. The topsoil stockpile will be typically no higher than 2 m to prevent degradation of the soil, and will be kept free from disturbance to reduce the possibility of physical damage and compaction. The careful storage of the topsoil is essential to protect the natural seed bank contained within the topsoil, which will aid the re-vegetation of the construction corridor during reinstatement works.

Some areas of the construction corridor may also be benched or graded to enable safe working, using typical construction site machinery to eliminate irregularities, large stones, tree stumps and other features.

Trenching

Each pipeline will be installed in separate, parallel trenches to achieve a centre line separation distance of approximately 19 m. The trenches will be excavated using mechanical excavators straddling or running alongside the pipeline trench. It is anticipated that some short sections of the pipeline route may encounter rock at trenching depth. Rock in such areas could be excavated by first fracturing it by mechanical means, typically a rock hammer attachment for an excavator. In the case of a large section of rock being encountered, the use of a chain trencher could be considered. Drilling and blasting of rocky sections of the pipeline route is not expected.

The open-cut pipeline trenches will be dug to a minimum depth of 2.5 m to allow for a minimum reinstated cover of 1.5 m. However, given local topography, the trench depth varies between 2.5 m and 4.5 m in order to minimise the amount of bends in the pipeline. Each trench will have a top of trench width of approximately 7 m, a trench bottom width of approximately 1.5 m and side slope angle of 45 degrees. The material excavated from the trenches (trench spoil) will be stored separately from the topsoil to prevent mixing of subsoil and topsoil that might hamper successful reinstatement.

At times it may be necessary to dewater the open-cut trench as a result of groundwater infiltration to the trench, surface run-off which has entered the trench, or directly from rainfall, although this is considered unlikely. Prior to such an activity commencing, schemes will be developed on an area by area basis. It is likely that if required, a soakaway (i.e. a pit filled with gravel or small stones) will be prepared within the construction corridor and the water will be pumped from the trench to the soakaway where it will slowly soak into the ground.

Pipe Delivery, Stringing and Bending

The 12 m pipe sections will be transported to the construction spread from the landfall pipeline construction site where the pipe sections are stored. The pipe sections will be transported along the construction corridor using stringing trucks and tracked vehicles. All pipes will arrive in a pre-coated condition (externally with 3LPP anti-corrosion coating and internally with an epoxy flow coating). Known commonly as ‘stringing’, the pipe sections will be placed end to end alongside the trench in preparation for welding. The pipe sections will be stored at least 100 mm above ground on timbers with padding and wedges.

In cases where there are significant changes in direction or elevation along the pipeline route (for example the crossing of the Graphova Gap), pipe sections with factory-manufactured bends will be installed. Final requirements for bending will be confirmed prior to pipeline installation. Where there are minor changes in elevation or direction along the pipeline route, cold bending of the pipeline will be undertaken by a bending crew. The bending crew will use a hydraulic bending machine to put gradual bends in the pipe. This equipment bends individual pipe sections to the desired angle at locations where there are changes in the natural ground contours, or where the pipeline route changes direction.

Welding, Testing and Joint Coating

The landfall section pipe ends will be bevelled in accordance with approved welding procedures using a pipe facing machine system to create a profile for welding, which will produce metal scraps (see Figure 5.14). The pipe sections will then be aligned and welded together using automatic, semi-automatic or manual welding equipment that travels along the length of the pipeline. The process is carried out inside a mobile shelter (see Figure 5.15) that covers the pipe section that is being welded and the people carrying out the work, thereby controlling the environment under which the weld is made. During welding, flux will be added to prevent oxidation of the base and filler materials. Metal scraps from bevelling and weld flux will be collected and stored in containers in the temporary construction sites before being collected by licensed waste hauliers for disposal.

Once welded, the welds will be subject to visual inspection and NDE, and the weld approved before a coating is applied to the welds on site. Any welds not meeting the required specification will be removed by cutting out a cylinder of pipe containing the weld and the pipeline re-welded and subject to full NDE.

After the welds have been checked, tested and approved, the coating crew will clean the exposed steel section at the joint between the pipes, sand-blast the steel, and apply a protective coating to it. The coating will consist of polyethylene HSS around the pipe (Figure 5.16).

Figure 5.14 Pipe Bevelling

Figure 5.15 Pipe Welding Shelter

Figure 5.16 Application of Field Joint Coating

Pipe Lowering and Backfilling

Following inspection of the weld coatings, the pipeline will be carefully lowered into the trench in a continuous operation with the aid of side booms (Figure 5.17). The pipeline trench will be backfilled in the reverse order to which it was excavated. The backfill will consist of fine grained granular material, mechanically sieved and well graded with a maximum particle size of 6 mm and will contain no sharp edges or deleterious matter.

The backfill material will be obtained, as far as practicable, using the same trench spoil that was taken from the trench originally. In rocky or uneven ground where the potential for pipe coating damage exists, the trench bottom will be given a protective 200 mm bed of soft earth or sand backfill material. Approximately 40,000 tonnes of imported material may be required to backfill the four pipeline trenches.

Backfill will normally be placed over the pipeline immediately after the pipeline has been lowered into the trench in order to protect the pipeline coating and to stabilise the open trench. The backfill is carefully compacted around and over the pipeline up to the top of the trench. Extreme care will be taken with the initial fill to avoid damage to the coating. During the burial process, a brightly coloured plastic warning tape will also be installed above the pipelines, along the entire length of the trench to provide warning in the event of future excavations in the area.

It will not be possible to return all the originally excavated trench spoil due to the volume of space taken up by the installed pipelines and removal of rock and other unsuitable backfill material, etc. It is estimated that up to 45,000 m^3 of surplus spoil will be left over from the installation of the four pipelines. Therefore, some will need to be either disposed of or incorporated into landscaping initiatives. Any surplus or unsuitable backfilling material (such as inert waste) will be removed from site and disposed of at an approved waste handling facility in accordance with applicable waste management regulations.

Reinstatement

After completion of pre-commissioning tests of the landfall and nearshore section pipelines (Section 5.4), the restoration of the construction corridor will begin. All affected areas along the construction corridor will be reinstated and restored as far as reasonably practicable to the original landform and condition. The removed topsoil will be placed back on the construction corridor. The original contours of the land will be restored as closely as possible; the topsoil will be stone picked and cultivated to enhance re-vegetation of the area.

Particular care will be taken to ensure that land drainage infrastructure, access roads and other networks and facilities disturbed / moved during construction, will be reinstated to their former state or replaced by a better quality system. Photographic records will be made of the route, where necessary, before and after the works to document any changes.

Figure 5.17 Pipe Lowering into Trench

The use of the stored topsoil (which preserves the natural seed bank and natural soil materials) will encourage natural processes and natural re-vegetation using only native plant species found on the site, thus conserving genetic biodiversity and composition of the original plant communities. Re-planting will take into account the requirements to protect the pipeline from deep-rooted vegetation.

Translocation of species of conservation concern gathered from the construction corridor before the start of the construction work will be undertaken in suitable locations where appropriate. Translocation will be undertaken in accordance with the requirements of the relevant Russian Federation authority and South Stream Transport environmental specialists. There will also be the opportunity to replant trees along the construction corridor outside the permanent 95 m wide RoW, which must be kept clear of deep rooted vegetation such as trees.

After re-instatement, the area will be monitored and maintained, as required, until normal growth patterns are re-established and confirmed by South Stream Transport's environmental specialists in accordance with requirements set out in South Stream Transport's activity-specific Russian Landfall CMP and overarching CMP - Biodiversity Management Plan. Details of the CMPs to be produced are described in **Chapter 22 Environmental and Social Management**. Further information on habitat reinstatement is provided in **Chapter 11 Terrestrial Ecology**, including provision for the replanting of areas outside the permanent 95 m wide RoW with trees.

Pipeline Markers

After re-instatement, the only visible evidence of the pipeline will be the RoW and pipeline and aerial markers placed along the route of each pipeline for future monitoring and line walking purposes. Each marker will have line of sight to its previous and following marker. A marker will also be installed wherever there is a change of direction.

Crossing of the Graphova Gap

Only one watercourse is crossed by the open-cut pipelines, an unnamed tributary of the Sukko River which is located in the Graphova Gap. This unnamed tributary has no or low flow during the summer months and more significant flow during the winter months. The Graphova Gap is approximately 15 m deep with slopes of up to 30 degrees.

If possible, the crossing will be undertaken during periods of low rainfall to minimise the potential for pollution and minimise the need for the installation of flume pipes or channel diversion, which may be required to maintain water flow during periods of heavy rain. Suitable mitigation measures to maintain flow and minimise transport of sediments will be undertaken as required in accordance with the Russian Landfall CMP. The location of the Graphova Gap can be seen in Figure 5.10.

The watercourse will be crossed using open-cut techniques. For each of the four pipelines crossing the gap, a dedicated trench will be excavated perpendicular to the watercourse, such that the top of pipeline will be approximately 1.5 - 2 m below the bed of the watercourse. The bottom of the trench will be approximately 2 - 3 m wide, with side slopes of approximately 45 degrees. Excavation of the pipeline trenches can be performed using standard hydraulic excavators and the pipeline will be installed conventionally using standard pipe-laying equipment. During installation some pipe sections will undergo cold bending to ensure the pipeline follows the contours of the watercourse crossing.

After installation of the pipeline in the trench, protective measures will be installed to prevent possible flash floods from eroding the bed of the watercourse and exposing the external coating of the pipeline. This protection can be achieved by installing a pre-cast concrete slab (approximately 1.2 m wide and 0.15 m thick) and suitable engineering backfill, i.e. graded material on top of the pipeline with boulders placed above to prevent erosion, prior to general backfilling. An indicative design of the watercourse crossing is shown in Figure 5.18.

A detailed design of the crossing will be prepared by the appointed contractor prior to pipeline installation, for approval by South Stream Transport.

Following backfilling of the trench the crossing will be reinstated. However, due to the steepness of the existing gully slope, the reinstated slope profile will have to undergo some excavation and grading works to ensure the slopes remain stable during the Operational Phase of the Project so as to reduce the risk of damage to the pipelines and also to allow safe access for inspection purposes.

A number of techniques exist that could be used to stabilise the slopes. A possible solution is the use of geotextiles. Geotextiles are installed in layers between layers of fill material. After every layer of fill (about 0.5 to 1.0 m, depending on the quality of the fill material and angle and height of the slope) a geotextile blanket will be added and wrapped around the subsequent layer of fill. In this way, the stability of the slopes is significantly increased. The surface of the slope will be covered with a thin layer of topsoil.

To prevent erosion of the topsoil a special erosion-control geotextile mat will be installed. This geotextile mat, with an open structure, reinforces the upper 1 to 2 cm of the topsoil, and prevents surface erosion on the slope and supports the growth of vegetation such as grass or small bushes.

All temporary works will then be removed in a controlled manner so as to minimise sediment disturbance. A detailed design of the crossing will be prepared by the appointed contractor during the detailed design phase prior to pipeline installation. The design will ensure that the water course will be fully functional following reinstatement. Although it is not anticipated that there will be water present in the watercourse during construction, silt fences and/or other suitable measures (i.e. sediment entrapment matting or straw bales) will be located along and adjacent to this watercourse as required.

Crossing of the Marfovsky Fault

The landfall section pipelines will pass through the Marfovsky Fault as shown in Figure 5.10. The fault will be crossed using traditional open-cut techniques. However, to minimise the effect of potential displacement from seismic activity, each pipeline will be laid in an enlarged trench approximately 200 m long that will have a bottom trench width approximately 5 m wide.

The depth of the excavated trench shall be at least 3 m below the lowest point of the pipeline and the cover depth above the top of the pipeline will be approximately 1.5 m. The pipelines in the fault section will be laid on a bed of sand and backfilled with loose sand rather than the previously excavated soils. The combination of the wider trench and backfilling with loose sand allows the pipelines to move in a lateral direction should there be any movement by the fault, thereby lowering the risk of damage to pipeline integrity.

Crossing of Dirt Roads

Multiple dirt roads associated with agricultural activities are crossed by the pipelines, for which the open-cut construction methods described above are considered suitable. Landowners will be consulted by South Stream Transport to inform them of temporary road closures. Measures, such as creating detours or phasing road closures, will be implemented to minimise nuisance to agricultural traffic.

Microtunnel Construction Site Requirements

The construction of the microtunnels will require a construction site of approximately 8.76 ha as shown Figure 5.10. The microtunnel construction site will contain all the plant and equipment required for construction of the microtunnels and will also include the location of the four microtunnel entry shafts. A typical layout of the microtunnel construction site is shown in Figure 5.19.

It should be noted that the final layout (within the defined area) will be subject to the preference of the appointed microtunnel installation contractor. For the purposes of this ESIA Report, it is anticipated that the microtunnels will be constructed one after the other, with only one tunnel boring machine (TBM) in operation at once. The microtunnel construction site will be in operation for approximately two years (includes from site preparation to completion of reinstatement work). However, the appointed microtunnel installation contractor may choose to start microtunnelling a second tunnel before the first is complete, which would reduce the construction period.

Microtunnel Construction Method

Microtunnelling is a trenchless construction method used to excavate underground tunnels. The microtunnelling method involves pushing pre-cast concrete jacking pipes (pipes designed to be driven through the soil to line and stabilise the pipe tunnel) behind a steerable, remotely controlled TBM from an entry shaft to an exit pit. On completion of the microtunnel, the pipelines are installed within the microtunnel by pulling the welded pipeline string through the microtunnel. The total length of each microtunnel is approximately 1.4 km (approximately 1 km is below the land surface and approximately 0.4 km of the microtunnel is below the seabed). The microtunnel will enable the crossing of the Varvarovka to Sukko road and the Shingar River without any damage or interruption.

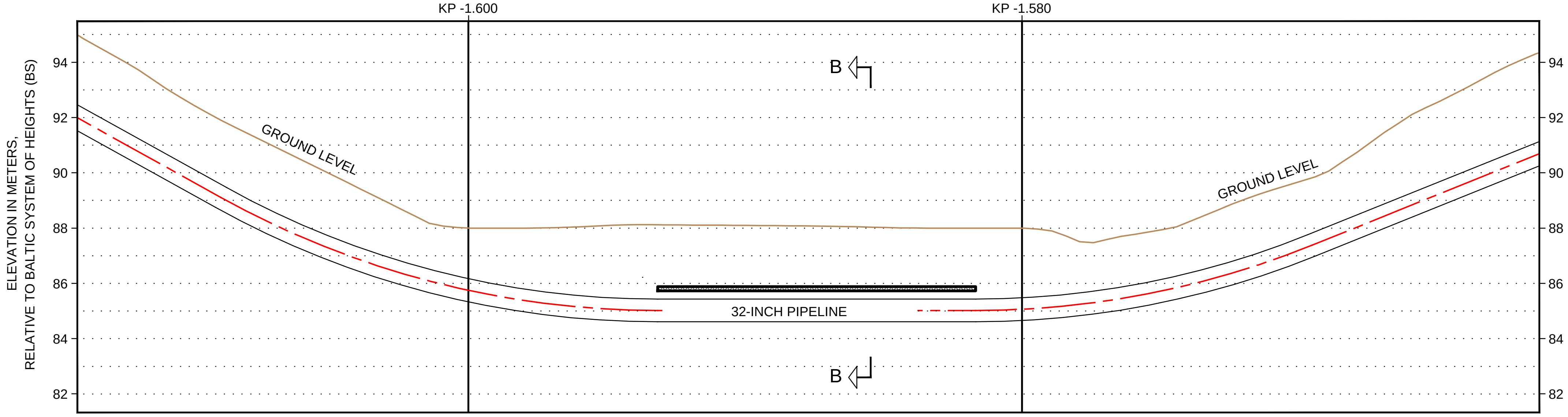
Each microtunnel will be a circular shape and will have an outer diameter of approximately 2.5 m.

The location of the four microtunnels is shown in Figure 5.20 and a longitudinal profile of the microtunnel for pipeline #1 is illustrated as an example in Figure 5.21. All four pipelines will have similar longitudinal profiles. The construction of the microtunnels will consist of the following main activities:

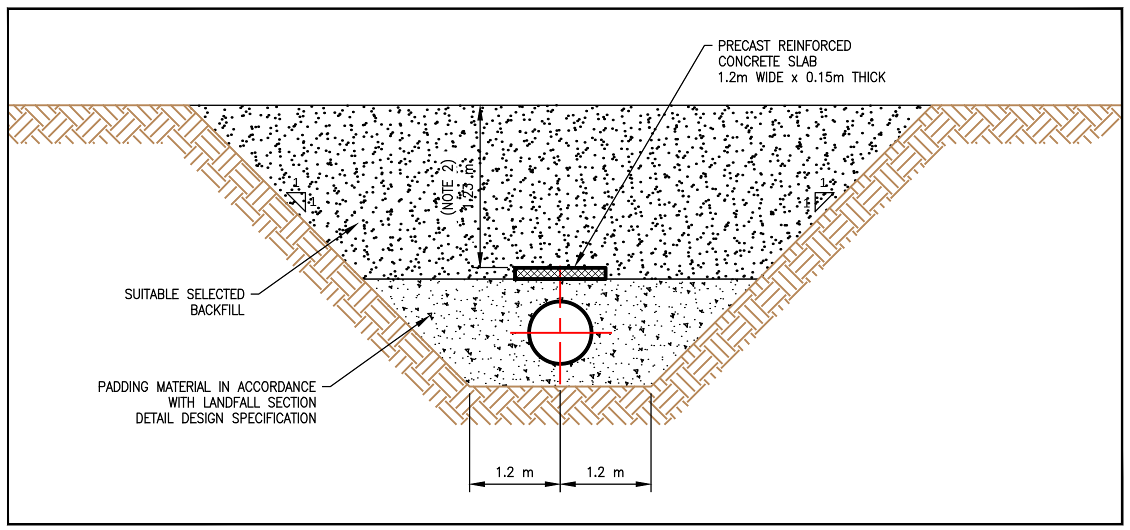
- Excavation and construction of the entry shaft to launch the TBM followed by the concrete jacking pipes;
- Excavation of the microtunnel, which will be continuously lined by the concrete jacking pipes;
- Excavation of the offshore microtunnel exit pit and recovery of the TBM; and
- Pipeline installation and grouting of the microtunnels.

An illustration of a typical microtunnel being constructed is shown in Figure 5.22 and a list of the equipment necessary to construct the microtunnels is provided in Table 5.9. The construction of the microtunnel will require construction activities to be undertaken in both the landfall and nearshore sections of the Project Area. This section of the chapter provides details on the activities associated with the landfall section although makes reference to activities in the nearshore section in order to clearly set out the microtunnelling construction process. More detailed information on the construction activities within the nearshore section is provided in Section 5.3.4.

LONGITUDINAL SECTION A - A (SCALE 1:100)



CROSS SECTION B - B (SCALE 1:50)



RUSSIAN SECTOR OF THE SOUTH STREAM OFFSHORE PIPELINE

NOTES

1. Elevations are in meters, relative to Baltic System of Heights (BS).
2. Minimum cover 1.22 m. from top of precast concrete slab.
3. Length and extend of precast concrete slabs to be determined during detail design.
4. Cover depth of pipeline section in crossing and location of concrete protection slabs to be re-evaluated with additional survey data, to be available for detail design.

Projection: Lambert Conformal Conic

Revision Details	By / Check	Date	Suffix

Purpose of issue

For Information

Client

South Stream
Offshore Pipeline
ENERGISING EUROPE

Project Title

SOUTH STREAM
OFFSHORE PIPELINE

Drawing Title

Indicative Design for Pipeline Crossing of the Unnamed Tributary of the Sukko River

Designed	Drawn	Checked	Approved	Date
RW	OAS	MJW		19/03/14

URS Internal Project No.	Scale @ A3
46369078	As Shown

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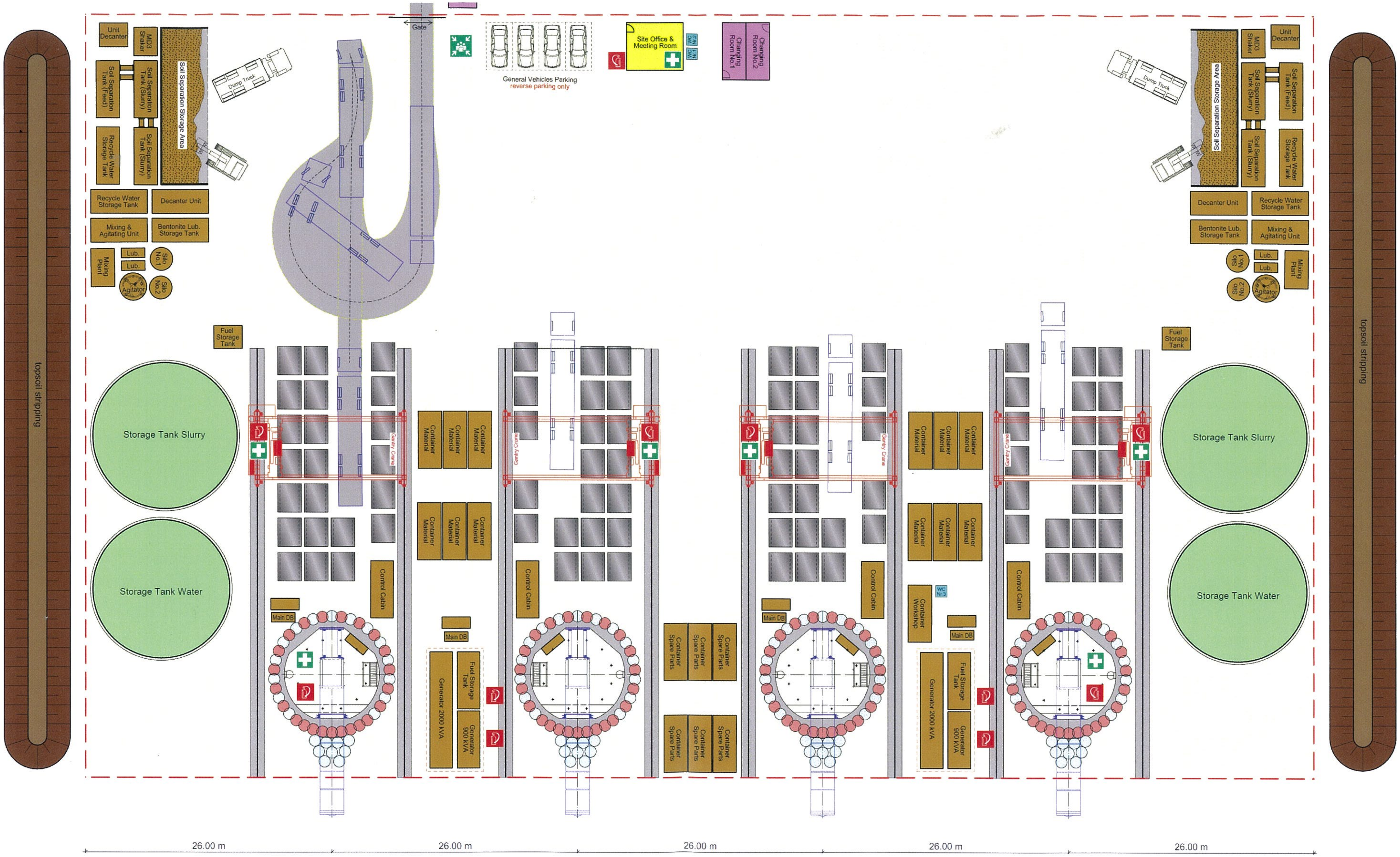
Drawing Number	Rev
Figure 5.18	

Figure 5.19 Typical Microtunnel Construction Site Layout



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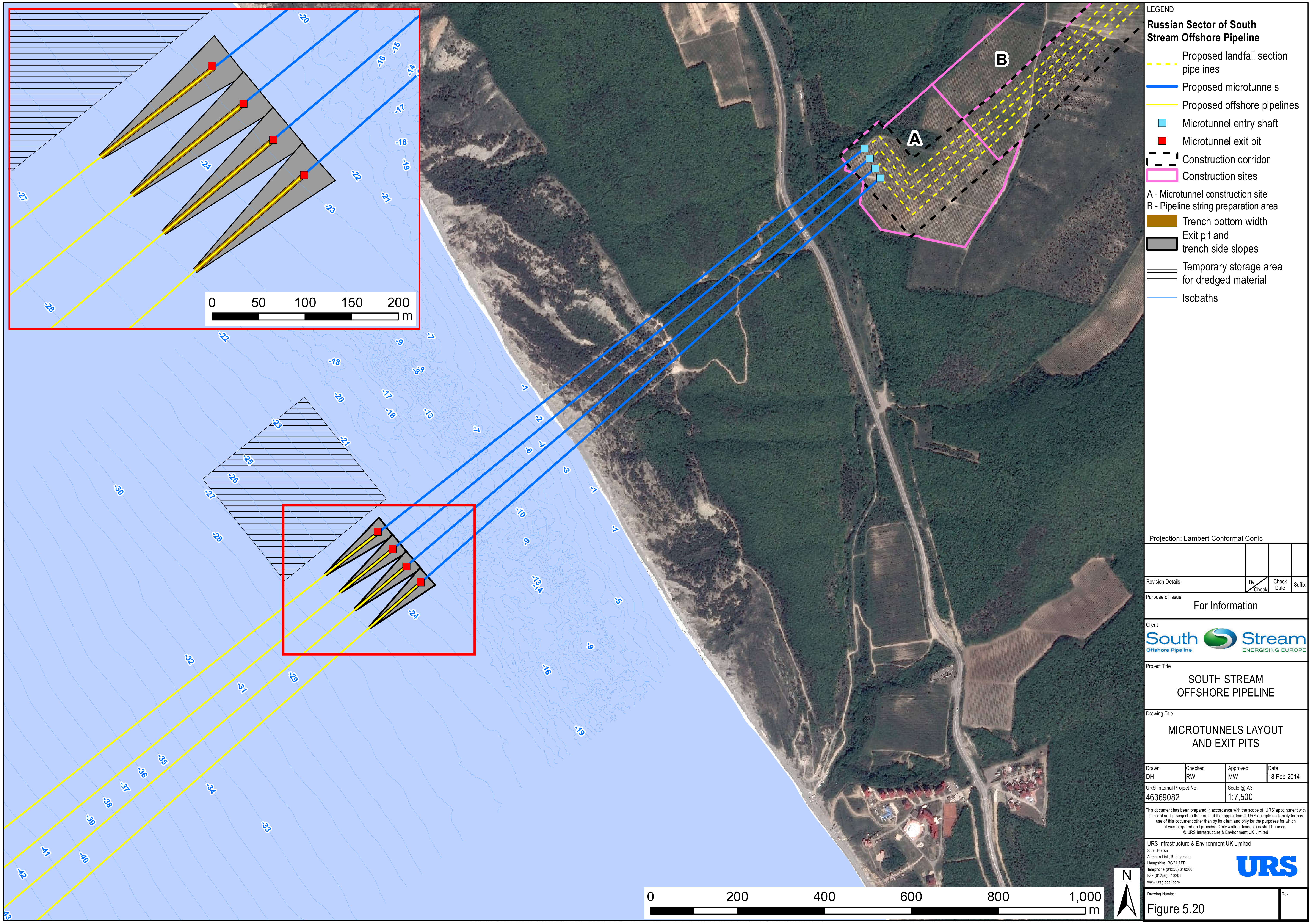

Revision Details	By Check	Check Date	Suffix

Purpose of Issue: For Information

Client: South Stream Offshore Pipeline — Energising Europe

Project Title: SOUTH STREAM OFFSHORE PIPELINE

Drawing Title: MICROTUNNELS LAYOUT AND EXIT PITS

Drawn	Checked	Approved	Date
DH	RW	MW	18 Feb 2014

URS Internal Project No.	Scale @ A3
46369082	1:7,500

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Drawing Number: Figure 5.20
Rev

Plot Date: 18 Feb 2014
File Name:I:\5004 - Information Systems\46369082_South_Stream\MXDs\Report Maps - Russia\Russian ESIA v2\Chapter 5 Project Description\Figure 5-20 Microtunnels Layout and Exit Pits.mxd

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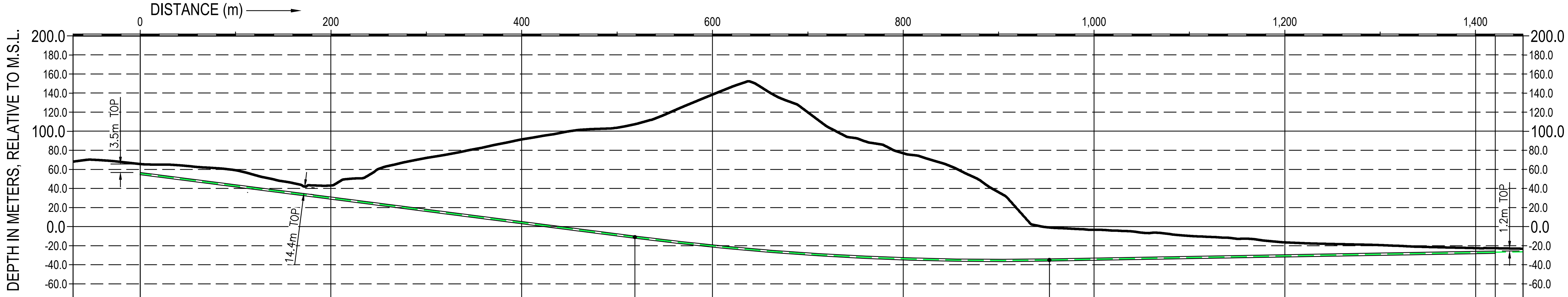
LONGITUDINAL PROFILE

VERTICAL SCALE 1: 5,000 HORIZONTAL SCALE 1: 5,000



HOR. DISTANCE FROM ENPT-1-R.1	0.00 m	200.00 m	400.00 m	518.59 m	600.00 m	800.00 m	953.18 m	1,000.00 m	1,200.00 m	1,420.66 m
GROUND ELEVATION	65.61 m	43.09 m	91.39 m	107.26 m	138.36 m	76.90 m	-0.94 m	-3.34 m	-16.52 m	-22.64 m
CENTER LINE MICRO TUNNEL	55.61 m	29.92 m	4.23 m	-11.01 m	-20.34 m	-33.76 m	-35.00 m	-34.18 m	-30.69 m	-26.84 m
VERTICAL ANGLE / LENGTH BENDING RADIUS / LENGTH	ANGLE= 7.3° / L= 522.8 m (NOTE 3)			R= 3,000 m / L= 435.6 m (NOTE 3)			ANGLE= 1° / L= 467.6 m (NOTE 3)			
TOP OF MICRO TUNNEL	56.82 m	31.13 m	5.44 m	-9.80 m	-19.13 m	-32.56 m	-33.80 m	-32.98 m	-29.49 m	-25.64 m
COVER (TOP OF MICROTUNNEL)	8.79 m	11.96 m	85.95 m	117.06 m	157.49 m	109.46 m	32.86 m	29.64 m	12.97 m	3.00 m

RUSSIAN SECTOR OF THE SOUTH STREAM OFFSHORE PIPELINE

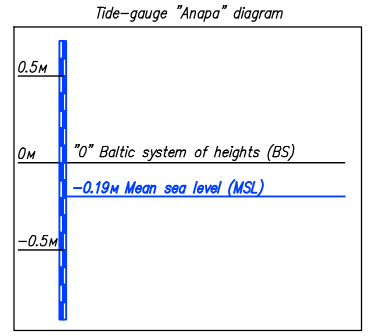
LEGEND

— — — — LANDFALL SECTION PIPELINE 1

NOTES

1. DIMENSIONS ARE IN METERS, UNLESS NOTED OTHERWISE.
2. ALL ELEVATIONS ARE IN METERS, RELATIVE TO BALTIC SYSTEM OF HEIGHTS (BS).
3. LENGTH IS MEASURED ALONG CENTER LINE OF MICROTUNNEL.
4. TOTAL LENGTH MICROTUNNEL = 1,426.0 m.
5. MICROTUNNEL DETAIL DESIGN (INCL. INSTALLATION ENGINEERING) TO BE PERFORMED BY CONTRACTOR.

Tide–gauge "Anapa" diagram



GEODETIC & PROJECTION PARAMETERS

GEODETIC DATUM	: WORLD GEODETIC SYSTEM 1984 (WGS84)
PROJECTION	: LAMBERT CONFORMAL CONIC
CENTRAL MERIDIAN	: 34° 00' 00" E
ORIGIN OF LATITUDE	: 43° 00' 00" N
FIRST STANDARD PARALLEL	: 30° 00' 00" N
SECOND STANDARD PARALLEL	: 50° 00' 00" N
FALSE EASTING	: 0.0 m
FALSE NORTHING	: 0.0 m
SCALE FACTOR	: 1.0000

METERS

0 20 100 200

HORIZONTAL SCALE 1:5000 (AT "A3" SIZE)

Projection: Lambert Conformal Conic

Revision Details	By / Check	Date	Suffix

Purpose of issue: For Information

Client: South Stream Offshore Pipeline — ENERGISING EUROPE

Project Title: SOUTH STREAM OFFSHORE PIPELINE

Drawing Title: Longitudinal Profile of Microtunnel for Pipeline 1

Designed	Drawn	Checked	Approved	Date
RW	OAS	MJW		19/03/14

URS Internal Project No.: 46369078 — Scale @ A3: 1:5000

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Drawing Number: Figure 5.21 — Rev:

Figure 5.22 Typical Microtunnel Construction

(Image supplied courtesy of Herrenknecht AG)

Entry Shaft Construction

A microtunnel entry shaft is required to ensure that the TBM commences excavation of the microtunnel at the correct angle. It is estimated that the entry shafts will be approximately 10 - 12 m deep and 12 m in diameter. The entry shafts are formed by drilling piles (typically a combination of reinforced and unreinforced bored concrete piles) to the required depth around the shaft location to form a continuous circular secant piled wall (secant pile walls are formed by constructing intersecting reinforced concrete piles) for the shaft. Once the outer frame is in place, the shaft will be excavated out to the required depth and a reinforced concrete slab will be constructed at the base of the shaft. Each shaft will require approximately 1,250 m^3 of material to be excavated and approximately 600 m^3 of concrete to form the shaft walls.

Table 5.9 Estimated Plant and Equipment Required for Construction of the Microtunnels

Construction Activity	Equipment	No.	Size / Weight	Capacity / Rating	Predicted Noise Level	% on-time 24 hours day	Duration of usage (total unless stated)	Notes
Entry Shaft Construction Equipment	Bore pile drilling rig	1	27.5 m high 142 tonne	Drilling depth of up to 80 m	LAeq, T at 10 m of 83 dB	50	60 days per tunnel	Only one of the two bore pile drilling rigs will be required to prepare each entry shaft. The preferred rig will depend on the ground conditions present
	Bore pile drilling rig (alternative depending on ground conditions)	1	26.5 m high 96 tonne	Drilling depth of up to 71 m	LAeq, T at 10 m of 83 dB	50	60 days per tunnel	
	Hilti drop in (HDI) in anchoring rig (a drop-in anchor designed for use in solid concrete)	1	31 tonne	Stroke up to 12 m	-	50	5 days per tunnel	
	Cement grouting injection unit	2	2 x 20" containers 18 tonne		-	100	14 days per tunnel	Injection unit will include mixing and injection of soilcrete (a mixture of soil and concrete)

Continued…

Construction Activity	Equipment	No.	Size / Weight	Capacity / Rating	Predicted Noise Level	% on-time 24 hours day	Duration of usage (total unless stated)	Notes
Cranage and Excavation	Gantry crane	2	11.8 x 15 x 14.6 m	50 t lifting capacity	LAeq, T at 10 m of 75 dB	40	20 months	For moving and lowering jacking pipes to entry shaft
	All terrain mobile crane	1	8.3 m x 4.9 m, height depends on setup 115 tonne	120 t lifting capacity	LAeq, T at 10 m of 74 dB	35	2 years	For general setup, mobilisation and demobilisation, heavy equipment handling and movement of jacking pipes around site
	Excavators	4	20 – 40 tonne	60 – 215 kW	LAeq, T at 10 m of 76 dB	50	There will only be a need for one excavator to be used continuously for the two year construction period. The other three will be used as required	
Tunnel Boring	TBM	2	OD 2.5 m ID 2.25 m 48 tonne	-	Sound power level 75-80 dB (inside TBM)	100	100 days per tunnel	
	Air lock (decompression chamber attached to TBM)	2	OD 2.5 m ID 2.25 m 23 tonne	-	-	100	100 days per tunnel	

Continued…

Construction Activity	Equipment	No.	Size / Weight	Capacity / Rating	Predicted Noise Level	% on-time 24 hours day	Duration of usage (total unless stated)	Notes
Tunnel Boring	Control cabin	2	6 m x 2.4 m x 2.6 m 17 tonne	-	Sound power level 75 dB (inside cabin)	100	100 days per tunnel	
Microtunnel Ventilation and Lubrication	Compressor with air cooling and dryer	2	1.25 m x 1.8 m x 1.35 m	12.7 m^3/min @ 7.5 bar	Sound power level 70 dB	100	120 days per tunnel	Power provided by separate generator
	Ventilation fan	2	1.2 m x 1.2 m x 3 m 3 tonne	2 x 7.5 kW	Sound power level 65-70 dB	10	120 days per tunnel	Standby only – unlikely to be used
	Injection pump for lubrication	2	1.5 m x 0.8 m x 1 m 1.2 tonne	100 bar	Sound power level 65 dB	100	90 days per tunnel	
	Automatic mixing unit usable for bentonite and grouting	3	2.44 m x 2.44 m x 2.44 m 5 tonne	20 m^3/hour	Sound power level 65 dB	25	105 days per tunnel	Three months bentonite mixing and two weeks grout mixing

Continued...

Construction Activity	Equipment	No.	Size / Weight	Capacity / Rating	Predicted Noise Level	% on-time 24 hours day	Duration of usage (total unless stated)	Notes
Microtunnel Ventilation and Lubrication	Storage silos (20-30 m^3)	4	3.6 m x 3.6 m x 1 m 6 tonne	20-30 m^3	-	-	120 days per tunnel	
Solids Control and Slurry Handling	Separation plant	2	2.44 m x 2.44 m x 6.09 m 12 tonne	500 m^3/hour	LAeq, T at 10 m of 79 dB	100	20 months	
	Centrifugal plant	3	2.44 m x 2.44 m x 6.09 m 12 tonne	150 m^3/hour	Sound power level 90 dB (inside container)	20	16 months	
	Flocculation plant	2	2.44 m x 2.44 m x 6.09 m 12 tonne	30 m^3/hour	-	10	16 months	Usage unlikely due to geology along tunnel route
	Water / slurry separation tanks	10	2.4 m x 2.4 m x 6.2 m 6 tonne	25 m^3	-	-	20 months	
	Water / slurry storage tank	2	Diameter 15 m	1,000 m^3	-	-	20 months	

Continued…

Construction Activity	Equipment	No.	Size / Weight	Capacity / Rating	Predicted Noise Level	% on-time 24 hours day	Duration of usage (total unless stated)	Notes
Solids Control and Slurry Handling	Water / slurry storage tank	2	Diameter 15 m	1,000 m^3	-	-	20 months	
	Separation agitators	6	2 m x 1.8 m wings	Up to 30 m^3 5.5 kW	-	60	16 months	
Generators and Tanks	Diesel generator	2	12 m x 2.5 m x 3 m 21 tonne	1,130 kVA 904 kW 400 V	LAeq, T at 10 m of 67 dB	100	16 months	Main generator for microtunnelling equipment
	Diesel generator (back-up)	2	6 m x 2.5 m x 3 m 15 tonne	810 kVA 648 kW 400 V	LAeq, T at 10 m of 65 dB	30	16 months	Only used to supplement main generators if necessary
	Construction site diesel generator for offices, security lighting and telecoms	1	4.2 m x 1.4 m x 2.2 m 4.5 tonne	250 kVA 200 kW 400 V	LAeq, T at 10 m of 74 dB	100	20 months	Only required if the site does not have a connection to the national grid

Continued...

Construction Activity	Equipment	No.	Size / Weight	Capacity / Rating	Predicted Noise Level	% on-time 24 hours day	Duration of usage (total unless stated)	Notes
Generators and Tanks	Tanks with appropriate secondary containment for leakage control of slurry	2	6 m x 2.5 m x 3 m	9,000 litres	-	-	20 months	
	Tanks with appropriate secondary containment for diesel storage	2	3 m x 2.3 m x 3 m	3,000 litres	-	-	20 months	

Complete.

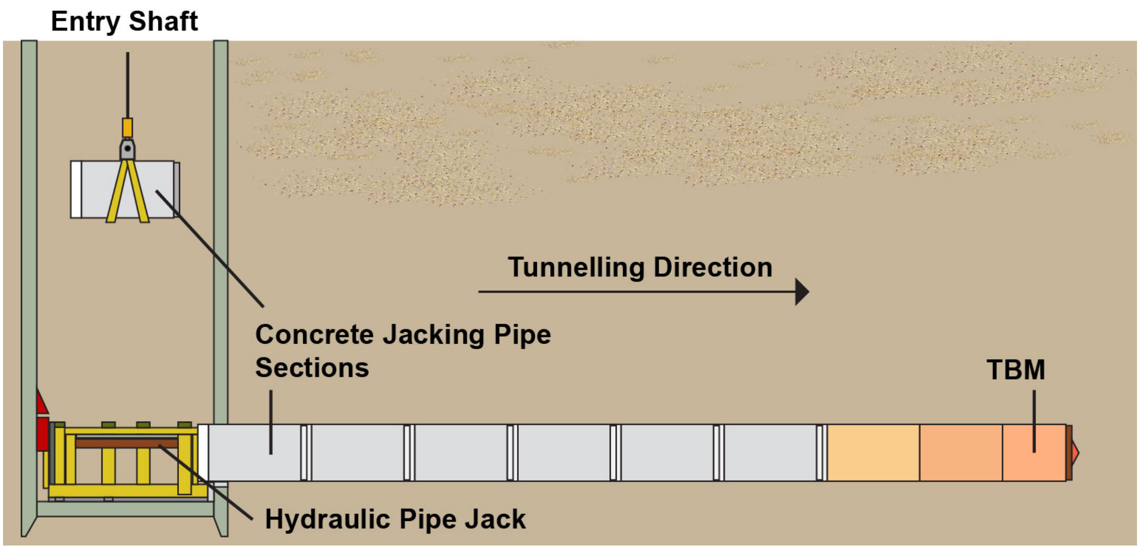
Microtunnel Excavation

Microtunnelling will be undertaken using a remotely controlled TBM, which is lowered into the entry shaft by a crane. The microtunnelling operation will be undertaken on a 24 hour day, seven day per week basis and the average rate of tunnel excavation will be approximately 10 to 15 m per day. It is anticipated that each microtunnel will take approximately four months to excavate. The construction schedule assumes that each of the four microtunnels will be constructed one after the other; however, it is possible that the contractor (with agreement from South Stream Transport) could choose to construct two tunnels simultaneously.

In addition to the TBM, additional equipment will be used to advance and control the TBM and concrete jacking pipes and manage excavated soils and slurry. Further details on equipment are provided in Table 5.9.

The pipe jacking process which will be used to advance the TBM and concrete jacking pipes is shown in Figure 5.23. Approximately 485 concrete jacking pipes (each approximately 3 m long and 2.5 m in diameter) will be required for each microtunnel. Each jacking pipe section will have a spigot at one end and a socket at the other end. The spigot end of one pipe section is inserted into the socket of another pipe section with a secure seal being made between the two within the socket. It is anticipated that concrete jacking pipes will be delivered to the site pre-fabricated and ready for installation. Alternatively, they could be prepared at site within a temporary shed constructed within the Pipeline String Preparation Area (Site B).

Figure 5.23 Pipe Jacking Process



In addition to the main hydraulic pipe jack in the entry shaft, there will be a number of intermediate jacking stations installed approximately every 100 m along the microtunnel. The intermediate jacking stations effectively break the whole microtunnel jacking length into smaller pipe jacking sections and redistribute the total required jacking force.

The TBM will be equipped with an air lock. The air lock is effectively a decompression chamber that is attached to the TBM that allows workers to safely adjust to the atmospheric conditions at the tunnel face under compressed air.

TBMs have a rotating cutting head to excavate the ground material. The cutting head is lubricated with slurry made of water and bentonite (a natural, inert, non-toxic clay) that is pumped through hoses to the cutting head from slurry mixing equipment located in the microtunnelling construction site. The bentonite will be in a dry powder clay form and will be mixed with the fresh water in the microtunnel construction site prior to being pumped to the cutting head. It is estimated that approximately 1,200 tonnes of bentonite will be required for the slurry and lubrication to construct all four microtunnels.

Each microtunnel will require approximately 9,250 m^3 of freshwater during construction for lubrication, slurry production and grouting purposes. It is anticipated that the water will be supplied by tankers, which will collect the water from a well located at the northern edge of the village of Sukko as described in Section 5.3.3.2 and shown in Figure 5.8. It is estimated that a maximum quantity 10,000 m^3 of water may need to be stored for the construction of the microtunnel due to a five month restriction period (May to September inclusive) when water may not be taken from this source. The water required for slurry (5,000 m^3 per microtunnel) will be mixed with soda ash (known chemically as sodium carbonate (Na_2CO_3)) to achieve an ideal pH of approximately 9.0 before mixing with the bentonite in a standard mixing agitator. It is anticipated that approximately 25 tonnes of soda ash will be required for the construction of the four microtunnels. The additives in the slurry (e.g. bentonite) will be selected from the OSPAR/PLONOR list of substances. The Oslo Paris Commission (OSPAR)[3] List of Substances and Preparations Used and Discharged Offshore which are considered to Pose Little or No Risk to the Environment (PLONOR) contains a list of substances whose use and discharge offshore are subject to expert judgment by the competent national authorities or do not need to be strongly regulated.

A residual coating of the slurry mixture on the exterior of the concrete jacking pipes will help reduce the friction between the jacking pipes and the surrounding soil. The TBM is also equipped with a crushing cone to crush larger particles into smaller sizes for transport through the slurry lines, a hydraulic or electric motor to turn the cutting head, a pressurised slurry mixing chamber behind the cutter head to maintain face stability, an articulated steering unit with steering jacks for steering corrections, various control valves, pressure gauges, flow meters, and a data acquisition system. Additionally, the TBM has inline cameras to relay information to the operator and a target system for guidance control.

Slurry and Waste Management

Each microtunnel will require approximately 7,000 m^3 of material to be excavated. The drill cuttings are removed from the tunnel by means of slurry. Slurry pumps in the tunnel section behind the TBM will transport the slurry through pipes to the microtunnel construction site.

[3] OSPAR refers to the Oslo and Paris *Conventions for the Protection of the marine Environment of the North-East Atlantic* (OSPAR Conventions), 1992.

Most of the slurry (consisting of water, bentonite and drill cuttings) will be returned to the surface where a separation plant located within the microtunnel construction site will filter the slurry to remove the drill cuttings and store it in temporary mud storage tanks for re-use.

The separation plant contains various stages of modular units which incorporate physical grating shaker screen filters and hydrocyclone units. Each of the stages shown in Figure 5.24 will separate and remove materials of different sizes from the slurry starting with coarse rock particles from approximately 60 mm down to fine material of size just below 0.1 mm.

The soil separation process is shown in Figure 5.24 which illustrates that after the solids and fines separation, the slurry is returned via the pumped process and will re-circulate to the TBM face via the tunnel piped circuit, thereby completing the cycle. The slurry's soil-carrying attributes will deplete over time in this process, due mainly to the inclusion of very fine excavated materials. The condition and capability of the slurry is constantly monitored. Either make-up slurry, which is mixed adjacent to the separation plant, or recycled/cleaned slurry, is added via the reservoir feed header tanks and replenishes the slurry circuit as needed.

All of the solid outputs of the slurry separation process will be removed from the temporary storage areas by dump truck to facilities capable of reusing the material (rock, gravel and sand), or to approved waste sites in accordance with national waste regulations if there are no means of recycling the material offsite or if the soil is contaminated.

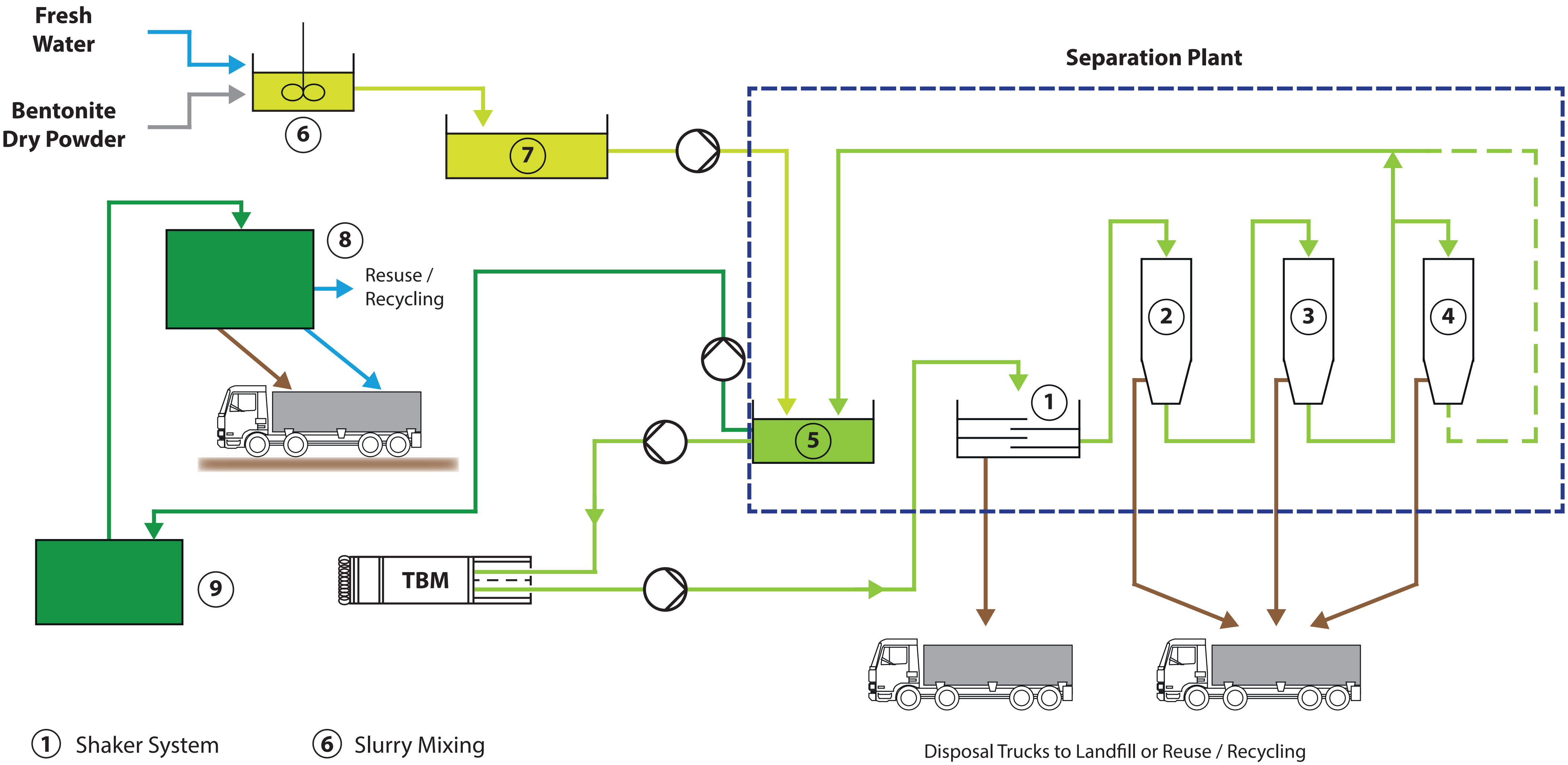
The separation plant storage area shown in Figure 5.24 will be equipped with its own floor drainage system. Wet slurry draining from the separated material will run-off to local drains within the microtunnel construction site and from there it will be pumped into the recycled slurry process for reuse.

The unused waste slurry liquid that is residual from the centrifuge or filter press is recycled and re-introduced back into slurry preparation. After completion of the microtunnel works, any remaining slurry will be transported from the used slurry storage tank to a licensed waste facility, where it is typically handled as normal soil waste. By undertaking careful calculations of slurry requirements and using efficient slurry recycling systems, the amount of surplus slurry will be kept to a minimum.

Excavation of the Offshore Microtunnel Exit Pits and Recovery of the TBM

The recovery of the TBM at the exit of the microtunnel requires the excavation of an offshore exit pit for each pipeline. The exit pits are located approximately 400 m offshore in a water depth of approximately 23 m. Further information on the excavation of the microtunnel exit pits and TBM recovery is presented in Section 5.3.5.4.

Figure 5.24 Slurry Separation Process



1 Shaker System
2 Large Cyclone
3 Medium Cyclone
4 Small Cyclone
5 Header Tank
6 Slurry Mixing
7 Fresh Slurry
8 Filter Press
9 Used Slurry Storage

Installation of the Pipeline in the Microtunnel

Following completion of each excavated microtunnel exit pit and trench in the nearshore section, the pipeline will be installed within the microtunnels using a pull-in winch. Welding, field joint coating and inspection of the pipeline string will be undertaken onboard a pipe-lay vessel located near the microtunnel exit pits. As the pipeline string is welded together onboard the pipe-lay vessel the completed pipeline is pulled through the transition trench and microtunnel from the stern of the pipe-lay vessel by a cable or rods connected to a linear winch located onshore within the microtunnel construction site.

The pipeline pull-in process will require some reconfiguration of the microtunnel construction site. This is to provide room for the pull-in equipment, including a suitable area for the installation of anchor hard points for the winch system and locating the winch and reel winder that will store the pull-in cable. The winch system will likely be constructed using sheet or tubular piles as anchors. It is anticipated that a multiple winch system will be required to provide the necessary force to pull-in each pipeline. The pipeline string will have the outer surface of the pipe coated with a Glass-Fibre Reinforced Plastic (GFRP) sheath to protect the 3LPP coating against impact or friction wear as it is pulled through the microtunnel. It is anticipated it will take approximately five days to complete the pipeline installation within each of the microtunnels.

Construction activities in the nearshore section associated with the installation of the pipeline in the microtunnels is described in more detail in Section 5.3.5.5.

Following pipeline installation within the microtunnel, a tie-in between the microtunnel pipeline string and the open-cut landfall section pipelines will be made within the entry shaft.

Grouting of Microtunnels

The gap between the outside of the pipeline and the inside wall of the microtunnel will be filled with grout following hydrotesting of the landfall and nearshore sections of the Project pipelines (described in more detail in Section 5.4.2). The purpose of the grout is to secure the pipelines within the tunnels. The grout (a mixture of cement, bentonite and freshwater) will be batched within the microtunnel construction site. Approximately 5,500 m^3 of grout will be required per tunnel, and 22,000 m^3 for all four tunnels.

Prior to grouting, both ends of the microtunnels will be sealed. At the entry shaft end, a brick wall is built by hand and sealed around the product pipeline and the various grouting fill pipes. The grout shall be pumped into the flooded and sealed microtunnel from the entry shaft end through several injection tubes until the microtunnel is completely filled. This process will displace the seawater through a seaward-end outlet pipe. It is expected that a certain amount of mixing of the grout with the seawater will occur. The expelled water will be monitored at a sea surface outlet pipe where it is expected a mixture including some grout will eventually appear. The amount of mixed material that may be released to the marine environment is estimated to be small.

The mixed material will be tested and if it is deemed to contain too much solid grout material for discharge to sea (as determined by local regulations and international standards), it will be pumped to a tank upon a vessel at the microtunnel exit pit where separation of the grout from the seawater will be undertaken using on-board filtering equipment. There are three possible filtering methods that could be selected:

- Settlement and dilution with seawater;
- Centrifuges; and
- Flocculation.

The chosen filtering option will be selected by the installation contractor based on the quantity of mixed material, the grade of grout, and water pH and temperature. The grouting process will be monitored until the correct (input) concentration of grout appears on the discharge end. The grouting pipes at both ends of the microtunnel will be plugged and the microtunnel construction will be completed.

5.3.4.5 Landfall Section Construction Material Use, Utilities, Waste and Emissions

Material Use

During construction of the landfall section pipelines and landfall facilities a number of materials will be required. An estimate of the quantities of the main materials to be consumed for construction of the four landfall section pipelines and landfall facilities are shown in Table 5.10. Quantities shown are approximate and subject to final optimisation during the detailed design process.

Table 5.10 Material Consumption during Construction of the Landfall Section

Material	Quantity (all four pipelines)
Landfall Section Pipelines	
Steel (pipe sections)	8,600 tonnes
Imported Backfill Material (sand or soft earth)	20,600 tonnes
Field Joint Coating (HSS)	950 sleeves
Weld Material	21.5 tonnes
Pre-cast Concrete Jacking Pipes	2,000 jacking pipes
Concrete (microtunnel entry shafts)	2,400 m^3
Bentonite	1,200 tonnes
Grout	22,000 m^3

Continued...

Material	Quantity (all four pipelines)
Landfall Facilities	
Steel (piping and equipment)	6,000 tonnes
Concrete (foundations of piping, equipment and containers)	10,000 tonnes
Imported fill material for site preparation (stone/rock)	134,000 tonnes
Field Joint Coating (HSS)	80 sleeves
Weld Material	0.5 tonnes
Paving Blocks / Slabs (to form areas of hardstanding)	6,000 tonnes
Crushed Rock (paving foundations)	8,000 tonnes
Gravel (surfacing of areas outwith hardstanding)	6,000 tonnes
Access Roads and Temporary Facilities	
Rock for access roads	297,331 m^3
Asphalt concrete for access roads	960 m^3
Rock for temporary facilities hardstanding areas	62,930 m^3

Complete.

Fuel Use

It is anticipated that an average of approximately 4.1 m^3 of diesel per day will be consumed by construction vehicles and equipment required for the construction of the landfall section. Diesel required for construction will be delivered to the construction sites by appropriately licenced road fuel tankers.

Fuel / Chemical Storage and Refuelling

There will be dedicated plant and vehicle refuelling areas within the construction sites, which will be situated away from surface waters, groundwater and surface water drains. Fuel tanks will be bunded. Secondary containment will be provided by forming an impermeable bund (i.e. a wall) around the refuelling area to provide containment in the event of a spill or rupture. Both storage tank and secondary bunding will be sufficient to contain at least 110% of the volume of fuel being stored. The location of the fuel tank storage areas within the construction sites will be subject to contractor preference.

Strict procedures will be followed when refuelling to minimise the risk of spills to the environment. All refuelling activities will be undertaken in line with requirements set out in the

Russian Landfall CMP, which will be developed as part of South Stream Transport's ESMP. The requirements of the CMP need to be met by both South Stream Transport and the appointed contractors (and sub-contractors). Other fuels, oils and chemicals will be securely stored in clearly marked containers in a contained area to prevent pollution. It will also be ensured that spill kits, containing clean-up/absorbent materials etc. are stored in close proximity to the refuelling areas and with any mobile fuel bowsers.

Chemicals and materials will be clearly labelled and Material Safety Data Sheets (MSDS) will be displayed at point of storage. Chemical and material storage areas will be well maintained, neat and tidy, with adequate inventory control. Chemical storage will be weather-proofed and on bunded hard standing. The bunds and hardstanding will be impermeable and resistant to the materials being stored. Requirements for the chemical storage will be set out in the Russian Landfall CMP.

Water Consumption

During construction of the landfall section water will be required for domestic purposes (drinking water, mess and welfare facilities) and industrial use (for example wheel washing, dust suppression; and microtunnel construction). Water will be brought in by road tankers. Bottled water will be provided for drinking purposes. The estimated consumption of water is presented in Table 5.11. Water requirements for hydrotesting are described in Section 5.4.

Table 5.11 Estimated Water Consumption during Construction of the Landfall Section

Water Type	Details	Maximum Consumption
Freshwater	60 l / person per day for domestic use	19.8 m^3 (at peak of construction) per day
Freshwater	Microtunnel construction	37,000 m^3
Freshwater	Various use (dust suppression, wheel washing etc.)	5 m^3 per day

Utilities

Utilities required during the construction of the landfall section will include:

- **Power** – the power required by plant, machinery and temporary offices etc. within the construction sites and construction corridor will be provided by diesel generators. When required, the generators will be refuelled by mobile bowsers;
- **Water** – potable and non-potable water will be available within the temporary construction sites shown in Figure 5.10. Water for general use within construction sites and construction corridor (including wheel-washing of vehicles going off-site, and dust suppression methods if necessary) will be supplied by bowsers as required. As described in Section 5.3.3.2, water will be sourced from a well near Sukko. Due to seasonal restrictions (May to September inclusive) when water may not be taken from this source it is anticipated that the

Contractor may require to store up to 10,000 m^3 of water in large water tanks within the Pipeline String Preparation Area (Site B) for microtunnel construction and up to 800 m^3 of water at the Landfall Facilities Construction Site and Pre-Commissioning/Commissioning Spread (Site E) for general construction use and hydrotesting of the landfall facilities pipework. The exact storage locations and dimensions of the storage tanks will be finalised during the detailed design and will be agreed between the Contractor, South Stream Transport and the relevant Local Authorities;

- **Sewage** – temporary sanitary facilities (i.e. chemical toilets) will be provided at a number of locations across the construction sites. Sewage will be contained and tankered and then collected by an appropriately licenced waste haulier to take the sewage offsite for appropriate treatment; and
- **Drainage** – to prevent possible pollution of surface waters, sediment and erosion controls, including appropriate drainage systems, will be implemented at construction sites to manage run-off and to limit the loss of soil from the site. The drainage systems will separate out the sediments from the drainage water and will include oil interceptors. Where vehicles carrying concrete and other equipment are required to be washed out on site this will be undertaken in dedicated bunded areas.

5.3.4.6 Summary of Waste Generated during Construction of Landfall Section

There are a number of activities during the Construction Phase of the landfall section that have the potential to generate waste. Table 5.12 presents a summary of the waste types anticipated to be generated using the Federal Waste Classification Catalogue (FWCC), in accordance with Ministerial Order 786 '*On the adoption of the Federal Classificatory Catalogue of Wastes'* (Ref. 5.7) to categorise waste types.

All wastes will be collected, stored and transported off-site in appropriate bins and containers in accordance with applicable Russian Federation waste policy. The locations of potential waste disposal facilities which may be used for the Project are shown in Figure 5.9 However, it should be noted that no decisions as to which of these sites could or may be used have been taken at this time and will be subject to further investigation. Only appropriately licenced companies will be employed for the transportation, recycling and disposal of waste. Further information on waste generation and management, including predicted quantities, is described in **Chapter 18 Waste Management**.

Table 5.12 Estimated Types of Waste Generated during Construction of the Landfall Section

Description of Waste Type	FWCC Code	Hazard Class
Fluorescent tubes and other mercury-containing lamps	353 301 00 13 01 1	1
Oily wastes, including: - waste oils, filters, oily rags, spill response waste, etc.	546 015 01 04 03 3 541 002 05 02 03 3 920 000 00 00 00 0 549 027 01 01 03 3 314 023 03 04 03 3 546 002 00 06 03 3	3
Waste protective clothing and worn work footwear	582 000 00 00 00 0 147 006 01 13 00 4	4
Waste drilling sludge	314 000 00 00 00 0	4
Waste paint resources	555 000 00 00 00 0	4
Sludge from wastewater treatment	943 000 00 00 00 0	4
Mixed municipal waste	912 004 00 01 00 4	4
Scrap metal	351 301 00 01 99 5	5
Uncontaminated soil	314 011 00 08 99 5	5
Welding waste	351 216 01 01 99 5	5
Crushed stone	314 009 02 01 99 5	5
Uncontaminated rock / sand	314 023 01 01 99 5	5
Plastic	571 018 00 13 00 5	5
Cardboard	187 102 02 01 00 5	5
Tree stumps	173 001 02 01 00 5	5
Waste (slurry) from cesspools and domestic sewage	951 000 00 00 00 0	4

The estimated generation of sanitary waste (black water) and wash water (grey water) during the peak of construction (approximately 330 workers on site) is provided in Table 5.13.

Table 5.13 Estimated Volumes of Grey and Black Water

Discharge Type	Details	Maximum Produced per Day (m^3)
Grey Water	48 l / person per day	15.8 (at peak of construction)
Black Water	12 l / person per day	3.96 (at peak of construction)

5.3.4.7 Emissions to Atmosphere during Construction of the Landfall Section

Table 5.14 presents the anticipated GHG and non-GHG emissions from the construction and installation (excluding pre-commissioning (Section 5.4)) of the landfall section pipelines and landfall facilities based on the expected plant and equipment required on site outlined in Table 5.7 and Table 5.9

Table 5.14 Atmospheric Emissions from Landfall Construction Plant (tonnes/year)

	CO_2	NO_X	CO	PM	SO_2	NMVOC
Tonnes / year	10,529	319	135	24	0.13	33

Table 5.15 presents the anticipated GHG and non-GHG emissions predicted to be generated by road traffic emissions associated with the daily movement of construction traffic to and from site as outlined in Table 5.8.

Table 5.15 Atmospheric Emissions from Road Traffic during Construction (tonnes/year)

	CO_2	NO_X	CO	PM	SO_2	NMVOC
Tonnes / year	2,147	11	41	0.2	0.01	5

Further information on emissions to atmosphere is provided in **Chapter 9 Air Quality**.

5.3.5 Construction of Nearshore Section

5.3.5.1 General Overview

The nearshore section of the Project Area commences at the exit of the microtunnels in a water depth of approximately 23 m and extends out to a water depth of approximately 30 m where an above water tie-in between the nearshore and offshore section pipelines will be made.

The main construction activities in the nearshore section include:

- Surveys of the pipeline route prior to, during and after the pipe-laying process;

- Dredging of each microtunnel exit pit and transition trench and recovery of the TBM on four occasions;
- Installation of the pipelines in the microtunnels;
- Pipe-laying;
- Backfilling of the microtunnel exit pits and transition trench; and
- Tie-in of the nearshore / offshore pipeline sections at the 30 m water depth.

Furthermore, there will be a requirement to temporarily store some of the dredged material from the microtunnel exit pits and transition trenches for the duration of the dredging works associated with each respective pipeline. The stored material will be used for backfilling of the exit pits and trenches following pipeline installation. Temporary storage areas will be located adjacent to the microtunnel exit pits, to the north, as indicated in Figure 5.20.

Marine plant and equipment used for the Project that originates from outside the Black Sea brings a risk of introducing marine invasive alien species. Specific measures will be adopted to reduce this risk. Where relevant and practical, these measures will be based on those identified in the IPIECA (Global Oil and Gas Industry Association for Environmental and Social Issues) document *Alien Invasive Species and the Oil and Gas Industry, Guidance for Prevention and Management* (Ref. 5.8) and the International Maritime Organization (IMO) *Ballast Water Management Convention and Guidelines* (Ref. 5.9). They will be applied to all marine plant and equipment that is used on the Project and which has the potential to be a vector of live organisms, spores, larvae and young and will include ballast water management, use of antifouling coatings, cleaning of equipment prior to deployment and the change of cooling water. Ballast management will be included in the Vessels and Marine Transport CMP. Further information on the Vessels and Marine Transport CMP and South Stream Transport's ESMP are described in **Chapter 22 Environmental and Social Management**.

5.3.5.2 Nearshore Vessel Spread

Table 5.16 presents a summary of the type and number of vessels that are anticipated to be used during the nearshore pipeline installation works.

Construction activities associated with the installation of the nearshore pipelines will require a number of vessels. The main vessel will be the vessel required for the installation of the pipeline in the microtunnels, which may be a multipurpose vessel equipped with winching gear or a shallow water pipe-lay vessel depending on the installation method selected by the contractor. In addition, other vessels will be involved in construction activities, such as dredging vessels, support vessels (survey, dive support, etc.) and supply vessels (pipes, fuel and provisions). The vessels associated with the marine pre-commissioning spread are presented in Table 5.31.

The actual vessel spread will depend on the contractors preferred method of pipeline installation in the microtunnels and the availability of vessels at the time that the necessary construction permits are granted.

Table 5.16 Typical Nearshore Construction Vessel Spread per Pipeline

Construction Activity	Type of Vessel	Task	No.	Duration (days) per vessel	Indicative Vessels	Power Rating (kW)	Persons on Board	Utilisation (%)
Dredging microtunnel exit pits and 170 m long transition trenches (from 23 – 26 m water depth)	Cutter Suction Dredger (CSD) (Option 1)	Dredging of microtunnel exit pit and transition trench	1	5 days Plus 19 days at 25% capacity for mobilisation/ demobilisation	Dikson	3,795	13	60
	Trailer Suction Hopper Dredger (TSHD) (Option 2)	As above	1	As above	Taccola	6,330	17	60
	Grab crane (Option 3)	As above		As above	Kahmari 2	920	4	60
	Hopper barge	Transport of dredged spoil	2	As above	Sand Carrier 101	300	10	60
	Small survey vessel	Surveys during and after dredging works	1	As above	Dunai	500	10	60

Continued…

Construction Activity	Type of Vessel	Task	No.	Duration (days) per vessel	Indicative Vessels	Power Rating (kW)	Persons on Board	Utilisation (%)
Dredging microtunnel exit pits and 170 m long transition trenches (from 23 – 26 m water depth)	Tug	Transporting the CSD or grab crane and transport of water and fuel, etc.	1	As above	Mustang	4,536	8	60
	Fast supply vessel	Crew changes	1	1 (i.e. 2 half-day trips)	GSP Lyra	2,520	70	60
	Fuel / waste water collection vessel	Bilge and waste water collection	1	1	Bryansk	610	5	60
	Rescue Vessel	Safety and Rescue Operations	1	Only required in case of emergency	GSP Vega	9,548	23	60
Backfilling of microtunnel exit pits and transition trenches	CSD (Option 1)	Collection of stored spoil from temporary storage areas for backfilling exit pit and transition trench	1	4 days	Dikson	3,795	13	60
	TSHD (Option 2)	As above	1	As above	Taccola	6,330	17	60
	Grab crane (Option 3)	As above		As above	Kahmari 2	920	4	60

Continued...

Construction Activity	Type of Vessel	Task	No.	Duration (days) per vessel	Indicative Vessels	Power Rating (kW)	Persons on Board	Utilisation (%)
Backfilling of microtunnel exit pits and transition trenches	Hopper barge	Transport of dredged spoil	2	As above	Sand Carrier 101	300	10	60
	Small survey vessel	Surveys during and after backfilling works	1	As above	Dunai	500	10	60
	Tug	Transporting the CSD or grab crane and transport of water and fuel, etc.	1	As above	Mustang	4,536	8	60
	Fast supply vessel	Crew changes	1	1 (i.e. 2 half-day trips)	GSP Lyra	2,520	70	60
	Fuel / waste water collection vessel	Bilge and waste water collection	1	1	Bryansk	610	5	60
	Rescue vessel	Safety and Rescue Operations	1	Only required in case of emergency	GSP Vega	9,548	23	60

Continued…

Construction Activity	Type of Vessel	Task	No.	Duration (days) per vessel	Indicative Vessels	Power Rating (kW)	Persons on Board	Utilisation (%)
Shallow water (23-30 m water depth) pipe-lay activities including pipeline installation in microtunnels	Shallow water pipe-lay or multipurpose vessel	Fabrication of pipeline string for shore pull and nearshore pipe-lay (if applicable)	1	6 (5 days installation of pipeline in microtunnel and 1 day pipe-lay from 23-30 m water depth (if applicable) Plus 3 days at 25% capacity for mobilisation/ demobilisation	Tog Mor	3,750	144	40
	Anchor handling tug	Handling the anchors for the pipe-lay or multipurpose vessel	2 (plus 1 standby)	As above	Normand Neptun	13,880	40	60
	Pipe Supply Vessel (PSV)	Supplying pipe to pipe-lay vessel. This vessel will only be required if the pipeline is to be welded on the pipe-lay vessel and pulled onshore through the microtunnel	1	As above	Normand Flipper	7,160	16	60

Continued…

Construction Activity	Type of Vessel	Task	No.	Duration (days) per vessel	Indicative Vessels	Power Rating (kW)	Persons on Board	Utilisation (%)
Shallow water (23-30 m water depth) pipe-lay activities including pipeline installation in microtunnels	Survey vessel	Surveying the sea floor in front and behind the pipelay vessel	2	As above	GSP Prince	7,604	62	60
	Multi Service Vessel (MSV)	ROV and diving support, and supply of consumables, bunker, provisions and freshwater	2	As above	Normand Mermaid	10,000	70	60
	Fast supply vessel	Crew changes	1	1 (i.e. 2 half-day trips)	GSP Lyra	2,520	70	60
	Fuel / waste water collection vessel	Bilge and waste water collection)	1	1	Bryansk	610	5	60
	Rescue vessel	Safety and Rescue Operations	1	Only required in case of emergency	GSP Vega	9,548	23	60

Continued…

Construction Activity	Type of Vessel	Task	No.	Duration (days) per vessel	Indicative Vessels	Power Rating (kW)	Persons on Board	Utilisation (%)
Above water pipeline tie-in between nearshore and offshore sections at 30 m water depth	Multipurpose supply vessel	Lifts and lowers pipeline to seabed and performs above water tie-in	1	14 days Plus 6 days at 25% capacity for mobilisation / demobilisation	Calamity Jane	15,086	72	60
	Small survey vessel	Surveys during above water tie-in	1	As above	Dunai	500	10	60
	Fast Supply Vessels	Crew changes	1	1	GSP Lyra	2,520	70	60
	Fuel / waste water collection vessel	Bilge and waste water collection	1	1	Bryansk	610	5	60
	Rescue vessel	Safety and rescue operations	1	Only required in case of emergency	GSP Vega	9,548	23	60

Complete.

5.3.5.3 Surveying

The design and routing of the microtunnels and nearshore section of the pipelines has been informed by a number of studies as outlined in the baseline data sections of Chapters 7-18 of this ESIA Report. However, a number of further surveys will be required before, during and after installation of the pipeline.

Pre-Construction Surveys

Pre-construction surveys will be carried out along each pipeline route prior to commencement of the dredging and pipe-lay works. The purpose of such surveys is to confirm the previous route surveys and optimise the exact route of the pipeline. The survey will typically include a range of standard geophysical survey techniques, and/or visual surveys using a remotely operated vehicle (ROV).

These surveys will also confirm the need for and guidance of the removal of boulders, rocks or potentially unexploded ordnance (UXO). Potential UXO could constitute a danger for the construction workers, the pipelines and the environment during the installation works and the operational life of the Project.

UXO surveys will be carried out in specific areas along the pipeline route where there is a higher likelihood of UXOs being present in advance of the pre-lay surveys. Identified UXOs will either be avoided through re-routing or cleared. A UXO Clearance Plan will be developed by the Contractor in close conjunction with South Stream Transport and relevant national authorities. However, a final check for the presence of UXOs may be undertaken during pre-lay surveys ahead of the pipe-lay spread.

It is anticipated that some of the vessels working in the nearshore section will use anchors. Therefore, an anchor corridor survey will also be carried out within a corridor on either side of the pipeline routes, the area of which will be calculated by the EPC contractor. Within this corridor, anchors from dredgers, pipe-lay vessel or anchor handling tugs may be laid on the seabed during installation of the pipelines.

The primary purpose of the anchor handling survey is to identify potential risks that will result from anchoring activity, as a result of the presence of potential UXO, anthropogenic debris or geological features and also Cultural Heritage Objects (CHO), which require safeguarding from damage by the anchors, and to avoid or minimise disturbance of sensitive habitats. The surveys will include standard geophysical and visual survey (such as ROV) techniques and the results will be subject to expert evaluation. Where UXO, CHO, sensitive habitats or potentially dangerous debris is detected, anchor exclusion zones will be established where practicable. The appointed pipeline installation contractor will be required to develop anchor patterns and procedures and undertake a risk assessment to ensure that the areas of concern are not impacted by the anchors or the sweep of the anchor cables.

Touch-down Monitoring and As-Laid Surveys

During installation of the pipelines in the nearshore, real-time touch-down monitoring will be conducted to ensure correct installation of the pipeline with regard to its alignment and with respect to lateral separation between adjacent pipelines. The real-time monitoring will ensure that boulders and, potential UXOs are avoided and that environmentally and culturally sensitive areas are not accidentally encroached by the pipelines. An as-laid survey will be performed once each pipeline has been laid on the seabed. The survey will establish the as-laid position (horizontal and vertical) and condition of the pipeline and would comprise bathymetry and other survey sensors in conjunction with visual inspection by ROV.

As-Built Survey

After completion of pipe-laying works, an as-built survey will be conducted to ensure the pipeline has been installed correctly, to document the condition and to ensure the integrity of the installed pipelines. The survey will comprise the integration of as-laid survey results from free-lay installation operations with the post-installation rectification/acceptance surveys for specific construction activities, e.g. crossing supports, post-lay interventions and site rectification.

5.3.5.4 Excavation of the Offshore Microtunnel Exit Pits and Recovery of the TBM

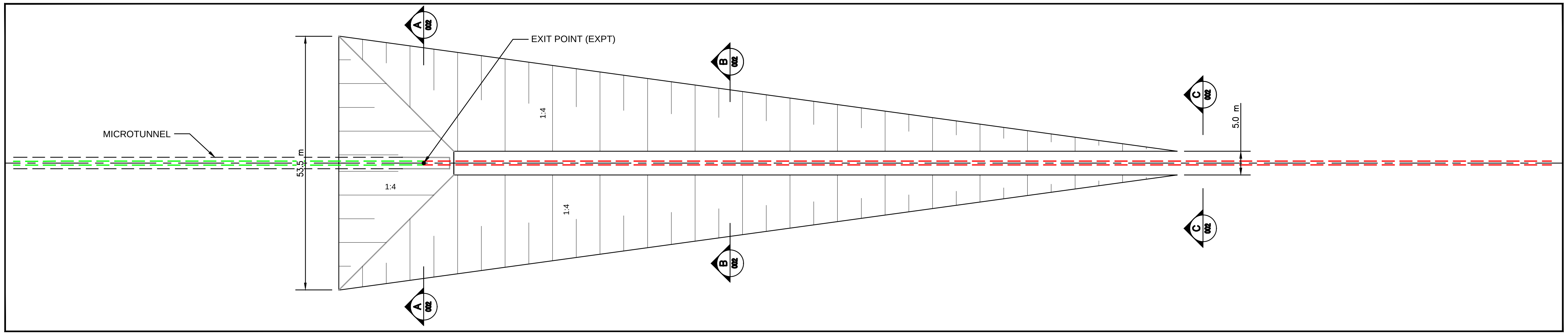
The recovery of the TBM at the exit of each microtunnel requires the excavation of an offshore exit pit. The exit pits are located approximately 400 m offshore. At the microtunnels exit locations, the spacing between the centreline of the pipelines will be approximately 50 m, and consequently each microtunnel will require its own exit pit. The microtunnel exit pits will be located in a water depth of approximately 23 m and the topside of the microtunnel will be approximately 3 m below the surface of the seabed.

From the microtunnel exit pit, the pipelines will be laid in a pre-dredged transition trench for a length of approximately 170 m out to a water depth of approximately 26 m. The exit pit and trench will be excavated in a single dredging operation. The transition trench will gradually reduce in depth as it moves away from each microtunnel exit pit (located approximately 5 m below the seabed surface) to provide a shallow gradient transition for the pipeline between each microtunnel exit pit and the seabed surface itself as illustrated in Figure 5.25.

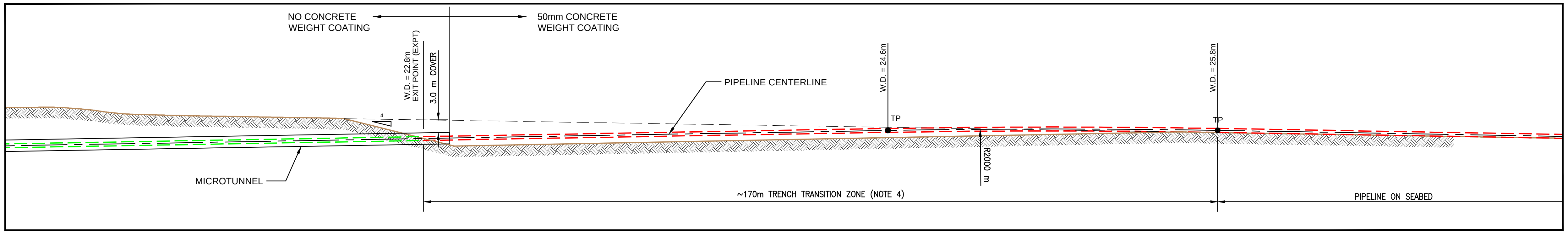
The TBM will be recovered from each exit pit using a barge that will be fitted with a crane to lift the TBM from the water. The TBM will be transferred back to the microtunnel construction site where, following any necessary repairs, it will start work on the next microtunnel, or alternatively, it will be demobilised on completion of all four microtunnels.

When the TBM emerges into each exit pit, there will be a small discharge of slurry into the marine environment. However, this will be carefully controlled by reducing the pressure of slurry supplied to the TBM on nearing emergence to each exit pit and immediate shutdown of the TBM slurry circuit when the TBM emerges into each exit pit. Since bentonite is denser than seawater, the slurry tends to stay on the seabed rather than mix with the surrounding water column. Furthermore, the depth of each exit pit (approximately 5 m) will reduce the exposure of the slurry to seabed currents and will capture the majority of slurry discharged from the tunnel. The slurry mixture can then be collected and disposed of onshore.

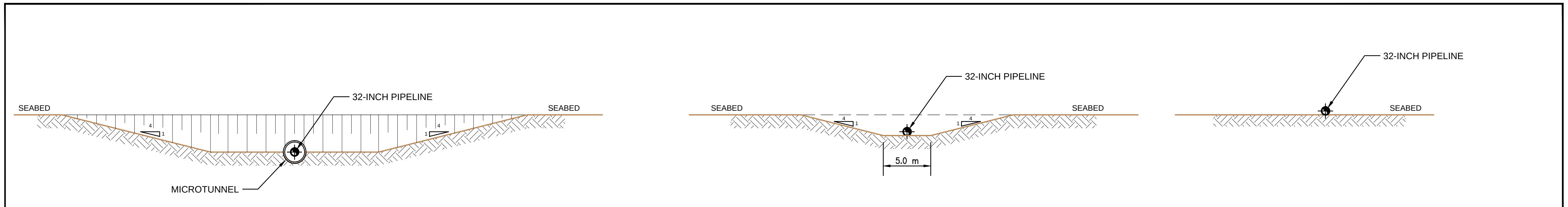
PLAN VIEW (SCALE 1:1000)



LONGITUDINAL PROFILE ALONG PIPELINE CENTER LINE (SCALE 1:1000)



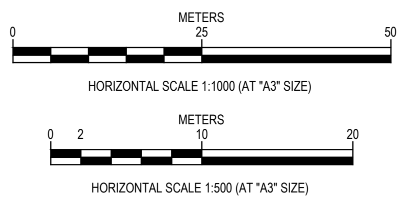
CROSS SECTIONS (SCALE 1:500)



CROSS SECTION A - A

CROSS SECTION B - B

CROSS SECTION C - C



RUSSIAN SECTOR OF THE SOUTH STREAM OFFSHORE PIPELINE

LEGEND

LANDFALL SECTION PIPELINE

NEARSHORE SECTION PIPELINE

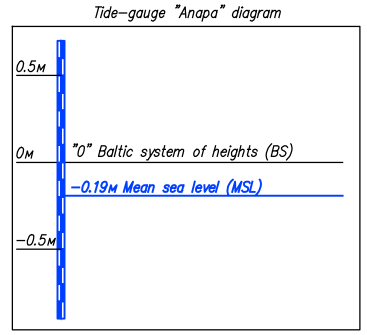
SIDE SLOPES

SEABED PROFILE

NOTES

1. DIMENSIONS ARE IN METERS, UNLESS NOTED OTHERWISE.
2. ALL ELEVATIONS ARE IN METERS, REDUCED TO BALTIC SYSTEM OF HEIGHTS (BS).
3. FINAL DEPTH OF MICROTUNNEL WILL BE BASED ON DETAIL INSTALLATION ENGINEERING.
4. TRANSITION LENGTH BASED ON MINIMUM BENDING RADIUS OF 2,000m.
5. MICROTUNNEL DETAIL DESIGN (INCL. INSTALLATION ENGINEERING) TO BE PERFORMED BY CONTRACTOR.

Tide–gauge "Anapa" diagram



GEODETIC & PROJECTION PARAMETERS

GEODETIC DATUM	: WORLD GEODETIC SYSTEM 1984 (WGS84)
PROJECTION	: LAMBERT CONFORMAL CONIC
CENTRAL MERIDIAN	: 34° 00' 00" E
ORIGIN OF LATITUDE	: 43° 00' 00" N
FIRST STANDARD PARALLEL	: 30° 00' 00" N
SECOND STANDARD PARALLEL	: 50° 00' 00" N
FALSE EASTING	: 0.0 m
FALSE NORTHING	: 0.0 m
SCALE FACTOR	: 1.0000

Projection: Lambert Conformal Conic

Revision Details	By / Check	Date	Suffix

Purpose of issue

For Information

Client

South Stream Offshore Pipeline ENERGISING EUROPE

Project Title

SOUTH STREAM OFFSHORE PIPELINE

Drawing Title

Microtunnel Exit Pit and Transition Trench Dredging Requirements

Designed	Drawn	Checked	Approved	Date
RW	OAS	MJW		19/03/14

URS Internal Project No. 46369078

Scale @ A3 As Shown

URS Infrastructure & Environment UK Limited
URS House
Horne Lane
Bedford MK40 1TS
44 (0) 1234 349641
44 (0) 1234 216268
www.ursglobal.com

URS

Drawing Number

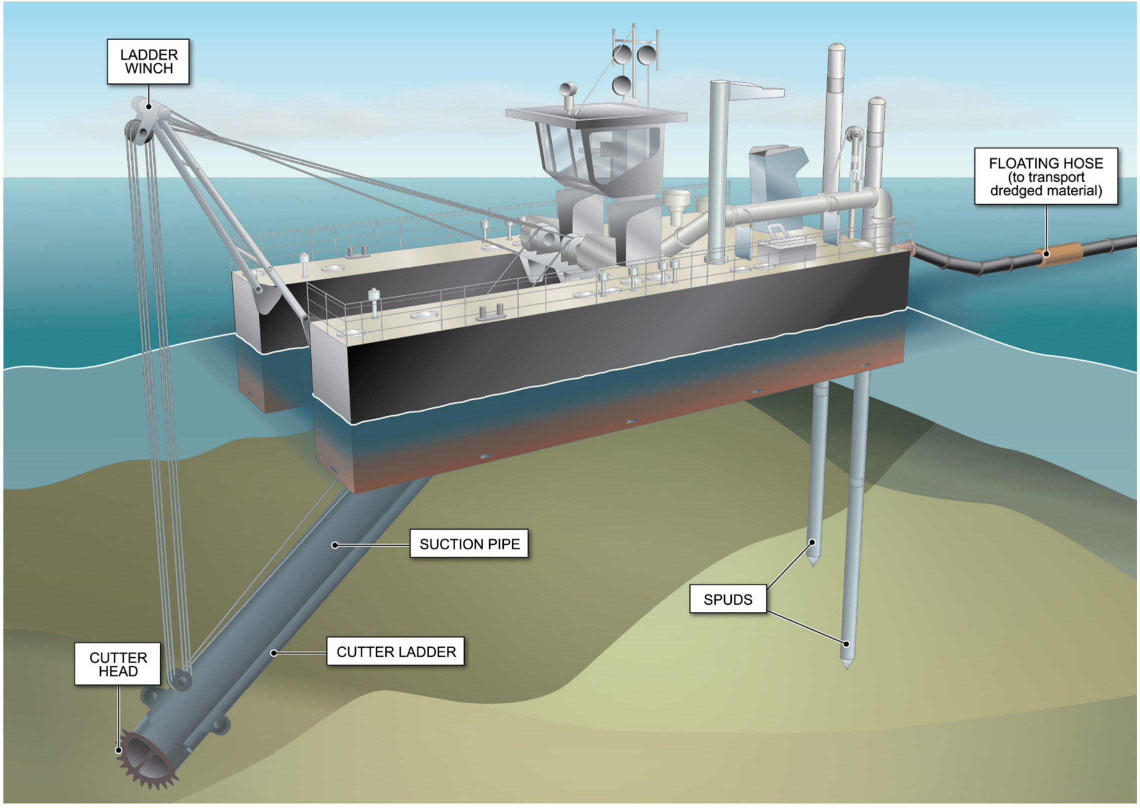
Figure 5.25

Rev

It is anticipated that a Cutter Suction Dredger (CSD) or a grab crane will be employed to dredge each microtunnel exit pit and associated transition trench. A trailing suction hopper dredger (TSHD) may be employed, if sediment conditions allow (the TSHD cannot be used for hard sediments/rock), to dredge part of the trench, and to clean out the trench prior to pipeline installation if it has backfilled with sediments.

A CSD is either anchored to the seabed or kept in position by poles (known as spuds) that penetrate into the seabed below the barge. A CSD is equipped with a rotating cutter head, which cuts hard soil into fragments. The cut soil is sucked in by dredge pumps and then transported away from the trenches to a specified location using pumps and a floating pipeline attached to a spreader pontoon. Alternatively, the spoil can be loaded into a split hopper barge moored alongside, which in turn can then transport the dredged spoil to the specified storage area. A schematic of a typical CSD vessel is shown in Figure 5.26.

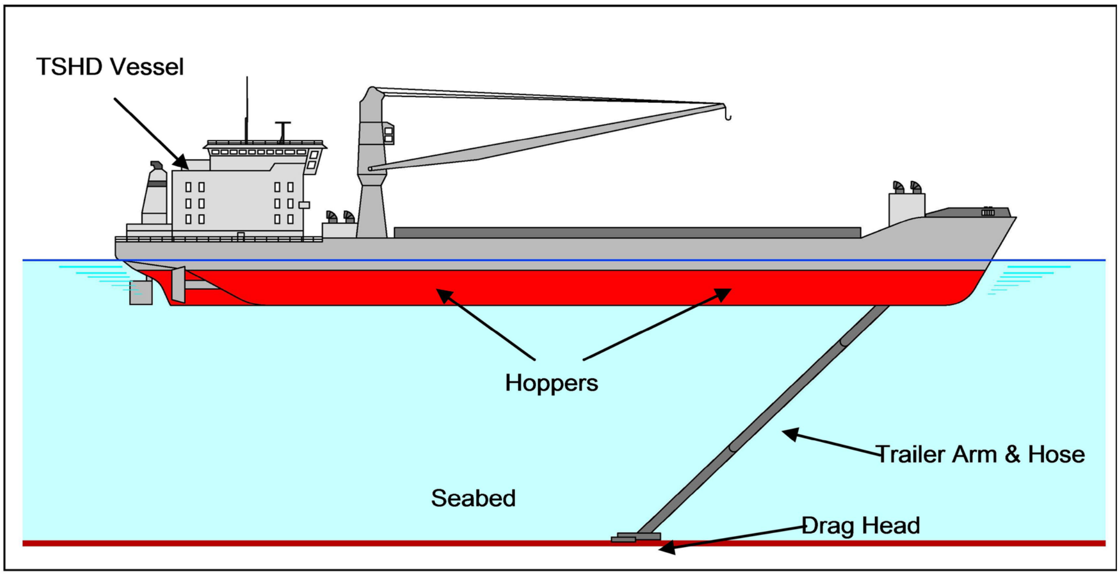
Figure 5.26 Schematic of a Cutter Suction Dredger



Floating grab cranes are mounted on a pontoon (either self-propelled or stationary) and dredge material using a bucket mounted to the crane, the jaws of which are opened and closed like a clamshell to trap sediments. The grab cranes deposit excavated material in independently operated split hopper barges, which transport the dredged material to the desired location. The pontoon is usually anchored by spuds, however in exposed locations or in deeper waters anchors can be used to increase stability.

The TSHD uses a drag head attached to a suction pipe to excavate material from the seabed. The excavated material is then stored in compartments (hoppers) on the vessel itself. The excavated spoil is temporarily stored offshore until it is re-utilised to bury the pipelines. A schematic of a typical TSHD vessel is shown in Figure 5.27.

Figure 5.27 Schematic of Trailer Suction Hopper Dredger



Each pipeline will be laid in an individual trench from the microtunnel exit point to a water depth of approximately 26 m depth. Each trench will be approximately 170 m long with side slopes of approximately 1:4 and width of approximately 10 m at the trench bottom. The trench will be excavated to a maximum depth of approximately 5 m at the microtunnel exit point with the excavation depth gradually reducing to the 26 m water depth where the pipeline will start to be laid directly onto the seabed. This will result in an estimated dredged volume of 25,000 m^3 per pipeline.

The total estimated volume of material to be dredged for all four pipelines (for the four microtunnel pits and four transition trenches) is approximately 100,000 m^3. A summary of the dredging required is shown in Table 5.17.

Table 5.17 Estimated Volume of Dredged Material in the Nearshore Section

Length of Dredged Section (m)	Side Slope	Trench Bottom Width (m)	Dredging Depth (m)	Dredged Volume per Pipeline (m^3)	Total Dredged Volume (four pipelines (m^3)
170	1:4	10	Gradually decreases from 5 m to 0 m	25,000	100,000

Material removed from the dredged trenches may be deposited either adjacent to the exit pits and trenches or in a temporary storage area located to the north of the microtunnel exit pits and transition trenches as shown in Figure 5.20. The dredged materials may not be able to be stored immediately adjacent to the trenches as there is the potential for sea currents to transport the sediments and refill the trenches prior to pipe installation. Following pipe installation in the trenches, the stored material will be dredged back up (using the same dredging equipment used previously) and used to backfill the microtunnel exit pits and transition trenches. Backfilling of the trenches with the direct placement of the previously excavated sediment over the pipelines will not be undertaken until completion of pre-commissioning tests. It is anticipated the material from each exit pit and trench will be stored for approximately two months, before it is dredged back up and used as backfill.

A detailed Dredging Management Plan will be developed once the dredging contractor has been appointed and the dredging plant identified. This will be developed by the Contractor in collaboration with South Stream Transport and the regulatory authority.

5.3.5.5 Installation of the Pipelines in the Microtunnel and Nearshore Section

Installation of Pipelines within the Microtunnels

As described in Section 5.3.4.5, following completion of the microtunnels, the pipelines will be installed within the microtunnels by welding together the pipeline string on an anchored pipe-lay vessel located near the microtunnel exit pits. The pipeline string is pulled through the transition trench and microtunnel towards the onshore entry shafts with a cable or rod system connected to a winch located within the onshore microtunnel construction site.

Upon completion of the microtunnel pipeline installation, pipe-lay in the nearshore section will be continued by the pipe-lay vessel laying away from the Russian coast towards the tie-in location at 30 m water depth. The construction activities associated with pipe-lay in the nearshore section is described in the following section.

Pipe-lay in the Nearshore Section

Pipe-lay in the nearshore section is accomplished by the sequential alignment, welding and lowering of pipe from a shallow water pipe-laying vessel. Pipe sections are transported to the pipe-lay vessel pre-coated with polypropylene anti-corrosion coating and internally with epoxy flow coating. Furthermore, to ensure the protection of the pipelines in shallow water, concrete coating of the pipelines is undertaken to provide on-bottom pipeline stability and also acts as a safety measure to avoid damage through interaction with respect to third party activities (for example, trawling gear and anchors). The concrete coating protecting the pipelines will be approximately 50 mm thick. It is anticipated that pipelines will be concrete coated out to a water depth of approximately 88 m.

The pipes are carefully stacked on board the pipe-lay vessel using deck cranes. The pipes are then transported using conveyor systems to the pipe bevelling station where the pipes are made ready for welding. Bevelling consists of shaping the edge of the pipe, which is to be welded, so that the weld itself fits within the overall pipe profile. The bevelling process produces large volumes of scrap metal which require to be stored in containers for collection and disposal onshore. It is estimated that approximately 161 tonnes of bevel waste will be generated by the construction of each pipeline from each microtunnel exit pit to the Russian and Turkish EEZ boundary.

Following bevelling, the pipes are transported to the line-up station, where the pipes are lined up in preparation for welding, using traverse carriage (roller) systems. This is the beginning of what is called the firing line.

Following alignment, the pipe sections are moved along the firing line to the first welding station where the pipe sections are clamped and joined together using automatic welding techniques. Root pass (first, and most critical layer of a multi-layer weld) and hot pass (second weld, which cleans out any remaining slag from root pass) welds are undertaken in the first welding station before the pipe is then moved to subsequent weld stations for the external welds to be completed. When the welding process is completed, the welded pipe section is moved to the inspection station where the weld is subject to visual inspection and NDE to ensure the weld meets the required specification. Any welds not meeting the required specification will be cut and the pipeline re-welded and subject to full NDE.

Following successful weld testing, the pipes move along to the coating stations. The number of coating stations will depend on the pipe-lay vessel used. In the coating stations, field joint coating will be applied to the welds for corrosion protection. For concrete coated pipe sections, infilling of the gap between the concrete ends of the pipe sections will be undertaken with moulded solid polyurethane or polypropylene to ensure a flush outer pipe surface is obtained.

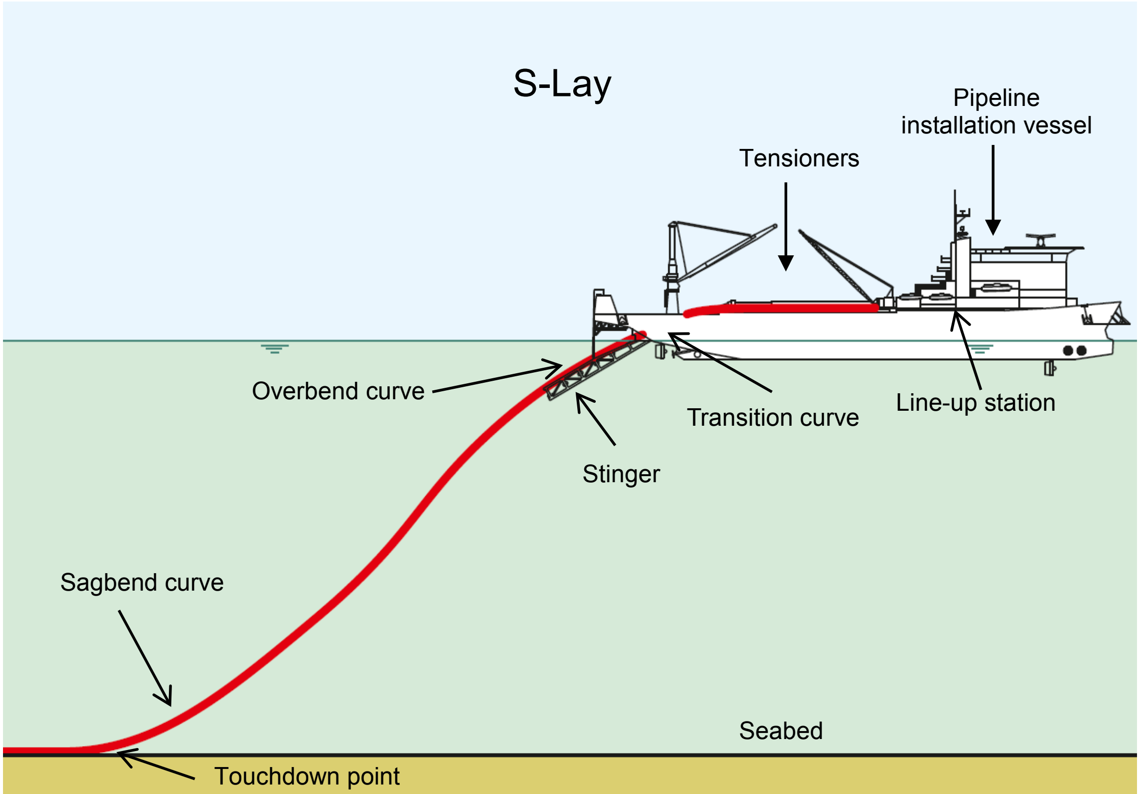
All critical processes onboard the pipe-lay vessel will be inspected by the pipe-lay contractor's quality assurance crew, and thereafter inspected by representatives of the certification company and South Stream Transport.

The newly welded, coated and inspected pipe section is then moved into the water via the stinger, which is buoyancy controlled to maintain a smooth curve profile to the target water depth to minimise stresses on the pipeline during installation. Stingers are a steel structure, which extend from the stern of the vessel to support the pipe as it is moved into the water, as well as control the curvature of the installation.

During the installation of the pipeline in the microtunnel, the pipeline string will be pulled from the pipe-lay vessel by the land based winch. However, during pipe-lay in the remainder of the nearshore section the pipe-lay vessel moves the pipe section into the water by advancing an appropriate distance (dependent on pipeline string length) by pulling on its anchor lines, resulting in the pipeline string exiting the pipe-lay vessel via the stinger. Once the pipeline string has exited the pipe-lay vessel, the pipe-lay vessel will stop forward motion, and work on welding the next pipeline string together commences.

Pipe-lay in the nearshore section will be performed by the S-lay technique. The S-Lay technique requires the load out of single 12 m pipe sections to the pipe-lay vessel. This method involves welding the pipe sections horizontally, and continuously 'feeding' the jointed sections over the vessel's pipe-lay stinger from the stern of the vessel as the vessel moves forward in such a way that the pipeline forms an "S" shape from the vessel's exit point to the touchdown point on the seafloor. Sufficient tension is required during the S-Lay process to avoid overstressing the pipeline. This is maintained via tensioning rollers and a controlled forward thrust, that keeps the pipe from buckling. Figure 5.28 presents a schematic drawing of the S-Lay pipe-lay method.

Figure 5.28 Schematic of S-Lay Pipe-Lay Method



It is anticipated that it will take approximately one day for the S-Lay pipe-lay vessel to complete pipe-lay in the nearshore section out to 30 m water depth following the installation of the pipeline in the microtunnel, depending on weather conditions.

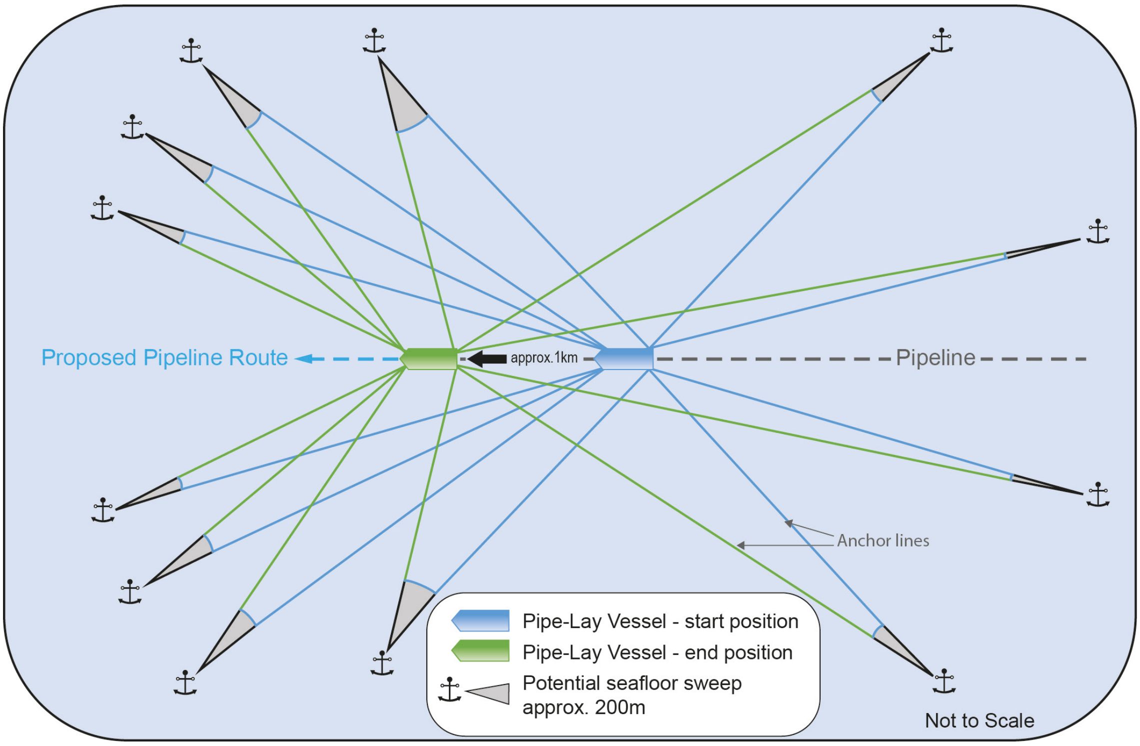
In order to lay pipe in shallow water, a vessel must be of shallow draft. This shallow draft typically requires a flat bottom vessel with limited or no built-in propulsion systems. Figure 5.29 shows a typical shallow water S-Lay vessel.

Typical shallow water vessels are outfitted with anchor winches, anchor wires and anchors. Typically, an anchored vessel deploys 8 to 12 anchors in a semi-circular pattern in the fore and aft position, generally from its four corners. There are normally two or three anchor wires located at each corner of the vessel. During pipe-lay, an anchor handling tug boat is used to run the anchors out in a pattern that allows the pipe-lay vessel to move itself ahead by hauling in wire on the forward winches while paying out wire on the aft winches. As pipe-lay continues, the tug boat(s) continually re-locate the anchors forward as necessary to allow the vessel to lay pipe without delays. It is estimated that all anchors will be re-positioned for every 1 km of pipeline laid. The position of the anchors could be as far as 1.5 km (0.8 nautical miles (NM)) from the centreline of the vessel, depending on the water depth and pipe-lay vessel used. A typical pipe-lay vessel anchor pattern is shown in Figure 5.30.

Figure 5.29 Typical Shallow Water S-Lay Vessel

Image supplied courtesy of Allseas, Switzerland

Figure 5.30 Typical Pipe-Lay Vessel Anchor Spread



A safety exclusion zone will be enforced around the pipe-lay vessel during pipe-laying. A safety exclusion zone of approximately 3 km (1.6 NM) radius (depending on the extent of the anchor spread) around the pipe-lay vessel will be enforced during pipe-laying to avoid incidents with marine traffic. Agreement with the appropriate marine authorities shall be obtained regarding the exact exclusion distances and safety measures to be adopted during pipe-laying to avoid incidents with marine traffic. Unauthorised vessels including fishing vessels will not be permitted access to the safety exclusion zone. The pipe-lay vessel will be equipped with navigation lights, radar and radio communications. Due to the construction spread advancing along the pipeline route as the pipe is laid, constant (at least daily) consultation will be undertaken by the pipe-lay contractor with the appropriate marine authorities to inform them of the location of the construction spread. The marine authorities will then be responsible for informing marine traffic of the location of the pipe-laying activities and the associated exclusion zones. Further information on safety exclusion zones and marine navigation safety measures will be included in the Vessels and Marine Transport CMP which is outlined in **Chapter 22 Environmental and Social Management**.

Following completion of the nearshore pipe-laying at the 30 m water depth location, a temporary subsea laydown / test head (capable of launching and receiving PIGs) will be fitted to the end of each pipeline. The pipeline is then lowered to the seabed and left there until pre-commissioning tests of the landfall and nearshore section pipelines are carried out as described in Section 5.4.2.

After the successful pre-commissioning tests of the landfall and nearshore sections, the two ends of the pipeline (nearshore and offshore sections) will need to be joined (tied-in) above water. The above water tie-in will be performed where the water depth is approximately 30 m. The pipelines will be picked up from the seabed by the pipe-lay vessel by means of a davit wire connected by divers to the laydown head on the pipeline and subsequently winched on to the pipe-lay vessel.

The two pipeline ends are lifted above the water to the side of the pipe-lay vessel to enable a dry welded connection to be made. Following cutting of the two pipeline ends to the correct length, the ends are welded together. The weld will be subject to NDE prior to application of the field joint coating and careful lowering of the connected pipeline back to the seabed. This process will be carried out for each of the four pipelines.

A safety exclusion zone of approximately 0.5 km (0.3 NM) radius for tie-in construction vessels will be adopted during construction to avoid incident with marine traffic.

5.3.5.6 Reinstatement of Nearshore Section

Backfilling of the dredged microtunnel exit pits and transition trenches with spoil stored in the temporary storage locations will be undertaken following successful pre-commissioning tests of the nearshore and landfall section pipelines. It is anticipated that it will take approximately four days to backfill and reinstate each microtunnel exit pit and transition trench. Final seabed relief and bathymetry restoration of the microtunnel exit pits, transition trenches and temporary storage areas will be performed using side scan sonar and a survey vessel to perform bathymetric surveys. Both survey vessels and the dredgers used in the works will be equipped with a positioning system that allows them to work with the necessary precision.

5.3.6 Construction of Offshore Section

5.3.6.1 General Overview

The main activities in the offshore section of the Project Area include:

- Surveys of the pipeline route prior to, during and after the pipe-laying process;
- Offshore pipe-laying;
- Seabed intervention works;
- Crossings of existing offshore cables; and
- Tie-in of the nearshore / offshore sections.

5.3.6.2 Offshore Construction Vessel Spread

As with the nearshore section, the contracts for the installation of the Pipeline in the offshore section have not yet been awarded. However Table 5.18 presents a summary of the type and number of vessels that are anticipated to be used during the installation of a single offshore section pipeline. The actual pipe-laying spread will depend on the availability of vessels at the time that the necessary permits are granted.

The main vessel required will be the pipe-lay vessel. In addition, other vessels will be involved in the pipe-laying activities, such as support vessels (survey, dive support, crew change) and supply vessels (pipes, fuel and provisions).

5.3.6.3 Surveying

As described in Section 5.3.5.3, a number of further surveys will be required before, during and after installation of the pipeline. Please refer to that section for a description of these surveys.

5.3.6.4 Offshore Pipe-laying Process

Offshore pipe-laying is accomplished by the sequential alignment, welding and lowering of pipe from the pipe-lay vessel. Pipe sections are transported to the pipe-lay vessel pre-coated with polypropylene anti-corrosion coating and internally with epoxy flow coating. The pipe fabrication process on board the pipe-lay vessel (bevelling, line-up, welding and inspection etc.) will be similar to the process described for the shallow water S-Lay vessel in Section 5.3.5.5.

Table 5.18 Typical Offshore Construction Vessel Spread per Pipeline

Construction Activity	Type of Vessel	Task	Number of Vessels	Duration (days) per vessel	Indicative Vessels	Power Rating (kW)	Persons on Board	Utilisation (%)
Pre-Lay Seabed Intervention Works (for free-span correction)	MSV plus subsea excavating equipment (Option 1)	Pre-lay free-span correction and span shoulders sheaving	1	19 days of peak shaving per pipeline 7 days for pre-lay rock dump for span correction Pipeline #1 1 day each for pre-lay rock dump span correction for Pipelines #2, #3 and #4 Plus 3 days at 25% capacity for mobilisation/ demobilisation	Calamity Jane	15,086	72	60
	Grab crane (Option 2)	Dredging on the continental rim/ slope	1	As above	Tertnes	8,390	46	60
	Hopper barge (if soils are not allowed to be stored on seabed) (Option 2)	Spoil transport	2	As above	Sand Carrier 101	300	10	60

Continued...

Construction Activity	Type of Vessel	Task	Number of Vessels	Duration (days) per vessel	Indicative Vessels	Power Rating (kW)	Persons on Board	Utilisation (%)
Pre-Lay Seabed Intervention Works (for free-span correction)	Survey Vessel	Surveying the sea floor during intervention works	1	As above	GSP Prince	7,604	62	60
	Fast supply vessels	Crew changes	1	1 (i.e. 2 half-day trips)	GSP Lyra	2,520	70	60
	Maintenance vessel	Delivery of spare parts / equipment	1	1	Normand Flipper	7,160	16	60
	Fuel / waste water collection vessel	Bilge and waste water gathering	1	1	Bryansk	610	5	60
	Rescue vessel	Safety and rescue operations	1	Only required in case of emergency	GSP Vega	9,548	23	60
Pre-Lay Seabed Intervention Works (for pipeline protection, stability and cable crossings)	Fall-pipe rock dumping Vessel	Accurate placement of rock	1	10 days Plus 3 days at 25% capacity for mobilisation / demobilisation	Tertnes	8,390	46	60
	Survey Vessel	Surveying the sea floor during intervention works	1	As above	GSP Prince (GSP)	7,604	62	60

Continued…

Construction Activity	Type of Vessel	Task	Number of Vessels	Duration (days) per vessel	Indicative Vessels	Power Rating (kW)	Persons on Board	Utilisation (%)
Pre-Lay Seabed Intervention Works (for pipeline protection, stability and cable crossings)	Fast supply vessels	Crew changes	1	1 (i.e. 2 half-day trips)	GSP Lyra	2,520	70	60
	Maintenance vessel	Delivery of spare parts / equipment	1	1	Normand Flipper	7,160	16	60
	Fuel / waste water collection vessel	Bilge and waste water gathering	1	1	Bryansk	610	5	60
	Rescue vessel	Safety and rescue operations	1	Only required in case of emergency	GSP Vega	9,548	23	60
Offshore Pipe-laying 30 m to 600 m water depth	Intermediate depth pipe-lay vessel	Pipe-laying	1	9 (30 km at 3.5 km per day) Plus an additional 38 days running at 25% capacity for mobilisation/ demobilisation	Castoro Sei	20,500	342	40
	Anchor handling tugs	Handling the anchors for the pipe-lay vessel	3	As above	Normand Neptun	13,880	40	60
	PSV	Supplying pipe to pipe-lay vessel	1*	As above	Normand Flipper	7,160	16	60

Continued...

Construction Activity	Type of Vessel	Task	Number of Vessels	Duration (days) per vessel	Indicative Vessels	Power Rating (kW)	Persons on Board	Utilisation (%)
Offshore Pipe-laying 30 m to 600 m water depth	Survey vessel	Surveying the sea floor in front and behind the pipe-lay vessel	2	As above	GSP Prince	7,604	62	60
	MSV	ROV support Diving support Consumables supply Bunker supply Provisions supply Water supply	2	As above	Normand Mermaid	10,000	70	60
	Fast supply vessels	Crew changes	2	1 (i.e. 2 half-day trips)	GSP Lyra	2,520	70	60
	Helicopter	Crew changes	2	1 (i.e. 2 half-day trips)	Super Puma	1,200	10	60
	Maintenance vessel	Delivery of spare parts / equipment	1	1	Normand Flipper	7,160	15	60
	Fuel / waste water collection vessel	Bilge and waste water gathering	1	1	Bryansk	610	7	60
	Rescue vessel	Safety and rescue operations	1	Only required in case of emergency	GSP Vega	9,548	50	60

Continued…

Construction Activity	Type of Vessel	Task	Number of Vessels	Duration (days) per vessel	Indicative Vessels	Power Rating (kW)	Persons on Board	Utilisation (%)
Offshore Pipe-laying >600 m water depth	Deep water pipe-lay vessel	Deep water pipe-laying	1	71 (195 km at 2.75 km per day) Plus 44 days at 25% capacity for mobilisation	Saipem 7000 Castorone	70,000	725	40
	Tug	General support	1	As above	Normand Neptun	13,880	15	60
	PSV	Supplying pipe to pipe-lay vessel	3†	As above	Normand Flipper	7,160	15	60
	Survey vessel	Surveying the sea floor in front and behind the pipelay vessel	2	As above	GSP Prince	7,604	50	60
	MSV	ROV support Diving support Consumables supply Bunker supply Provisions supply Water supply	2	As above	Normand Mermaid	10,000	70	60
	Fast supply vessels	Crew changes	1	2 (i.e. 4 half day trips)	GSP Lyra	2,520	70	60

Continued…

Construction Activity	Type of Vessel	Task	Number of Vessels	Duration (days) per vessel	Indicative Vessels	Power Rating (kW)	Persons on Board	Utilisation (%)
Offshore Pipe-laying >600 m water depth	Helicopter	Crew changes	1	4 (i.e. 8 half day trips)	Super Puma	1,200	10	60
	Maintenance vessel	Delivery of spare parts / equipment	1	4	Normand Flipper	7,160	16	60
	Fuel / waste water collection vessel	Bilge and waste water gathering	1	4	Bryansk	610	5	60
	Rescue vessel	Safety and rescue operations	1	Only required in case of emergency	GSP Vega	9,548	23	60
Post-lay Seabed Intervention Works (for free span correction and stabilisation of the pipeline on continental shelf edge)	Fall-pipe rock dumping vessel for post-lay rock dumping	Pipeline protection from rockfall and at cable crossing location	1	22 days Plus 19 days at 25% capacity for mobilisation / demobilisation	Tertnes	8,390	46	60
	Post-lay Trenching Support Vessel	Post-lay trenching on the slope for free-span correction and pipeline stabilisation on slope	1	As above	GSP Prince equipped with Beluga Trenching System, Calamity Jane	15,086	72	60

Continued…

Construction Activity	Type of Vessel	Task	Number of Vessels	Duration (days) per vessel	Indicative Vessels	Power Rating (kW)	Persons on Board	Utilisation (%)
Post-lay Seabed Intervention Works (for free span correction and stabilisation of the pipeline on continental shelf edge)	Survey Vessel	Surveying the sea floor during intervention works	1	As above	GSP Prince	7,604	62	60
	Fast supply vessels	Crew changes	1	1 (i.e. 2 half-day trips)	GSP Lyra	2,520	70	60
	Maintenance vessel	Delivery of spare parts / equipment	1	2	Normand Flipper	7,160	16	60
	Fuel / waste water collection vessel	Bilge and waste water gathering	1	2	Bryansk	610	5	60
	Rescue vessel	Safety and rescue operations	1	Only required in case of emergency	GSP Vega	9,548	23	60

* This indicative number only accounts for the maximum number of PSVs that may be present within the 'Offshore (30 mbsl - 600 mbsl)' section of the Russian EEZ whilst pipe-laying is undertaken in that section. A PSV will also pass through this section to reach the construction spread when it is pipe-laying in the Nearshore Section in Russia. This additional movement is accounted for in the fuel use (Table 5.24) and emission estimates (Table 5.28).

† This indicative number only accounts for the maximum number of PSVs that may be present within the 'Offshore > 600 mbsl' section of the Russian EEZ whilst pipe-laying is undertaken in that section. PSVs will also pass through this section to reach the construction spread when pipe-laying to the east of the 600 mbsl location. These additional PSV movements are accounted for in the fuel use (Table 5.24) and emissions estimates (Table 5.28).

Complete.

Offshore pipe-laying may be performed by the S-lay technique, or by a combination of S-lay and J-lay techniques. The method chosen mainly depends on water depth and/or cost/availability of an installation vessel. At the time of preparing this ESIA Report, the technique(s) to be employed for pipe-laying in the offshore section have yet to be confirmed. Therefore, it is assumed that either technique may be used for the Project and both are described in the following sections.

The S-Lay technique requires the load out of single 12 m pipe sections to the pipe-lay vessel, whilst the J-Lay technique requires some prior welding of the pipe sections at the marshalling yards in Bulgaria before load out to the offshore pipe-lay vessel. The average pipe-lay rate for S-Lay technique is expected to be in the order of 3.5 km per day (24 hour period), depending on weather conditions. Please refer to section 5.3.5.5 for further information on the S-Lay method.

For J-Lay, the pipe sections will be welded into strings of four pipes (quad joints), or two pipes (double joints). As described in Section 5.3.2.1, the welding, and field joint coating activities associated with quad jointing can be performed either onshore within a dedicated factory located in one of the marshalling yards in Bulgaria, or onboard a dedicated pipe-lay vessel that moors alongside the marshalling yard quayside and acts as the factory producing welded quads or double joints for load out to the J-Lay vessel offshore.

J-lay pipeline installation was developed for laying pipe in deep waters as it puts less stress on the pipeline by installing the pipeline from an almost vertical position. In the J-Lay method, the pipes are assembled and welded vertically in a tower erected on the centre or side of the pipe-lay vessel. A pipe tensioner or support frame is used to lower the pipeline string (quad or double joint) through the tower. As the pipe-lay vessel moves forward, the jointed pipeline is lowered near vertically in a J-shape from the launching point down to the bottom of the sea. The average pipe-lay rate using J-Lay technique is expected to be in the order of 2.75 km per day (24 hour period), depending on weather conditions. The J-lay method is considered to be suitable from a minimum water depth of 300 m, depending on the pipeline diameter. Figure 5.31 presents a schematic drawing of the J-Lay pipe-laying method.

The installation of the offshore pipeline section may require both intermediate depth and deep water pipe-lay vessels. An intermediate depth pipe-lay vessel is capable of working in a water depth range of approximately 20 m up to approximately 600 m. These vessels install the pipeline by the S-Lay method and may advance by pulling on their anchor lines or utilising dynamic positioning (DP) thrusters. DP is a computer-controlled system that drives the vessels thrusters (directional propellers) to maintain position without the use of anchors. A deep water pipe-lay vessel is capable of laying pipe in water depths from approximately 300 m to any depth required depending on the pipeline dimensions. These vessels are dynamically positioned and may use either the S-Lay or J-Lay methods.

Figure 5.31 Schematic of J-Lay Pipe-Lay Method

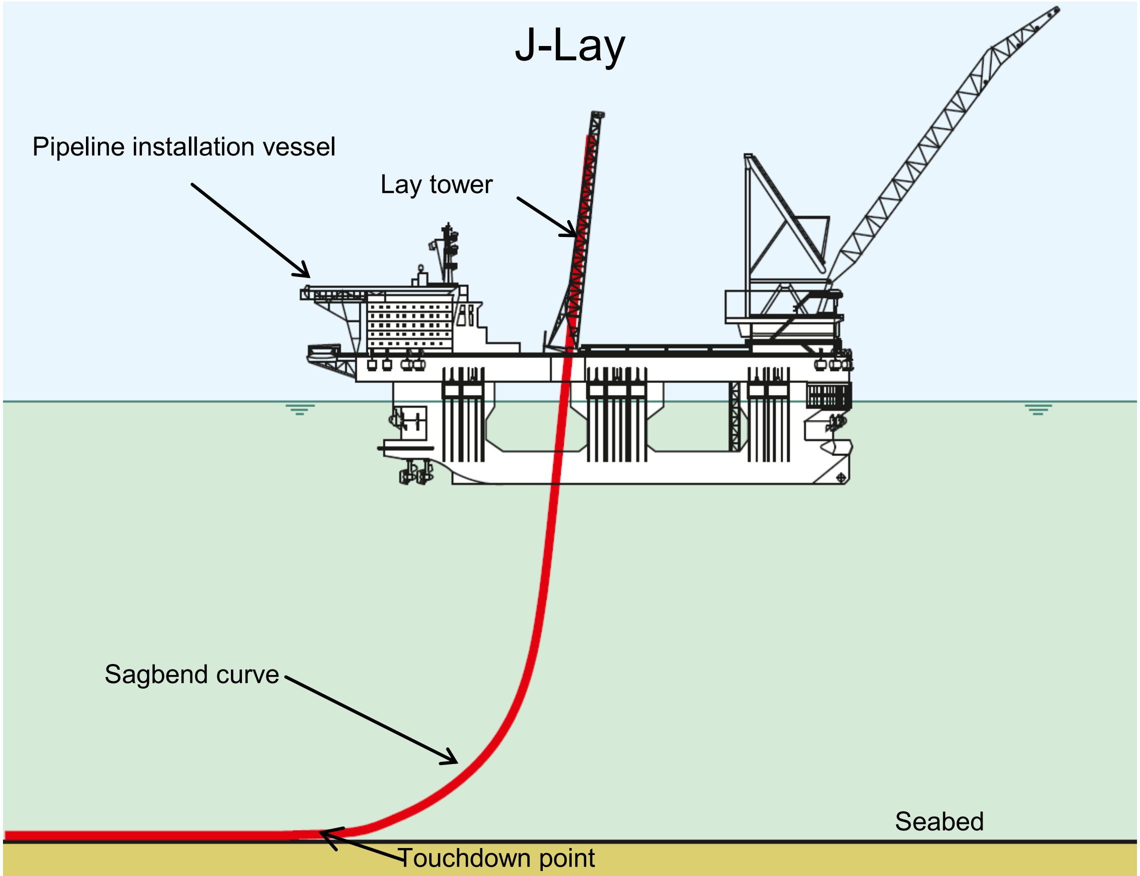


Figure 5.32 shows a typical intermediate water depth S-Lay pipe-lay vessel and Figure 5.33 shows a typical deepwater J-Lay pipe-lay vessel.

For the majority of the offshore section pipe-lay work the pipe-lay vessel will be manoeuvred along the pipeline route using DP. Anchored vessels can potentially be used in water depths of up to 600 m, however for the Project it is anticipated that anchored pipe-lay vessels will only be used up to a maximum water depth of approximately 350 - 380 m. If anchors are used, up to 12 anchors may be deployed from the pipe-lay vessel and the position of the anchor itself could be as far as 1.5 km from the centreline of the pipe-lay vessel, depending on the water depth. As described in Section 5.3.5.3, an anchor corridor survey will be required. A typical anchor spread is illustrated in Figure 5.30.

A safety exclusion zone will be enforced around the pipe-lay vessel during pipe-laying of approximately 2 km (1.1 NM) radius for DP vessels and approximately 3 km (1.6 NM) radius for anchored vessels (depending on the anchor spread). As described in Section 5.3.5.5, agreement with the appropriate marine authorities shall be obtained regarding the exact exclusion distance to be adopted during pipe-laying to avoid incidents with marine traffic.

Figure 5.32 Typical Intermediate Water Depth S-Lay Vessel

Image supplied courtesy of Allseas, Switzerland

Figure 5.33 Typical Deep Water J-Lay Vessel

Image supplied courtesy of Saipem

If a combination of S-Lay and J-Lay methods are utilised it is anticipated that the S-Lay method will be employed from the 30 m water depth pipeline tie-in location out to a water depth of approximately 600 m, a distance of approximately 30 km, although the J-lay method could potentially be used from a water depth of approximately 350 - 380 m. At this location, an abandonment and recovery head is welded to the end of the pipeline to prevent sea water entering the pipeline and it is then lowered to the seabed by a davit wire connected to a winch on the S-Lay vessel and left on the seabed. The S-Lay vessel spread is then demobilised. The J-Lay vessel spread is then mobilised to the pipeline abandonment location. The pipeline is recovered by the J-Lay vessel using a recovery winch. The J-Lay vessel then commences pipe-laying towards the EEZ boundary of Russia and Turkey, a distance of approximately 195 km.

Although the EEZ boundary of Russia and Turkey is the downstream boundary of the Project, the J-Lay vessel will maintain pipe-laying through the EEZ of Turkey and Bulgaria to continue construction of the South Stream Offshore Pipeline.

Pipeline Flood Protection during Installation

A flood prevention device will be developed by the appointed pipe-lay contractor for installation within the pipeline during construction. The device will sit inside the pipeline close to where the pipeline touches down onto the seabed. As the pipe-lay progresses the device will be moved along the pipeline in the same direction as pipe-laying. The actual means of movement of the flood prevention device will be determined by the pipe-lay contractor during the development of the flood prevention device. However, possible methods are listed below:

- Air pressure from a start-up head;
- Control umbilical connected to the pipe-lay vessel; and
- A battery powered drive unit.

Each device will be designed to be controlled remotely and to allow adequate operation and monitoring control.

In the event that there is a loss of tension or loss of vessel position during pipe-laying causing the pipeline to become overstressed to the point where it ruptures and floods, then the flood prevention device will detect the change in pressure, will activate and seal the pipeline, thus preventing untreated sea water from flooding the pipeline. The damaged section of the pipeline between the flood prevention device and the pipe-lay vessel will then be removed and the undamaged pipeline section (protected by the flood prevention device) will be recovered back to the pipe-lay vessel and pipe-lay will resume.

Pipeline Repair during Construction

Emergency pipeline repair, including information on South Stream Transport's Emergency Pipeline Repair Strategy (EPRS), during both the Construction and Pre-Commissioning Phase and Operational Phase is described in detail in Section 5.6.5.

5.3.6.5 Seabed Intervention Requirements

In the offshore section, the pipeline will be laid directly on the seabed. This technique will minimise seabed disturbance over most of the 225 km section. However, although the route of the pipelines has been designed to minimise seabed intervention requirements, some intervention will be required in specific areas, either before or after pipe-laying. This is to limit or remove pipeline free span lengths (for example in areas where the sea bed is rough and uneven), to protect the pipeline from geo-hazards such as rockfall in areas of excessive slopes (for example on the continental slope) and to protect the pipelines and cables at cable crossing locations.

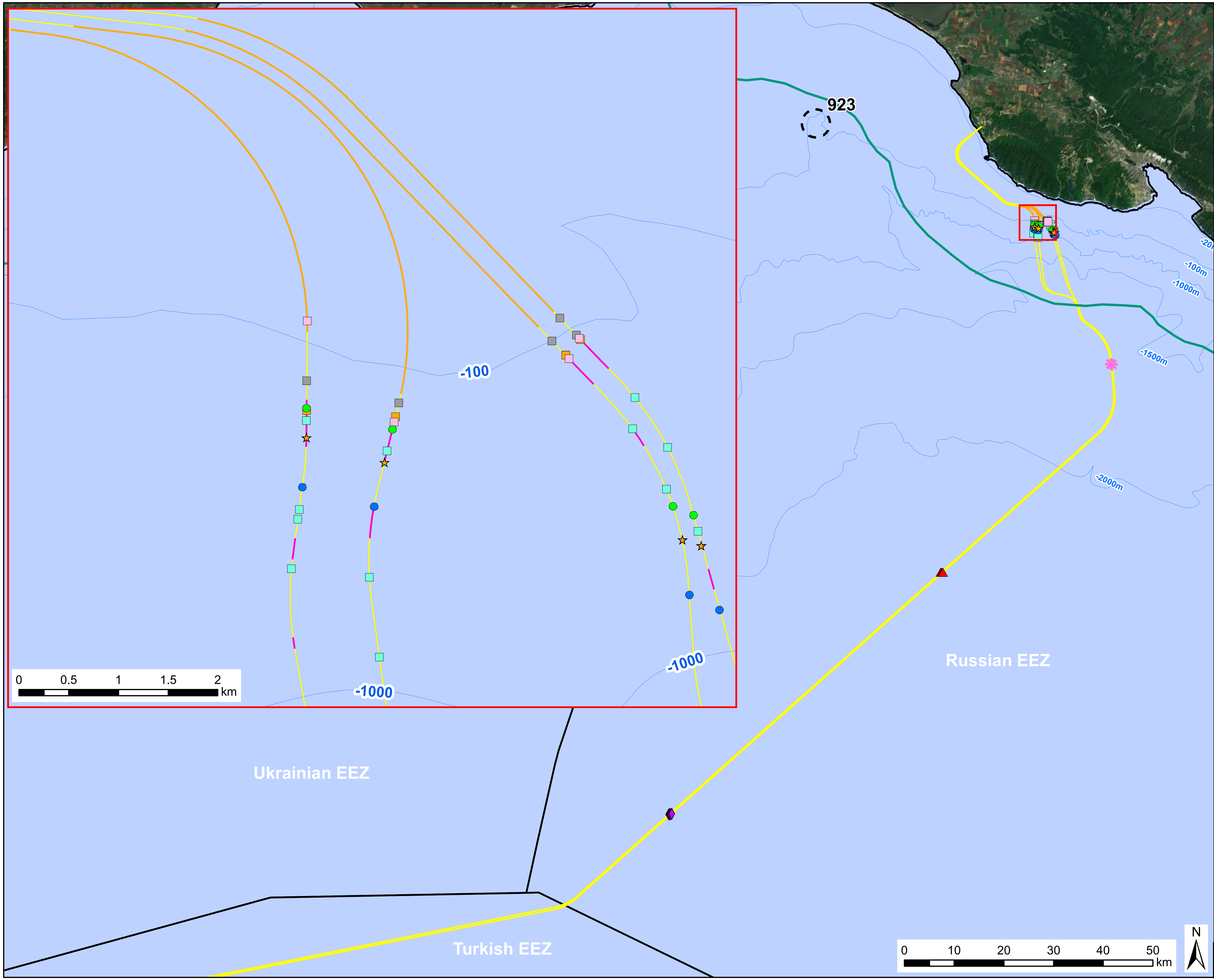
The type and extent of seabed intervention which is currently considered to be necessary is described in the following sections and the locations are shown in Figure 5.34. Full intervention requirements will not be confirmed until detailed design studies have been completed; however, any changes are anticipated to be minor and are not anticipated to alter the results of this ESIA Report. Should any major design changes be required which may affect the results of the ESIA, the management of change process described in Section 5.11 will be followed. There are various intervention methods and within each method a wide range of alternatives exist, which may be applied depending on particular circumstances such as water depth, burial depth or soil conditions.

The seabed intervention methods can be divided in two main categories: pre-installation intervention and post-installation intervention.

Pre-installation methods include dredging, and placing of supports by means of gravel or mattresses in areas where free span pipeline sections are anticipated. For post-installation intervention, a wide variety of methods can be applied. Typical post-installation methods include post-lay trenching, rock dumping, placement of mattresses and the installation of Vortex Induced Vibration (VIV) suppression strakes. The various intervention methods that may be applied along the Project pipelines are described below.

The seabed intervention requirements are summarised in Table 5.19, Table 5.20 and Table 5.21. It should be noted that where supports are listed as being required, these may be installed either before or after pipe-laying. Similarly, there are locations where either pre- or post-installation trenching may be undertaken. The decision on the techniques to be employed will be subject to detailed design and preference of the appointed pipe-lay contractor.

Pre- and post-installation methods associated with cable crossings are described in Section 5.3.6.6.



LEGEND

Russian Sector of South Stream Offshore Pipeline

Proposed offshore pipelines

Cable crossing location

- Cable 1
- Cable 2
- Black Sea Fibre Optic Cable (BS FOCS)
- Italy-Turkey-Ukraine-Russia (ITUR)
- Feodosiya (Ukraine) - Novorossiysk (Russia)
- Planned Fibre Optic Cable

Seabed intervention locations

- Pre-lay dredging/MFE
- Pre-lay rock dumping
- Pre/Post-lay support
- Pre/Post-lay trenching/MFE
- Post-lay rock dumping
- Post-lay trenching and backfilling
- Existing permitted disposal site
- Territorial waters boundary
- Exclusive Economic Zone boundary
- Isobaths

Projection: Lambert Conformal Conic

Revision Details	By / Check	Check / Date	Suffix

Purpose of Issue

For Information

Client

South Stream Transport AG

Stream ENERGISING EUROPE

Project Title

SOUTH STREAM OFFSHORE PIPELINE

Drawing Title

CABLE CROSSINGS AND SEABED INTERVENTION LOCATIONS

Drawn	Checked	Approved	Date
AH	RW	MW	12 Feb 2014

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Drawing Number

Figure 5.34

Rev

Plot Date: 12 Feb 2014
File Name:I:\5004 - Information Systems\46369082_South_Stream\MXDs\Report Maps - Russia\Russian ESIA v2\Chapter 5 Project Description\Figure 5-34 Cable Crossings and Seabed Intervention Locations.mxd

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Table 5.19 Offshore Section Seabed Intervention Requirements for Free Span Correction

Pipeline Number	Approximate Distance from Russian Coast (km) Measured along the Pipeline Route	Water Depth (m)	Volume of Dredging or Rock (m^3)	Seabed Area (m^2)	Seabed Intervention Required
1	28.8	90	N/A	100 per support	Pre- or post-installation artificial support (e.g. mattresses/grout bag)
	29.4	110	12,000	5,150	Pre-installation dredging or mass flow excavation (MFE)
	29.8	300	210	220	Pre- or post-installation trenching or MFE
	30.7	500	450	470	
	30.8	550	310	330	
	31.3	660	550	570	
	29.7	220	1,765*	6621	Pre- or post-installation mechanical, structural and / or rock berm support (it can be substituted with VIV suppression strakes if validated by detailed design)
	30.7	500	1,835	688	Pre-installation rock dump

Continued…

Pipeline Number	Approximate Distance from Russian Coast (km) Measured along the Pipeline Route	Water Depth (m)	Volume of Dredging or Rock (m^3)	Seabed Area (m^2)	Seabed Intervention Required
2	30.3	120	15,000	5,450	Pre-installation dredging or MFE
	30.5	200	1,4001	8201	Pre- or post-installation mechanical, structural and / or rock berm support (it can be substituted with VIV suppression strakes if validated by detailed design)
	30.8	350	510	530	Pre- or post-installation trenching or MFE
	32.1	680	510	540	
	32.9	860	500	520	
3	30.2	100	6,000	3,880	Pre-installation dredging or MFE
	30.4	165	370	390	Pre- or post-installation trenching or MFE
	31.4	420	500	520	
	32.1	580	650	680	
	30.4	140	1,8001	6751	Pre- or post-installation mechanical, structural and / or rock berm support (it can be substituted with VIV suppression strakes if validated by detailed design)

Continued…

Pipeline Number	Approximate Distance from Russian Coast (km) Measured along the Pipeline Route	Water Depth (m)	Volume of Dredging or Rock (m^3)	Seabed Area (m^2)	Seabed Intervention Required
4	29.9	100	6,000	3,880	Pre-installation dredging or MFE
	30.4	150	3,500	1,700	
	31.0	390	250	270	Pre- or post-installation trenching or MFE
	31.6	520	540	560	
	32.5	720	730	760	
	30.2	150	1,8001	6751	Pre- or post-installation mechanical, structural and / or rock berm support (it can be substituted with VIV suppression strakes if validated by detailed design)

Complete.

* Assumes use of rock dumping as this requires largest seabed footprint and volume of material

Table 5.20 Offshore Section Seabed Intervention Requirements for Pipeline Stabilisation

Pipeline Number	Approximate Distance from Russian Coast (km) Measured along the Pipeline Route	Water Depth (m)	Volume of Dredging / Rock (m^3)	Seabed Area (m^2)	Seabed Intervention Required
1	24.15-28.85	60-95	11,000 /	7,100	Post-lay trenching
	24.15-28.85	60-95	16,000	21,150	Post-lay backfilling of trench with Imported gravel / rock
2	24.46-30.16	60-90	11,000 /	7,100	Post-lay trenching
	24.46-30.16	60-90	16,000	21,150	Post-lay backfilling of trench with Imported gravel / rock
3	25.26-29.96	60-90	11,000 /	7,100	Post-lay trenching
	25.26-29.96	60-90	16,000	21,150	Post-lay backfilling of trench with Imported gravel / rock
4	25.07-29.77	60-90	11,000 /	7,100	Post-lay trenching
	25.07-29.77	60-90	16,000	21,150	Post-lay backfilling of trench with Imported gravel / rock

Table 5.21 Offshore Section Seabed Intervention Requirements for Rockfall Protection

Pipeline Number	Approximate Distance from Russian Coast (km) Measured along the Pipeline Route	Water Depth (m)	Volume of Rock (m^3)	Seabed Area (m^2)	Seabed Intervention Required
1	29.61-29.80	200-300	2,140	3,035	Post-installation rock dump
	29.90-30.09	340-400	2,140	3,035	
	31.02-31.18	610-650	1,800	2,550	
	31.95-32.05	820-850	1,120	1,580	

Continued...

Pipeline Number	Approximate Distance from Russian Coast (km) Measured along the Pipeline Route	Water Depth (m)	Volume of Rock (m^3)	Seabed Area (m^2)	Seabed Intervention Required
2	30.61-30.81	270-360	3,200	4,550	Post-installation rock dump
	31.41-31.66	500-570	4,000	5,650	
3	30.51-30.76	200-290	3,800	5,350	Post-installation rock dump
	31.41-31.51	445-465	1,600	2,300	
4	30.22-30.57	170-305	5,300	7,500	Post-installation rock dump
	32.90-33.02	800-830	1,900	2,700	

Complete.

Pre-Installation Seabed Intervention Requirements

As shown in Table 5.19, some pre-installation seabed intervention work is required in areas where sections of free span pipeline are anticipated due to the uneven seabed profile. Pre-installation seabed intervention methods proposed for the Project include dredging or mass flow excavation to remove shoulder spans, and the placement of pipeline support structures.

Dredging

Pre-installation dredging is undertaken to level or flatten out the seabed in areas of predicted pipeline spanning before the pipeline is laid. It is anticipated that approximately 42,500 m^3 of seabed sediments will require to be dredged for all four pipelines to correct free span locations. The dredged sediments will be transported to an existing permitted underwater dump site for disposal (Disposal Site Number 923). The dump site is located on the Russian continental slope as illustrated in Figure 5.34. No other dredged sediment is proposed to be taken to this permanent disposal site.

Due to the water depths where pre-dredging is necessary (between approximately 110-150 m water depth) to remove shoulder spans it is unlikely that conventional dredging vessels such as CSDs or TSHDs will be employed due to restrictions in the water depths that they can operate in. There are however, grab crane dredgers (as described in Section 5.3.5.4) that may be able to operate at these depths. Alternatively, dredging at these depths could be undertaken using special ROV dredging tools / vehicles designed to work in deep water and on steep slopes, which are controlled by operators located aboard a support vessel.

One such tool is a grab excavation system that uses an ROV that is mounted on top of the grab for precise manoeuvrability of the grab. By using two lifting points – one forward and one aft - the excavation system is able to transport the excavated material underwater and deposit it where necessary. An alternative method is the use of a dredging vehicle that levels or flattens out the seabed using a combination of water jetting and suction to remove soil from the area.

The dredging head is installed on an extendable arm to cover the operational area. The dredging vehicle moves along the seabed using powered tracks and/or articulated walking legs and is capable of working on steep slopes. Both excavation tools are controlled from a support vessel.

Mass Flow Excavation

An alternative option is the use of a mass flow excavation tool. This tool is an ROV that uses subsea jetting equipment to excavate the seabed. The mass flow excavation tool generates a large volume column of water travelling vertically down to the seabed at high velocity. The water column hits the seabed at high speed to produce a powerful excavation force. This type of equipment allows for localised pre- and post-installation span correction in very deep waters in most soils without risk of damage to the pipeline. The excavation tool is controlled from a support vessel.

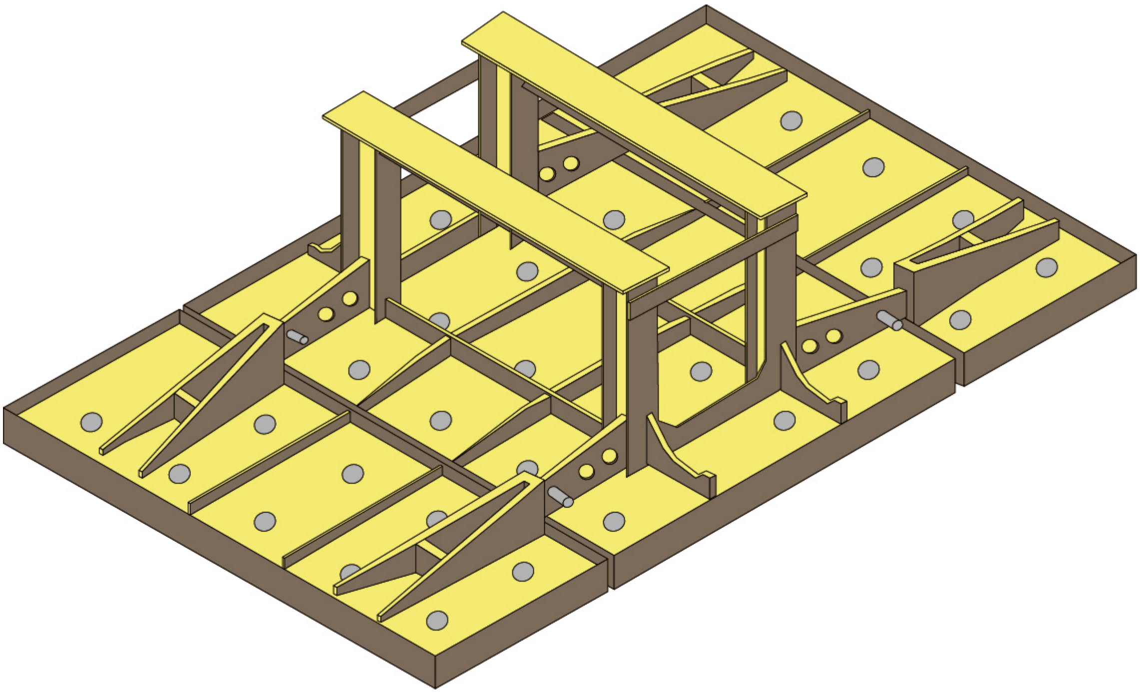
Support Structures

Support structures are strategically placed to provide vertical support to the pipeline at excessive span length locations. The exact details of the support structures are still subject to detailed design, although descriptions of typical methods are described below. Alternatively, it may be decided during detailed design studies to install these supports after pipe-lay or that the pre-installed supports for the VIV spans can be substituted with VIV suppression strakes. Suppression strakes are helical shaped plastic moulded structures which are designed to suppress damaging vibration forces to an acceptable level. If required, the strakes will be fitted to the pipelines on the pipe-lay vessel during pipe-laying.

Pre-installed supports may include concrete mattresses, structural support or rock berm, which need to be stable under earthquake and seabed currents conditions. Mattresses are normally installed from a vessel with a crane or A-frame with ROV support. Mattresses are available in different shapes and types and are generally made of concrete.

Rigid supports such as mud mats can also be installed to support the pipeline. Mud mats, which are made of steel (with self-sustaining cathodic protection system consisting of sacrificial anodes), consist of a base and top plate and a number of perpendicular vertical stiffeners that function as load-bearing beams. Rigid supports are installed with similar equipment as concrete mattresses, i.e. from a vessel with a crane or A-frame with ROV support. An indicative mud mat design is shown in Figure 5.35.

Figure 5.35 Indicative Mud Mat Design



Alternatively, pre-installation rock dumping can be undertaken. Pre-installation rock dumping will involve the placement of rock berms, which are constructed using coarse gravel or small stones to locally reshape the seabed to provide support for the pipelines to ensure their long-term integrity. The rock berm length and spacing will vary with location and will not be confirmed until the detailed design stage. However, it is conservatively estimated at this time that each rock berm will have a footprint of approximately 100 m^2. The total volume of rock required to complete the works should rock berms be constructed at all pre-installation support locations is conservatively estimated to be approximately 8,600 m^3.

Accurate placement of rock will be assured through the use of a dedicated rock-dumping vessel equipped with a fall-pipe, from which the rock is transported from the surface to just above the seafloor using suspended pipe sections. The shape of rock placements will depend on seabed conditions, but will be designed such that rock requirements are minimised. The end of the fall-pipe will be positioned by an ROV which is equipped with a positioning system to aid the accuracy of the rock placement and a post construction survey will be performed to confirm correct placement.

The placement of all rock material will be subject to a licence from the local authorities. The rock material selected will be chemically and mechanically stable for the entire lifetime of the Project. The type of rock selected will have to meet certain strength and durability requirements to ensure it lasts the length of the operational phase of the Project. The average size of the rock material will be 50 mm but may range from 20-100 mm. It will be a condition that the material used will not contain any contaminants, such as heavy metals.

Material for rock placement will be extracted from appropriately licensed onshore quarries or marine aggregate sites. At the time of preparing this ESIA Report, the source of rock material is unknown; rock may come from within Russia or from another country depending on the availability and quality of rock sources. Suitable rock types that could be used include basalt, gabbro and/or granite. The rock material will most likely be transported via a rock dump vessel and taken directly to the rock dump locations. Alternatively, if the rock comes from another country it may be transported by bulk carrier. If this is the case the rock will be transferred to a Russian port (Novorossiysk) and loaded onto a rock dump vessel.

Post-Installation Seabed Intervention Requirements

As shown in Table 5.19 some post-installation seabed intervention work is required in areas where sections of free span pipeline are anticipated due to the uneven seabed profile. Post-installation seabed intervention methods proposed for the Project include dredging (trenching) or mass flow excavation to remove shoulder spans and the placement of pipeline support structures. As shown in Table 5.20 post-lay trenching and backfilling of the trench with imported rock / stone may be required on the ridge of the continental slope (in water depth s of between approximately 60 - 95 m) to provide the pipeline with additional stabilisation. The actual requirement for this intervention work will be confirmed during the detailed design stage as concrete coating of the pipeline alone may be sufficient to meet stabilisation requirements. As shown in Table 5.21 rock dumping is required over the pipelines in areas where they are at risk from rock fall on the continental slope.

Mattresses and Grout Bags

Concrete mattresses or grout bags may be required to rectify a single free span section on pipeline #1 if the as-laid free span length exceeds 110 m length and 1.7 m height. The requirement will be identified during post-lay surveys. If required, concrete mattresses or grout bags will be installed underneath the pipeline to provide vertical support. Concrete mattresses will be installed as per the description in the pre-installation section above.

Empty grout bags would be lowered to the seabed on a deployment frame from a vessel for ease of ROV manipulation and filling. The empty bag is placed under the pipeline and subsequently pumped full of grout material. The weight of the pipeline is taken by the grout bag as it fills. The grout then hardens to create a rigid support point.

Post-Installation Dredging

Post-installation dredging (also referred to as post-lay trenching) will be necessary for rectifying free-span sections where shoulder spans have been identified (see Table 5.19) and where additional pipeline stabilisation (at the ridge of the continental slope) may be required as shown in Table 5.20. It will be carried out by lowering the pipeline sections in question below the natural seabed level using post-installation trenching techniques. Post-lay trenching can be done by various means. Some equipment is self-propelled, others pulled by a surface vessel, and some make contact with the pipeline, whereas others avoid direct contact and loads on the pipeline. The method to be applied depends on water depth, soil conditions and burial depth to be achieved. The trenching methods can be grouped into three main categories; jetting, mechanical cutters and ploughs. The final decision on which method to be employed will depend on the appointed installation contractor and subject to further detailed design. Each option requires a support vessel which will be equipped with special equipment to operate the ROV trenching equipment.

The jetting technique lowers the pipeline below the seabed surface through a combination of lateral excavation and high pressure water jetting to displace the sediment from under the installed pipeline. The pipeline then descends into the excavated space below it. If necessary, the displaced sediment may be pumped over the preceding section of the pipeline to backfill the trench. This method minimises displacement of sediment and associated benthic organisms and requires no temporary or permanent disposal of excavated sediments.

Mechanical cutters cut the soils under the pipeline to gradually lower it under the seabed surface. Mechanical cutters are normally heavy pieces of equipment fitted with crawlers that allow the cutter to crawl along the surface of the pipeline. This tool typically consists of cutter discs and suction pumps at the rear of the tool that push the excavated soil away from the trench. A mechanical cutter requires a support vessel to lower it into the water and position it accurately over the pipeline.

The ploughing technique uses a relatively large structure which is pulled over the seabed, which lifts the pipeline, cuts the soil and deposits it at the side of the trench and finally lowers the pipeline in the created trench. The trench can be left to backfill naturally or the deposited soil can be replaced on top of the pipeline in a successive operation by a backfill plough. A plough requires a support vessel with a large bollard pull and a large lifting A-frame.

At each span correction location to be trenched (shown in Table 5.19) it is anticipated that the pipelines will be lowered to a depth of approximately 1 m below the seabed surface. The width of seabed surface impacted by post-installation trenching will depend on the method employed, however it is anticipated to be approximately 20 m.

Mass Flow Excavation

Alternatively, MFE, as described in the Pre-Installation Seabed Intervention Requirements section above, could also be used for post-installation pipeline lowering / burial into the seabed. If MFE is used the management of change process described in Section 5.11 will be followed if it is deemed that this change may affect the results of the ESIA Report.

Backfilling of Trench with Gravel / Rock

As shown in Table 5.20, some areas of the pipeline located on the ridge of the continental slope may require post-lay trenching and backfilling of the trench to improve the stability of the pipeline. Backfilling of the trench with imported gravel / rock will be undertaken using a fall-pipe vessel as described in the pre-installation seabed intervention requirements section above. It is conservatively estimated that a total of approximately 64,000 m^3 of gravel/rock will be required to backfill the four pipeline trenches.

Rock Dumping

Rock dumping is required to cover the pipelines at certain sections of the pipeline route where there is a risk of damage from potential rockfall (see Table 5.21). Rock placement will be undertaken using a fall-pipe vessel as described in the pre-installation seabed intervention requirements section above. It is conservatively estimated that a total of approximately 27,000 m^3 of rock will be required to meet rockfall protection requirements.

The exact extent of these post-lay seabed intervention measures may be adjusted during the detailed design stage, and will be further reviewed after the pipeline has been installed and surveyed. However, any changes are anticipated to be minor and are not anticipated to alter the results of this ESIA Report. Should any major design changes be required which may affect the results of the ESIA, the management of change process described in Section 5.11 will be followed.

A safety exclusion zone of approximately 0.5 km (0.3 NM) radius for rock placement or mattress installation vessels will be adopted during construction to avoid incident with marine traffic.

5.3.6.6 Crossings of Existing Subsea Infrastructure

No existing pipelines will be crossed by the Project offshore pipelines. However, the offshore pipeline route will cross six subsea cables. Three cables have been identified on the continental slope (one in-service and two unknown) and two in-service cables have been identified on the abyssal plain, the final cable was laid on the abyssal plain in 2013. The locations of the first five cables listed have been confirmed by ROV surveys carried out during Front End Engineering Design (FEED). The location of the latest telecommunication cable, laid in 2013, has also been confirmed since completion of FEED. An overview of the six known cables and their operators is provided in Table 5.21 and the crossing locations are shown in Figure 5.34.

The in-service Feodosiya (Ukraine) to Novorossiysk (Russia) cable is thought to be one of the three cables on the continental slope; however, it is unclear which of the three cables it actually is as the other two cables are located in close proximity. The status (in service or out-of-service) of these other two cables (Identified Cable No. 1 and No. 2) is presently unknown, however a number of cable breaks in Identified Cable No.2 were observed during ROV surveys. Therefore, it is assumed that this cable is out-of-service. The two confirmed in-service cables on the abyssal plain are the Black Sea Fibre Optic Cable (BS-FOCS) and Italy-Turkey-Ukraine-Russia (ITUR). The new cable n is the Anapa-Dzhubga-Adler telecommunication cable that will be operated by Upravlenie Perspectivnyh Tehnologiy.

In addition, two further new telecommunication cables between Myskhako (City of Novorossiysk) – Cape Utrish and Cape Utrish – Cape Zhelezny Rog are understood to be planned for development in future although no route specific information has been obtained. These two cables are not shown in Table 5.22 and Figure 5.34.

Table 5.22 Cable Crossings

Name	Cable Type	Operator / Owner
Identified Cable Number 1	Unknown (out-of-service)	Russian Ministry of Defence
Feodosiya (Ukraine) - Novorossiysk (Russia)	Telecommunication	Russian Ministry of Defence
Identified Cable Number 2	Unknown (out-of-service)	Russian Ministry of Defence
BS-FOCS	Telecommunication	BTC / Vivacom / Rostelecom
ITUR	Telecommunication	Rostelecom
Anapa-Dzhubga-Adler	Telecommunication	Upravlenie Perspectivnyh Tehnologiy

Crossing Agreements

Known owners of active cables were approached with the aim of reaching mutual crossing agreements covering liabilities and procedures for crossing methods. According to the agreements, South Stream Transport will be required to provide crossing designs and installation procedures to the satisfaction of the owners prior to installation of the pipelines.

The crossing agreements used by South Stream Transport with the cable operators will be based on the guidelines prepared by the International Cable Protection Committee (ICPC) (Ref. 5.10), which are used worldwide for telecommunication cables.

Cable Crossing Techniques

For the in-service cables on the Russian Slope (assumed to be Identified Cable No.1 and the Feodosiya - Novorossiysk Cable), the identified cables are in free span at the location where they are crossed by the Project pipelines.

For the out-of-service cable on the Russian slope (assumed to be Identified Cable No.2), 150 m of the cable either side of the crossing location will be cut (after obtaining final permission from cable owner/authority). The cut cable will be removed from the pipeline corridor prior to pipeline construction and recovered and disposed of in an environmentally friendly manner as proposed by the ICPC. To ensure that the cut cable could not return to the pipeline corridor during the design life of the pipeline, the cable ends will be weighted with clump weights.

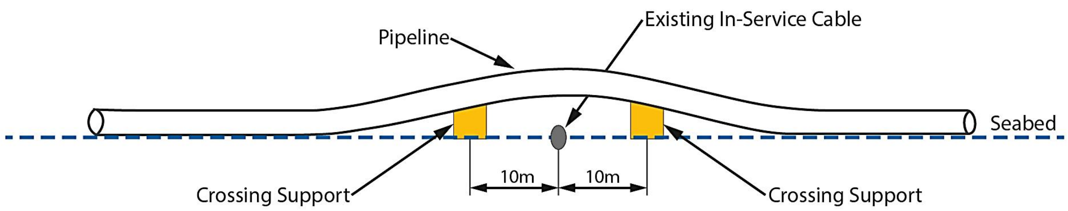
For the BS-FOCS, ITUR and Anapa-Dzhubga-Adler cables, the cable crossings will be constructed to ensure that the pipelines and cables remain at a safe distance from each other. The support height is selected in order to guarantee the agreed minimum vertical separation between the cable and the pipelines. The vertical separation between the pipelines and existing cables will be a minimum of 0.3 m for the BS-FOCS and Anapa-Dzhubga-Adler cable and 0.5 m for the ITUR cable (as specified by the owner Rostelecom) during the design life of the pipelines, taking into account settling of the pipeline and support settlement in the seabed as well as further settlement by the cables. The separation distance will also take account of free span vibrations, where this is applicable. This will ensure that the cables are not unduly stressed or loaded by the pipelines passing over them.

The cable crossing is achieved by elevating the pipeline by supporting it with rigid concrete mattresses or mud mat structures either side of the cable. The use of mud mats will be adopted if the soils are deemed too soft for the use of concrete mattresses.

It is anticipated that crossings of the BS-FOCS, ITUR and the Anapa-Dzhubga-Adler cable, which are located on the abyssal plain will be crossed using mud mat structures to provide the vertical support for the pipelines due to the soft sediments present at the cable crossing locations. This crossing method involves installing crossing supports (mud mats) on both sides of the existing cables prior to pipeline installation. It is anticipated that each mud mat will have base dimensions of 10 m x 5 m and an approximate submerged weight of 10 tonnes. The crossing support will be installed parallel to the existing cables with a distance of 10 m from centre of support to the existing cable; however the distance of the cable from the edges of the support should be 2 m as a minimum. The minimum height of the crossing supports will be specified accordingly during the detailed design process.

The final crossing designs will be subject to agreements between South Steam Transport and individual cable owners. However, an indicative illustration of the crossing layout for the BS-FOCS and ITUR cables is shown in Figure 5.36.

Figure 5.36 Indicative Cable Crossing for the BS-FOCS and ITUR Cables



5.3.6.7 Nearshore and Offshore Construction Material Use

Use of Resources

Materials

During construction of the nearshore and offshore section pipelines a variety of materials will be required. An estimate of the quantities of the main materials to be consumed is shown in Table 5.23. Quantities are approximate and subject to final optimisation.

Table 5.23 Material Consumption

Material	Quantity per Pipeline	Total (all four pipelines)
Steel (pipelines)	163,883 tonnes	655,532 tonnes
Concrete Coating	11,138 tonnes	44,552 tonnes
Coating (3LLP)	2,165 tonnes	8,660 tonnes
Coating (Field Joint)	499 tonnes	1,996 tonnes
Weld Material	161 tonnes	644 tonnes
Rock (pre- and post-installation seabed intervention)	Pipeline 1 – 26,800 m^3 Pipeline 2 – 24,600 m^3 Pipeline 3 – 23,200 m^3 Pipeline 4 – 25,000 m^3	99,600 m^3

Fuel

At sea, fuel and refuelling is referred to as bunker and bunkering, respectively. Where practical, vessels deployed in the Project area will use light fuels such as Marine Diesel Oil (MDO) or Marine Gas Oil (MGO). Sulphur content in fuel will be in compliance with requirements of Annex VI – 2008 to the MARPOL 73/78 Convention and any national legislation. Some vessel bunkering may be undertaken at support ports (most likely Novorossiysk) in Russia. The bunkering for some vessels (e.g. PSVs) will be undertaken at the marshalling yards in Bulgaria, as these vessels will be making return trips. However, for vessels located continually at sea (e.g. the pipe-lay vessel), the bunker will be pumped into the ships' tanks by the bunkering tanker. All bunkering activities will be undertaken in accordance with the Vessels and Marine Transport activity-specific CMP, which will be developed as part of South Stream Transport's ESMP. The CMP will contain activity-specific requirements, to be met by both South Stream Transport and the appointed contractors (and sub-contractors). Further details on the Vessels and Marine Transport CMP and South Stream Transport's ESMP are described in **Chapter 22 Environmental and Social Management**. Estimates of the average daily fuel consumption during the construction phase of the nearshore and offshore sections are provided in Table 5.24.

Table 5.24 Estimated Fuel Consumption

Fuel	Use	Average Quantity per Day (tonnes)	
		Nearshore	Offshore
MDO	Vessels	210	422
Diesel	On board Equipment	Included within MDO calculation	

Water Consumption

During construction of the nearshore and offshore section pipelines water will be required for domestic purposes on-board the vessels (this includes drinking water, washing, cooking, laundry and general vessel cleaning) and industrial use (various uses during pipeline fabrication process). Although some of the vessels listed in Table 5.16 and Table 5.18 may possess desalinisation equipment (distillation or reverse osmosis) to produce freshwater, it is assumed for the purposes of the ESIA that freshwater will be supplied by tankers. Bottled water may be provided for drinking purposes. Water requirements associated with the terrestrial construction activities associated with nearshore construction are included in Table 5.11. Water requirements for hydrotesting activities are described in Section 5.4.

Table 5.25 Estimated Water Consumption during Construction per Pipeline

Water Type	Details	Maximum Consumption per day during Peak of Construction (m^3)	
		Nearshore	Offshore
Freshwater	200 l / person per day	192.4	519

5.3.6.8 Summary of Waste Generated during Construction of Nearshore and Offshore Sections

There are a number of activities during the Construction and Pre-Commissioning Phase of the nearshore and offshore sections that have the potential to generate waste. Table 5.26 presents a summary of the waste types anticipated to be generated using FWCC codes to categorise waste types. For each waste type, a likely range is estimated for waste volumes arising from the installation of the nearshore and offshore section pipelines. It also includes wastes (such as Monoethylene Glycol (MEG)) generated during the pre-commissioning activities (excluding hydrotest seawater) for the landfall and nearshore section pipelines described in Section 5.4, as the MEG shall be collected by marine vessels. A more detailed breakdown of the waste generated during construction of the nearshore and offshore section pipelines is presented in **Chapter 18 Waste Management**.

Table 5.26 Estimated Types of Waste Generated during Construction of the Nearshore and Offshore Sections

Description of Waste Type	FWCC Code	Hazard Class
Fluorescent tubes and other mercury-containing lamps	353 301 00 13 01 1	1
MARPOL Annex I oily wastes	546 002 00 06 03 3 546 003 00 04 03 3	3

Continued…

Description of Waste Type	FWCC Code	Hazard Class
Mixed municipal waste	912 004 00 01 00 4	4
Ash, slag and dust from on-board incineration	313 000 00 00 00 0	4
Medical waste	971 000 00 00 00 0	4
Glass scrap (excluding fluorescent tubes)	314 008 02 01 99 5	5
Uncontaminated soil	314 011 00 08 99 5	5
Plastic	571 018 00 13 00 5	5
Scrap metal	351 301 00 01 99 5	5
Waste textiles	581 011 08 01 99 5	5
Biodegradable kitchen waste	912 010 01 00 00 5	5
Waste MEG	590 000 00 00 00 0	3
Sewage	951 000 00 00 00 0	4

Complete.

The estimated generation of sanitary waste (black water) and wash water (grey water) during construction of the nearshore and offshore sections is provided in Table 5.27.

Table 5.27 Estimated Volumes of Grey and Black Water Generated per Pipeline

Waste Type	Details	Average Quantity Produced per Day (m^3)	
		Nearshore	Offshore
Grey Water	180 l / person per day	173.4	467
Black Water	12 l / person per day	11.6	31

Should any of the vessels use desalinisation equipment to produce freshwater, the waste brine solution will be discharged to sea. Brine from the distillation and reverse osmosis processes must not contain or come in contact with machinery or industrial equipment, toxic or hazardous materials, or wastes. If brine does become contaminated by such materials, the brine will be transferred to a support vessel and disposed of properly onshore.

All wastes generated will be handled and disposed of in accordance with applicable Russian waste policy and MARPOL requirements. The locations of potential waste disposal facilities for waste generated by the Project at sea that needs taken ashore for disposal are shown in Figure

5.9. However, it should be noted that no decisions as to which of these sites could or may be used have been taken at this time and will be subject to further investigation. Further information on waste generation and management is described in **Chapter 18 Waste Management**. Waste water in relation to pre-commissioning tests is described in Section 5.4.

5.3.6.9 Summary of Nearshore and Offshore Emissions to Atmosphere

Table 5.28 presents the greenhouse gas (GHG) (i.e. CO_2) and non-GHG emissions predicted to be generated from the installation of the nearshore and offshore pipeline sections for a single pipeline, based on the expected vessels and number of days of operation outlined in Table 5.16 and Table 5.18. The emission estimates sources include marine equipment supporting microtunnelling activities in the nearshore section but excludes pre-commissioning activities (Section 5.4). Further information on emissions to atmosphere is provided in **Chapter 9 Air Quality**.

Table 5.28 Estimated Atmospheric Emissions from Construction Vessels per Pipeline (tonnes)

	CO_2	NO_X	CO	PM	SO_2	NMVOC
Nearshore vessels	10,912	271	26	5	104	10
Offshore vessels	144,541	3,591	338	69	1,372	128
Total	***155,453***	***3,862***	***364***	***74***	***1,476***	***138***

5.4 Pre-Commissioning Phase

5.4.1 Overview

After each pipeline has been installed a number of activities, known as pre-commissioning activities (as illustrated in the construction schedule shown in Figure 5.7), will be undertaken to ensure that the pipelines meet operational requirements. The primary objective of these activities is to verify that the pipeline has been laid without significant defects and that it is in a suitable condition to be filled to transport the gas at the anticipated pressure and to deliver the gas to the required specifications. The equipment required for the pre-commissioning activities will be used for cleaning, gauging, hydrotesting and drying of the installed pipelines.

The pre-commissioning approach for the Project involves hydrotesting of the landfall facilities and landfall and nearshore (to 30 m water depth) sections of the pipelines only. Hydrotesting (a hydrostatic test) involves filling the pipelines with water which is then pressurised to a level in excess of the design pressure of the pipelines to test the strength of the pipeline and confirm that there are no leaks.

The offshore section of the South Stream Offshore Pipeline (from 30 m water depth in Russia to approximately 36 m water depth in Bulgaria) will not be hydrotested. A traditional hydrostatic test pressure may cause lateral buckling all along the South Stream Offshore Pipeline and, as a result, the risk to the pipeline integrity may not be as low as reasonably practical. Furthermore, waiving of the hydrostatic test for the South Stream Offshore Pipeline presents various environmental and technical benefits, as follows:

- Costly and time consuming effects of pipeline flooding and dewatering operations are eliminated and any adverse environmental effects associated with the discharge of the test water from the full length of the Pipeline will be avoided;
- The construction schedule is shortened thereby reducing the duration of disturbance and temporary land use requirements;
- The potential adverse effects to the environment of lateral buckling (loss of containment) which may be caused by the relatively high hydrostatic test pressure will be eliminated, which will also result in elimination of the risk to the pipelines due to this failure mode; and
- Absence of flooding, dewatering and hydrostatic testing minimises the volumes of water, fuel and chemicals required and associated emissions and discharges to the environment.

Hydrotesting has been thoroughly investigated and intensively discussed with DNV (DNV are contracted by South Stream Transport for the verification of FEED and pre-qualification test of line pipe, buckle arrestors, coating and anodes for the Project) during the FEED design stage in 2012. The hydrotest for the pipelines in more than 345 m water depth is allowed to be waived according to DNV-OS-F101 (2010), Section B204. In addition a Concession Request has been approved by DNV for pipelines in water depth between 30 m and 345 m provided the following additional requirements are fulfilled:

- Safety class "High" shall apply for the installation and tie-in of the pipeline between 30 m and 345 m water depth;
- Subsea leak inspection by ROV shall be performed as soon as practicable following the start of operation of the pipelines;
- The allowable defect sizes for the girth welds shall be more restrictive than that permitted by the Engineering Critical Assessment; and
- The local incidental pressure (level of pressure that occurs incidentally at which safety devices operate) at 30 m water depth on the Bulgarian shelf does not exceed 291 bar.

All pre-commissioning activities will be undertaken in accordance with the requirements of South Stream Transport's Pre-commissioning CMP. Details of the CMPs are described in **Chapter 22 Environmental and Social Management**.

5.4.1.1 Hydrotest Sections

Each pipeline will be hydrotested separately between a temporary PIG launcher/receiver fitted to the pipeline just downstream of the landfall facilities fence and the edge of the nearshore section at 30 m water depth where a tie-in between the nearshore and offshore pipelines will be made. During the installation of the nearshore section pipelines, a temporary subsea test head will have been welded to the ends of the pipelines to enable pre-commissioning tests to be undertaken. The temporary subsea test head will be designed to contain and launch flooding, cleaning and gauging PIGs towards the onshore PIG traps and to receive dewatering PIGs sent from the temporary PIG launcher/receiver located at the landfall facilities.

The landfall facilities themselves, upstream of the temporary PIG launcher / receiver location will be cleaned, hydrotested and dried separately from the landfall section pipelines.

The offshore section of the pipeline will not be hydrotested as described above. However, following the completion of pre-commissioning tests of the nearshore and landfall sections in Bulgaria and in Russia, and pipeline tie-ins at the 30 m water depth in Russia and approximately 36 m water depth in Bulgaria, the pipeline will undergo cleaning, gauging and drying between the temporary PIG launcher/receiver at the fence of the landfall facilities in Russia and a temporary PIG launcher/receiver located at the fence of the landfall facilities in Bulgaria.

5.4.2 Landfall and Nearshore Section Pipeline Testing and Pre-commissioning (Hydrotesting)

The pre-commissioning of the landfall and nearshore sections of each pipeline will be undertaken separately. The pre-commissioning of each pipeline will take approximately four weeks to complete (including mobilisation of the pre-commissioning spread). There is a gap of approximately three months between the pre-commissioning of each pipeline.

In order to undertake the pre-commissioning test, a suitable offshore support vessel will be mobilised to the tie-in location at 30 m water depth. The vessel will be equipped with a diving or ROV spread to deploy and connect a down line (hose) between the vessel and the subsea test head. Pre-commissioning tests of the landfall and nearshore section pipelines will use seawater.

A flooding, gauging and hydrostatic testing spread will be installed onboard the support vessel. This pre-commissioning spread will enable water supply, water treatment, flooding and testing of the pipeline. PIGs will also be launched from the subsea test head towards the PIG launcher/receiver located at the fence of the landfall facilities.

The terrestrial pre-commissioning equipment (compressors, water storage tanks etc.) will be located within the Landfall Facilities Construction Site and Pre-Commissioning/Commissioning Spread (Site E) (shown in Figure 5.10) and connected to the temporary PIG launcher/receiver via a series of hoses. In order to reduce noise pollution from the equipment, a sound wall comprising temporary noise attenuation panels which will surround the rotating assets, may be used. These panels shall be designed and built with high noise absorption characteristics.

5.4.2.1 Cleaning and Gauging

Typically, cleaning and gauging are performed as a single operation together with flooding. It is expected to take approximately three hours to flood each pipeline. Upon connection of the vessel based spread to the subsea test head, a PIG train(s) is inserted to the pipeline to clean and gauge the pipeline and remove construction debris. The PIG trains are pushed through the pipelines to the onshore PIG launcher / receiver near the landfall facilities by pumped seawater (drawn from the Black Sea), which has been chemically treated and filtered.

Diesel driven water supply pumps with a capacity of 25 cubic metres per minute (m^3/minute) will be used to extract water from the sea via two temporary 6-inch hoses whose intakes are supported by buoys and suspended approximately 3-5 m above the seabed in a suitable offshore location near the tie-in location at 30 m water depth. The suction hoses will be equipped with suitable strainers (2 mm screen mesh) to prevent coarse debris or sea life from entering the suction hose. Water will be collected in a break tank (water tank fitted with filter systems) on board the supply vessel. From the break tank, water will be pumped through a filtration skid to remove all particles larger than 50 microns. The filtered water is then injected with an oxygen scavenger (sodium bisulphite)[4] to prevent internal corrosion of the pipeline prior to dewatering at an injection rate of 250 parts per million (ppm). It is anticipated that approximately 452 litres (l) of oxygen scavenger will be necessary per pipeline.

Diesel driven flooding pumps with a capacity of 25 m^3/minute and suitably sized downlines will be used to inject the filtered and chemically treated seawater directly into the subsea pipeline to push the cleaning and gauging PIGs.

A valve will be open on the onshore test head during the flooding operation, which will be connected to vents to vent air from the pipeline as it is filled with seawater. During the flooding operation, 100 m^3 of seawater will initially be pumped into the pipeline followed by a cleaning and gauging PIG. A further 1,900 m^3 of seawater will then be pumped into the pipeline. The first 100 m^3 of water and debris (consisting of rust, coating and weld debris) in front and in-between the PIGs, as well as overfill water, will be captured in temporary onshore water storage (break) tanks.

On receipt of the PIG, the valves at both ends of the pipeline will be closed. The collected water will be stored for a sufficient length of time to allow the debris to settle to the bottom. It is expected that approximately 200 kg of debris may be produced per pipeline. The debris will be removed from site and disposed of through an approved waste disposal company. The 100 m^3 of water will be temporarily stored and then pumped back into the pipeline during hydrotesting.

When all the cleaning and gauging PIG train(s) have been received into the temporary PIG receiver and the gauge plate(s) have been inspected for pipeline defects, the cleaning and gauging operation is complete.

The total seawater volume required for flooding, cleaning, gauging and hydrostatic testing will be approximately 2,000 m^3 per nearshore and landfall pipeline section. Seawater intake information for each pipeline is summarised in Table 5.29.

[4] Sodium Bisulphite is listed in OSPAR's PLONOR list.

Table 5.29 Seawater Intake Information at Subsea Test Head Location (per pipeline)

Subject	Value
Location	Nearshore / offshore section tie-in location at 30 m water depth
Intake Water Depth	Approximately 3-5 m above the seabed
Flooding Flow Speed	2 x 6.25 m^3/minute
Flooding Duration	3 hours
Flooding Fluid: Type Total Volume	 Seawater 2,000 m^3
Intake Dimensions: Intake Hose Intake Mesh Size	2 x 6-inch 2 mm
Chemical: Type Injection Rate Total volume	 Sodium Bisulphite (oxygen scavenger) 250 ppm 452 litres

5.4.2.2 Hydrotesting

Upon confirmation of successful cleaning and gauging of the pipeline, the pipeline will be hydrostatically tested. Hydrotesting will be undertaken by pumping the 100 m^3 stored treated seawater used to clean and gauge the pipelines back into the pipelines. Further treated seawater will then be pumped into the pipeline, using hydrostatic test pumps located on the support vessel, to raise the pressure in the pipeline to 330.8 bar (at +180 m reference elevation). The test pressure is based on the requirements set out in DNV Offshore Pipeline Standard DNV-OS-F101 requirements. In line with DNV-OS-F101 acceptance criteria, the pipeline pressure test will have a hold period of at least 24 hours.

Once the results of the hydrotest have been validated and accepted, the pipeline will be depressurised to ambient pressure. In the event that the hydrotest fails, the contractor will be required to detect the leak and then propose a repair method to South Stream Transport. The repair method will depend on the nature and location of the leak. Following agreement between South Stream Transport and the contractor of the repair method to be employed, the repair will be undertaken and the hydrotest repeated following the steps described above.

5.4.2.3 Dewatering and Drying

After a successful hydrostatic test, the pipeline will be dewatered and chemically conditioned (dried) using MEG. Dewatering/conditioning (drying) will be undertaken from the temporary PIG launcher/receiver at the landfall facilities towards the temporary subsea PIG receiver at 30 m water depth.

It is anticipated that dewatering will be performed by sending a PIG train consisting of two PIGs, separated by a batch of MEG from the temporary PIG launcher/receiver to the subsea PIG receiver to push out the seawater. The PIG train will be propelled by oil free, dry, compressed air provided by an onshore based compressor spread. In order to accomplish an average dewatering PIG speed of 0.5 metre per second (m/s) the compressor spread will consist of primary air compressors feeding air into an air drying unit. Each compressor will have a total capacity of maximum pressure of 34.5 bar and have a standard flow rate of 59.4 Standard Cubic Metres per Minute (Sm^3/minute) at 20°C.

In order to remove and treat residue seawater from the pipeline wall during dewatering, a pre-calculated slug of MEG will be sent through the pipeline. The slug volume is estimated to be a worst case of 30 m^3 based on the need to remove a 0.1 mm thick residual water film after pigging, and a required remaining water film mix in the pipelines of at least 97% MEG versus 3% water content after dewatering and conditioning. It is expected that approximately three hours will be required to dewater each pipeline.

During dewatering operations, the rate of discharge of treated seawater into the sea at the subsea PIG receiver will be 12.5 m^3/minute, corresponding to a PIG speed of 0.5 m/s. Seawater will be disposed of from the temporary subsea test head (PIG receiver). The subsea test head is equipped with several valves and down line connection points to enable the launch and receipt of PIGs and water separately. The water exit point (located in the approximately the same location as the initial intake) will consist of a four or six-inch diffuser positioned approximately 1 m above the seabed, which is used to reduce the speed of water flow as it exits the pipe in order to reduce turbidity and possible creation of sediment plumes. The diffuser also act as an aerator, improving the oxygen concentration in the water, thereby compensating for the oxygen scavenging effect of the oxygen scavenger added to the hydrotest water.

The conditioning agent (MEG) will form part of the dewatering PIG train. MEG will not be disposed into the sea but will be pumped from the subsea test head to the support vessel via a down line. MEG will be received and stored in suitable secure tanks onboard the vessel and will be shipped to shore to be disposed or recycled by an approved waste handling company. The pipeline will then be depressurised to atmospheric pressure at a controlled rate through silenced vents.

Table 5.30 presents the expected volume and location of discharges associated with cleaning and gauging, hydrotesting and dewatering of the nearshore and landfall section pipelines. It should be noted that the water required for hydrotesting of the first pipeline will not be re-used for hydrotesting of the other pipelines and each pipeline will require separate water intake and discharge activities.

Should the detailed design process and discussions with the appointed contractor result in any changes to the dewatering and drying operations described here, the management of change process described in Section 5.11 will be followed if it is deemed that this change may affect the results of the ESIA Report.

Table 5.30 Estimated Pipeline Cleaning, Gauging, Hydrotesting and Dewatering Discharges

Activity	Substance	Discharge Location	Estimated Discharge Volume per pipeline (m^3)	Total Estimated Discharge Volume (m^3)
Cleaning and gauging	Filtered and chemically treated seawater and debris from cleaning PIGs	Temporary PIG launcher / receiver at landfall facilities fence	Up to 100 (temporarily stored in onshore tanks)	400 (temporarily stored in onshore tanks prior to injection back into pipeline)
Flooding, hydrotesting / dewatering	Chemically treated seawater	Temporary subsea test head at 30 m water depth	2,000	8,000
	MEG	Collected and stored in tanks on support vessel for onshore disposal	30	120

On completion of the drying operations, and prior to the introduction of gas, the pipeline will require purging with nitrogen to a pressure of 0.5 bar to avoid the formation of a potentially explosive gas/air mixture. When the oxygen level in the pipeline, as measured at each pipeline end, is equal to or less than 5% by volume, nitrogen purging is stopped, pre-commissioning of the pipeline is finished and commissioning can commence by introducing gas at the Russian end. Approximately 3,000 m^3 (1.5 times the pipeline volume) of nitrogen will be injected to each pipeline from the offshore pre-commissioning spread or the temporary onshore PIG launcher/receiver. The nitrogen will be generated and injected into the pipelines by an electrostatic nitrogen membrane unit in conjunction with the air compressor spread. The membrane unit works by extracting nitrogen from the air and emitting the oxygen and carbon dioxide to the atmosphere. The units will generate nitrogen with a minimum purity of 95%.

The estimated equipment and vessels required for the pre-commissioning tests of the landfall and nearshore section pipelines are presented in Table 5.31.

5.4.3 Landfall Facilities Testing and Pre-commissioning (Hydrotesting)

The landfall facilities will undergo pre-commissioning tests separately from the landfall and nearshore section pipelines. The 24-inch and 32-inch pipelines within the landfall facilities may undergo pre-commissioning simultaneously or separately. For the purposes of this ESIA it is assumed that the pre-commissioning of the landfall facilities will be undertaken in two segments. The first segment to be tested is associated with the 32-inch pipelines and associated pipework upstream of the landfall and nearshore section pipelines previously tested, and the second segment is associated with the 24-inch pipelines and associated pipework. A schematic showing the two segments to be tested is shown in Figure 5.37.

No PIGs are required for cleaning and gauging of the landfall facilities pipework. Checks for defects in the landfall facilities pipework are made during fabrication and construction of the pipework. The internal pipework will be cleaned by the water used for the hydrotesting and collected during the dewatering process. Each pipeline segment will have a temporary test head fitted which will be equipped with valves system to allow the connection of hoses and venting to take place during pre-commissioning activities.

5.4.3.1 Hydrotesting

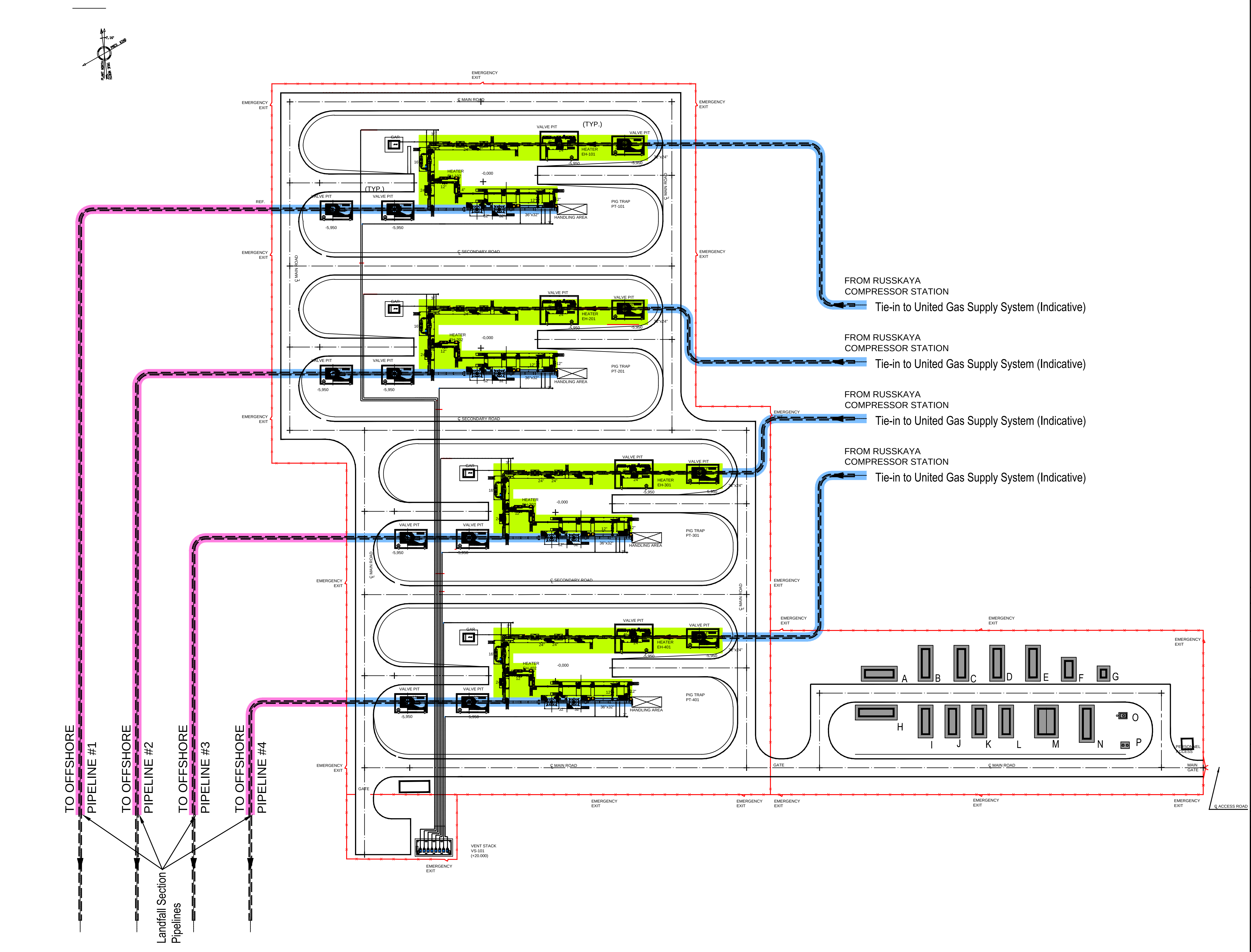
It is anticipated that it will take up to six days to undertake the hydrotest of the pipework associated with a single 32-inch pipeline (first segment) and the corresponding 24-inch pipeline (second segment). Hydrotesting of each segment of the landfall facilities will be undertaken by pumping freshwater into the pipelines via the temporary test head from one end of the pipeline. It is anticipated that approximately 500 m^3 of water will be required in total to hydrotest both 32-inch and 24-inch pipeline segments of the landfall facilities. The freshwater required will be imported by road tankers (lorries). The water will be pumped into the pipeline using a hydrostatic test pump to raise the pressure in the pipelines and associated pipework. It is anticipated that it will take up to two days to completely fill the pipework associated with a single 32-inch pipeline (first segment) and the corresponding 24-inch pipeline (second segment).

A valve will be open on one of the test heads during the flooding operation, which will be connected to a vent to vent air from the pipeline as it is filled with water. Once water is seen discharging from the vent, the vent point on the test head shall be closed. The 32-inch pipeline segment will be filled with water to raise the pressure in the pipelines to a maximum test pressure of 260 bar and the 24-inch segment pipelines will be pressured to a maximum of 450 bar (at +180 m reference elevation). The pipework will be pressure tested for a 24 hour period although the pipework will only be tested to the maximum test pressure for two separate one hour periods.

Once the results of the hydrotest have been validated and accepted, the pipelines will be depressurised to ambient pressure. In the event that the hydrotest fails, the contractor will be required to detect the leak and propose a repair method to South Stream Transport. The repair method will depend on the nature and location of the leak. Following agreement between South Stream Transport and the contractor of the repair method to be employed, the repair will be undertaken and the hydrotest repeated following the steps described above.

Table 5.31 Summary of Equipment and Vessels Required for Pre-Commissioning of the Landfall and Nearshore Sections per Pipeline

Equipment (per pipeline)	Number	Engine Power (kW)	Activity dB LAeq,T @10 m	Duration of Use (days)
Diesel water extraction pumps	2 (on pre-commissioning vessel)	1,000	87	1
Diesel flooding pumps	2	700	85	1
Diesel hydrostatic test pumps	2	700	85	1
Primary high pressure compressor	2 onshore and 2 on pre-commissioning vessel. Maximum of 2 working at any one time on vessel and onshore	440	72	4 (2 onshore and 2 on pre-commissioning vessel)
Air drying unit	1	300	72	5
Nitrogen membrane unit	1	672	85	5
Pre-commissioning spread vessel	1	15,086	Located offshore	18 plus 10 days at 25% capacity for mobilisation/ demobilisation
Fast supply vessel	1	2,520	Located offshore	1
Fuel / waste water collection vessel	1	7,160	Located offshore	1
Rescue vessel	1	610	Located offshore	Only required in case of emergency



RUSSIAN SECTOR OF THE SOUTH STREAM OFFSHORE PIPELINE

LEGEND:

- SECURITY FENCING
- LANDFALL AND NEARSHORE SECTION HYDROTEST
- LANDFALL FACILITIES 32" HYDROTEST SEGMENT
- LANDFALL FACILITIES 24" HYDROTEST SEGMENT
- PRE-FABRICATED CONTAINERS AND PORTAKABINS

A. COMMON ELECTRICAL AND INSTRUMENTATION ROOM
B. ELECTRICAL AND INSTRUMENTATION ROOM PIPELINE 1
C. ELECTRICAL AND INSTRUMENTATION ROOM PIPELINE 2
D. ELECTRICAL AND INSTRUMENTATION ROOM PIPELINE 3
E. ELECTRICAL AND INSTRUMENTATION ROOM PIPELINE 4
F. MEASURING ROOM
G. CP CONTAINER
H. COMMON LOCAL CONTROL ROOM
I. MEETING / STAFF ROOM
J. MEETING / STAFF ROOM
K. OPERATORS ROOM
L. STORAGE FOR SPARE PARTS
M. TRANSFORMERS
N. DIESEL GENERATOR
O. DIESEL STORAGE TANK (9 m³)
P. DIESEL DISCHARGE TANK (1 m³)

NOTES:

1. ALL DIMENSIONS ARE IN mm.

Projection: Lambert Conformal Conic

Revision Details	By / Check	Date	Suffix

Purpose of issue: For Information

Client: South Stream Offshore Pipeline — ENERGISING EUROPE

Project Title: SOUTH STREAM OFFSHORE PIPELINE

Drawing Title: Landfall Facilities Pre-commissioning Segments

Designed	Drawn	Checked	Approved	Date
RW	OAS	MJW		19/03/14

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Drawing Number: Figure 5.37 — Rev:

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5.4.3.2 Dewatering and Drying

Following a successful hydrostatic test, the pipeline will be dewatered and dried using oil free, dry compressed air provided by compressors and heatless desiccant air drying units. The compressor will have a total capacity of maximum pressure of 34.5 bar and have a standard flow rate of 59.4 Sm^3/minute at 20°C.

The dewatering process will clean the pipelines of any debris. Dewatering and drying will be performed by connecting a primary high pressure compressor and air drying unit to the temporary test head at one end of the testing segment and connecting a mobile tanker (lorry) or break tank to the test head at the other end of the testing segment to collect the hydrotest water. Oil free, dry, compressed air is then pumped into the pipeline to push out the hydrotest water and debris. It is anticipated that approximately 25 kg of debris will be produced by the dewatering process of the pipework associated with each 32-inch pipeline and corresponding 24-inch pipelines. The dewatering of the entire landfall facilities will produce approximately 100 kg of debris. The debris will be collected from the break tank (if used) and disposed of by an approved waste disposal company or alternatively, the mobile tanker (lorry) will collect the debris directly if a break tank is not used. As each pipeline within the landfall facilities will be hydrotested consecutively, it is possible that the filtered hydrotest water from the first pipeline segments (32-inch and 24-inch) will be collected and temporarily stored on site in tanks for hydrotesting the remaining three pipelines (32-inch and 24-inch segments) within the landfall facilities. If this is not possible, the filtered water (containing no particulates or chemicals) will be discharged by a hose into a sump constructed in an appropriate location within one of the temporary construction sites to allow the water to infiltrate into the ground.

Pumping of dry air into the pipeline segment will continue until the outlet dew point is approximately -50°C. On achieving the dryness criteria a 24 hour soak test shall be performed, followed by a further injection of the equivalent of two line volumes of dry air. A soak test is established industry practice of letting the pipeline soak towards the end of drying i.e. suspend the air injection and close-in the pipeline for 24 hours. Any remaining water will then be picked up by the undersaturated air and become visible when the flow of air is resumed. Drying of each pipeline (both segments) is anticipated to take approximately three days.

The hydrotesting, dewatering and drying of each pipeline (both segments) is anticipated to take approximately 23 days following set up of the pre-commissioning spread.

5.4.3.3 Purging of the Pipelines with Nitrogen

On completion of the drying operations, and prior to the introduction of gas, the pipeline will require purging with nitrogen to a pressure of 0.5 bar to avoid the formation of a potentially explosive gas/air mixture. Approximately 1,500 m^3 of nitrogen will be required for purging the entire landfall facilities pipework. Bottled nitrogen will be brought to the construction site. The nitrogen will be injected into the pipelines in conjunction with the air compressor spread.

When the oxygen level in the pipeline, as measured at each pipeline end, is equal to or less than 5% by volume, nitrogen purging is stopped, and pre-commissioning of the pipeline is finished. Purging of each pipeline (both segments) is anticipated to take approximately three days.

The estimated equipment required for the pre-commissioning activities at the landfall facilities are presented in Table 5.32.

Table 5.32 Summary of Equipment Required for Pre-Commissioning of the Landfall Facilities Pipework (both segments for a single pipeline)

Equipment	Number	Engine Power (kW)	Activity dB LAeq,T @10 m	Duration of Use (days)
Diesel flooding pumps	1	50	74	8
Diesel hydrostatic test pumps	1	10	67	6
Primary high pressure compressor	1	300	78	20
Air drying unit	1	300	78	14

5.4.4 Cleaning, Gauging and Drying of Whole South Stream Offshore Pipeline

As described in Section 5.4.1, there will be no hydrotesting of the pipelines between 30 m water depth in Russia and 36 m water depth in Bulgaria. Cleaning, gauging and drying of the South Stream Offshore Pipeline will be undertaken between a temporary PIG launcher/receiver at the fence of the landfall facilities in Russia and a temporary PIG launcher/receiver located at the fence of the landfall facilities in Bulgaria. The temporary PIG launcher/receiver used for each pipeline in Russia will likely be the same ones used for the pre-commissioning of the landfall and nearshore section pipelines. This cleaning, gauging and drying will be undertaken following completion of the pre-commissioning tests of the landfall and nearshore sections of the pipelines in both Russia and Bulgaria and completion of the pipeline tie-ins at the 30 m water depth between the nearshore and offshore pipeline sections. It should be noted that all wastes and discharges associated with cleaning, gauging and drying of the pipelines between Russian and Bulgaria will be collected and disposed of in Bulgaria.

The base case design, described here, assumes the cleaning and gauging PIGs will be transported through the pipelines from the temporary PIG launcher/receiver located at the Russian landfall facilities to the temporary PIG launcher/receiver located at the Bulgarian landfall facilities. However, it is possible that the outcome of the detailed design process and discussions with the appointed contractor may result in the PIGs being transported from Bulgaria to Russia. Should the direction that the PIGs are transported through the pipeline change, the management of change process described in Section 5.11 will be followed if it is deemed that this change may affect the results of the ESIA Report.

Cleaning, gauging and drying of the pipelines will be undertaken simultaneously using PIG trains consisting of cleaning and gauging PIGs and batches of MEG to dry the pipelines. The activities and durations are summarised in Table 5.33.

Table 5.33 Schedule of Pre-Commissioning Operations

Activity	Duration (days)
Pre-packing of pipeline with compressed air (undertaken in Bulgaria)	20
Cleaning, gauging and drying (using MEG) of pipeline	24
Venting of air from pipelines (undertaken in Bulgaria)	6
Purging of pipeline with nitrogen	3
Total	***53***

The dry air compressor package will consist of combined compressor and booster units, air drying units (to ensure there is not excessive moisture in the compressed air), metering, associated piping, spools, hoses and instrumentation. Each combined compressor and booster unit (same design ratings as those shown in Table 5.31) will have a total capacity of maximum pressure of 32 bar and have a maximum air delivery flow rate of 58.6 SM^3/minute at 20°C. The compressor spread will be located within the Landfall Facilities Construction Site and Pre-Commissioning/Commissioning Spread (Site E)

To meet compression requirements, approximately 80 combined compressor and booster units and 20 air drying units will be required at the PIG launching location to transport the PIG trains required for cleaning, gauging and drying activities of each pipeline.

It is anticipated that approximately 800 m^3 of MEG will be required to clean and dry each pipeline. The MEG and debris from the pipelines collected in front and in-between the PIGs, will be captured in temporary onshore tanks located at the temporary PIG launcher/receiver in Bulgaria, to allow the debris to separate from the MEG. The MEG and debris will be disposed of by an approved waste disposal company. It is anticipated that approximately 17-18 tonnes of debris will be collected by the cleaning PIGs for each pipeline.

It is anticipated that 10-20 m^3 of water may form within the pipelines during construction and installation as a result of condensation. Drying of the pipeline will be undertaken as part of the single PIG train launched from Russia that will simultaneously clean, gauge and dry the pipeline. As per the cleaning process described above, for the landfall and nearshore section pipelines, the MEG will be collected in secure tanks at the landfall facilities in Bulgaria and collected by an approved waste disposal company for disposal.

As is the case with the landfall and nearshore section pipelines, on completion of the drying operations of the pipeline, and prior to the introduction of gas, the pipeline will require nitrogen purging to avoid the formation of a potentially explosive gas/air mixture. When the oxygen level is sufficiently low, nitrogen purging is stopped, pre-commissioning of the pipeline is finished and commissioning can commence by introducing gas at the Russian end. Approximately 600,000 m^3 (at atmospheric pressure) of nitrogen will be injected into each pipeline at the Russian landfall facilities using two large electrostatic nitrogen membrane units. This results in 400,000 m^3 (assumed at 1.5 bar) of nitrogen being contained in each pipeline. Each pipeline will take approximately three to five days to fill with nitrogen.

The cleaning, gauging and drying of each of the four pipelines will be undertaken individually as they are completed. It is anticipated that all pre-commissioning activities of each pipeline between the temporary PIG launcher/receivers at the Russian and Bulgarian landfall facilities will take approximately seven weeks.

On completion of all pre-commissioning tests, the remaining pipeline tie-ins will be undertaken. This includes tie-ins to the "Expansion of the United Gas Supply System" upstream of the landfall facilities in Russia and tie-ins to the Receiving Terminal in Bulgaria being developed by South Stream Bulgaria AD (SSB) as part of the project known as "South Stream Pipeline System on the territory of the Republic of Bulgaria".

5.4.5 Summary of Waste / Discharges and Emissions Generated during Pre-Commissioning

5.4.5.1 Waste and Discharges during Pre-Commissioning Activities

A summary of the main wastes/discharges generated during pre-commissioning activities are summarised in Table 5.34. Further information on waste is provided in **Chapter 18 Waste Management**.

Table 5.34 Estimated Pre-Commissioning Wastes / Discharges

Pre-Commissioning Section	Waste / Discharge Type	Total Volume (all four pipelines)	Disposal Method
Landfall and Nearshore Section	Hydrotest water (seawater and oxygen scavenger)	8,000 m^3 including 1,808 litres oxygen scavenger (sodium bisulphite)	Discharged to sea at end of nearshore section in 30 m water depth
	Pipeline cleaning debris (rust, coating and welds)	0.8 tonnes	Collected at landfall facilities in breaker tanks and transported to licensed waste facility
	MEG	120 m^3	Collected onboard pre-commissioning vessel in secure tanks and shipped to shore for recycling or treatment and disposal at licensed waste facility.
	Grey and black water generated by pre-commissioning vessels	2,060 m^3 (grey water) 136 m^3 (black water)	Black water will be disposed of onshore or beyond 3NM from the shore. Disposal of grey water will comply with national regulations if more stringent than MARPOL requirements.
Landfall Facilities	Hydrotest water (freshwater)	500 m^3	Discharged to sump or removed from site by mobile tanker (lorry) to licensed waste handling facility.
	Pipeline cleaning debris (rust, coating and welds)	100 kg	Collected at landfall facilities in breaker tanks or directly in mobile tankers (lorry) and transported to licensed waste facility.

Continued...

Pre-Commissioning Section	Waste / Discharge Type	Total Volume (all four pipelines)	Disposal Method
South Stream Offshore Pipeline (Russian landfall facilities to Bulgarian landfall facilities)*	Batches of MEG for cleaning and drying	3,200 m^3	MEG received in Bulgaria will be collected in secure tanks and transported by mobile tankers (lorry) for recycling or treatment and disposal at licensed waste facility.
	Pipeline debris from cleaning (rust, coating and welds)	72 tonnes	Collected at Bulgarian landfall facilities in breaker tanks and transported to licensed waste facility.

* Waste and discharges collected at Bulgarian landfall facilities.

Complete.

5.4.5.2 Emissions to Atmosphere during Pre-Commissioning Activities

Table 5.35 presents the anticipated GHG and non-GHG emissions in Russia from the pre-commissioning activities to be undertaken for each pipeline.

Table 5.35 Atmospheric Emissions from Pre-Commissioning Activities (tonnes)

Pre-Commissioning Section	CO_2	NO_X	CO	PM	SO_2	NMVOC
Nearshore and Landfall Section (per pipeline)	41	2.2	0.5	0.2	0	0.2
Landfall Facilities (all 4 pipelines)	30	0.4	0.4	0	0	0.1
South Stream Offshore Pipeline (Russian landfall facilities to Bulgarian landfall facilities, per pipeline)	5,364	71	71	4	0	10

Further information on emissions to atmosphere is provided in **Chapter 9 Air Quality**.

5.5 Commissioning

The Project will be brought into service by the introduction of gas from the "Expansion of the United Gas Supply System", only after all control and monitoring systems have been commissioned in facilities upstream of the Project in Russia (Gazprom's Russkaya CS) and downstream of the Project in Bulgaria (SSB's Receiving Terminal).

Each pipeline will be commissioned separately and come into operation separately in line with the schedule set out in Figure 5.7.

The first injection of hydrocarbon gas can be made behind a PIG, or directly, without the presence of a PIG. The objective of the gas injection step is to sweep out the nitrogen or any non-sale gas (if MEG is not allowed in the export gas, for instance). The presence of MEG will depend on whether or not MEG was used for the drying of the pipelines as described in Section 5.4. The volume of nitrogen gas within each pipeline is 400,000 m^3 (assumed at 1.5 bar) and approximately 600,000 m^3 to 800,000 m^3 when vented to the atmosphere via the vent stack at the Project landfall facilities in Bulgaria.

After pre-commissioning is completed each pipeline will contain nitrogen and traces of water (estimated at 1 m^3) and MEG (estimated at 106 m^3) which has been used to dry the pipeline. The small volumes of water and MEG will not be vented but will exist as a thin layer of liquid against the walls of the pipeline. This thin MEG/water liquid film will be gradually entrained by the transport gas during the first days / weeks of gas transport operations. It anticipated that the small traces of MEG will be removed slowly from the pipeline at the Receiving Terminal in Bulgaria operated by SSB. These traces of MEG/water are not anticipated to have an impact on the operations of the Receiving Terminal.

5.5.1 Temporary Gas Heating Requirements

During the commissioning process the pressure in the South Stream Offshore Pipeline needs to be gradually raised from 1.5 - 2 bar (the settle out pressure after pre-commissioning) to 65 - 100 bar (the pressure required for the Receiving Terminal in Bulgaria to start exporting gas to the downstream South Stream Pipeline System).

However, it is anticipated that the initial gas supplied from the Russkaya CS for commissioning purposes will not be supplied at 2 bar and a temperature ranging between -5 and +50°C but at pressure ranging between 100 bar (for the pipeline #1, December 2015) and 283.3 bar for subsequent pipelines (pipeline #2, December 2016; pipeline #3, June 2017, and pipeline #4, December 2017).

Therefore, the gas pressure will have to be reduced at the landfall facilities prior to gas injection. However, by reducing the pressure to 1.5 - 2 bar, this will result in the gas in the pipelines cooling substantially, in the range of 40 - 90°C, due to the temperature reduction caused by the Joule Thomson effect as it is transported across the Black Sea. Thus, to avoid the gas arriving at the Bulgarian landfall facilities below the intended operating temperature of -5°C, a temporary commissioning heater is required to heat the gas at the landfall facilities in Russia prior to it being injected into the pipeline. The requirement for gas heating is only necessary as a result of the low pressures necessary during commissioning and start-up.

To achieve a minimum inlet gas temperature of 0°C at a pressure of 100 bar at the landfall facilities, a 4 MW direct fire heater is required to achieve this level of pressurisation. For the case of a second pipeline (assuming the compressors at the Russkaya CS are already running for the operation of pipeline #1) the same heater duty can be used for compressor discharge temperatures above 35°C. Although for the start-up of pipelines #2, #3 and #4, the gas temperature from the Russkaya CS will be >35°C, the pressure differential is larger (>280 bar) than for the pipeline #1 (approximately 98 bar), which is enough to result in temperature at the pipeline inlet to be below 0°C when the valve is open (due to Joule Thomson effect). Hence, to avoid the temperature dropping below 0°C, the heater is required.

The 4 MW direct fire heater will be mobile and deployed to the landfall facilities when required for commissioning of each pipeline. The heater will occupy a footprint of approximately 12 m by 13 m, and it is anticipated it be connected to the FCV bypass line with double block and bleed isolations to removable flange plates. The heater will be gas powered and is anticipated to consume approximately 400 kg / hour. Emissions to atmosphere from the heater will be via 10 m high, 0.5 m diameter chimney. The heater will require to be in operation for approximately six days (allowing a further four days for the compressors to bring the pipeline pressure and flow up to normal operating conditions as described in Section 5.6.1).

A summary of the characteristics of the heater is shown in Table 5.36 and estimated emissions per pipeline are provided in Table 5.37.

Table 5.36 Temporary Gas Heating Requirements per Pipeline

Parameter	Value
Power	4 MW
Fuel	Gas
Fuel Consumption	400 kg/hour
Calorific Value of Gas	50,000 kilojoules (kJ)/kg
Chimney Height	10 m
Chimney Diameter	0.5 m
Maximum Noise Level	90 dB
Duration of Operation	144 hours

Table 5.37 Atmospheric Emissions from Temporary Gas Heaters per Pipeline (tonnes)

	CO_2	NO_X	CO	NMVOC
Tonnes	158	0.13	0.04	0.009

5.5.2 Pipeline Gas Injection with a PIG

Injection of gas behind a PIG launched from the Russian landfall facilities will push the nitrogen towards the landfall facilities. Filling of the pipeline with gas is considered complete once the PIG has been recovered from the receiving trap in the landfall facilities.

During the early stages of the commissioning operation, a temporary valve within the Bulgarian landfall facilities is kept open so that the nitrogen is expelled from the pipeline at the receiving PIG trap and vented to the atmosphere via the vent stack as it is pushed through the pipeline by the PIG transported by the gas.

The duration required to sweep out the nitrogen mainly depends on the gas injection rate. Assuming a gas injection rate of 1.9 kilograms per second (kg/s), resulting in an average pigging speed of 3 m/s, it will take approximately five days for the pigging run to sweep out the nitrogen which will be vented from the vent stack within the Bulgarian landfall facilities. This will result in a venting release rate to atmosphere (at normal conditions) of 0.12 to 0.16 Million Cubic Metres per day (MMCM/day) from the vent stack.

5.5.3 Pipeline Gas Injection without a PIG

Alternatively, the gas could be injected directly into the pipeline, if the water dew point and the oxygen content requirements are met. The gas will displace the nitrogen, but a mixture of gases will form at the interface between the gas and nitrogen, forming what is commonly referred to as a mixing zone. The length of the mixing zone is estimated to be approximately three kilometres.

Assuming a gas injection rate of 14 kg/s, resulting in an average gas velocity of 22 m/s, it will take approximately two days to vent the nitrogen from the vent stack. This will result in a venting release rate to atmosphere (at normal conditions) of 0.3 to 0.4 MMCM/day from the vent stack located in the Bulgarian landfall facilities.

5.5.4 Pipeline Pressurisation

When the non-sale gas is swept out of the pipeline and the gas quality meets export conditions, the ESD valve at the Bulgarian landfall facilities end will be closed and pipeline pressurisation can commence. This pressurisation step will fill the pipeline up to an equalisation pressure of 65 bar (summer conditions) or 87 bar (winter conditions), making the South Stream Offshore Pipeline ready to start supplying gas to the Receiving Terminal. It is anticipated that each pipeline will take approximately ten days to fill with gas and commissioning activities will take approximately two weeks to complete.

During pipeline pressurisation quality control measurements will be carried out at the landfall facilities. Checks will be performed on all equipment used for detecting and sealing any gas leaks. In order to detect any leakage during start-up, there will be continuous metering of the pipelines for which the internal pipeline pressure exceeds the external pressure. Once the gas composition meter confirms that the gas at the landfall facilities meets the export gas specification, the South Stream Offshore Pipeline is ready to commence normal operation and gas transportation.

The entire filling and pressurisation operation will be documented in detailed work procedures prior to commencement of this activity. These procedures will be developed during the detailed design phase and will include all activities necessary to complete commissioning and achieve start-up status.

5.6 Operational Phase

5.6.1 South Stream Offshore Pipeline Operating Philosophy

The pipelines will have a maximum operating pressure of approximately 284 bar at the inlet to the landfall facilities. However, when the gas makes landfall in Bulgaria the operating pressure of the pipeline will have fallen to between 65 and 87 bar and the temperature of the gas will be approximately -5°C. The maximum daily capacity of each pipeline under normal conditions will be 47.9 MMSCM/day and a maximum of 63 BCM of gas will be transported by all four pipelines each year. The pipelines will be operated seven days a week, 24 hours per day.

The operating philosophy of the South Stream Offshore Pipeline is based on the principle of having a constant gas inventory (i.e. there is always gas stored in the pipelines) within the pipeline system. During normal operations, the gas inventory in each South Stream Offshore Pipeline is evaluated to range between 104 and 111 MMSCM with a pipeline throughput of 47.9 MMSCM/day.

The principle of a constant gas inventory relies on the proper, and synchronised, operation with the Russkaya CS in Russia and the Receiving Terminal in Bulgaria. The Russkaya CS and the Receiving Terminal in Bulgaria will determine the flow, pressure and temperature of the gas in the South Stream Offshore Pipeline during normal operation. The four individual pipelines will effectively be operated as a single pipeline and there will be no control system specific to each pipeline at the Russkaya CS or at the Bulgarian Receiving Terminal.

The South Stream Offshore Pipeline must operate within the pipeline inventory limits to maintain a safe and reliable system. A constant gas inventory guarantees that daily contractual gas transportation volumes (known as nominations) can be met when accurate flow measurement and reliable valve control are combined. The constant gas inventory also ensures that the time required to alter the gas supply rate in response to a decrease or increase in demand for gas can be met in the shortest time possible. This can be achieved by decreasing or increasing the pressure in the pipelines. The gas inventory of each South Stream Offshore Pipeline for various flow rates is summarised in Table 5.38. If for example, the flow rate was reduced to 60% of the maximum flow rate, it would take approximately three to five days for the flow rate to be ramped back up to 100%.

Table 5.38 South Stream Offshore Pipeline Gas Inventory

% of Maximum Flow Rate	Flow Rate (MMSCM/day)	Gas Inventory per Pipeline (MMSCM)	
		Average Winter Conditions	Average Summer Conditions
20	9.6	42.6	42.5
40	19.2	57.1	57.1
60	28.7	73.7	73.7
80	38.3	89.5	89.5
100	47.9	106.5	103.7

All four offshore pipelines will be operating at the same daily nomination, provided the discharge pressure of each offshore pipeline is the same. However, if necessary (for example due to a fall in demand for gas) it is possible to reduce the number of pipelines in operation as an alternative to reducing the flow of gas across all four pipelines.

The main process valves at the landfall facilities will be open during normal operations, and the landfall facilities will effectively only transport the gas from inlet to outlet. The landfall facilities will include customised containers with monitoring metrology equipment, which will effectively act as the local control room. During normal operation there will be no workers based at the landfall facilities, however some workers will be required during pigging activities, start-up (following a shutdown), and maintenance activities.

5.6.1.1 South Stream Offshore Pipeline Parameter Monitoring

Pressure, temperature, flow, and gas composition (including water and hydrocarbon dew point) will be monitored by equipment at the landfall facilities and remotely in the CCR and BUCR by continuous real time monitoring of process conditions via the Supervisory Control and Data Acquisition (SCADA) system. The aforementioned parameters will be monitored by the SCADA system to estimate the gas inventory in each of the four pipelines (or however many are in operation) on a real time basis through the Pipeline Performance System (online simulator). There is no control system at the landfall facilities or, more generally, within the South Stream Offshore Pipeline to manage gas flows, pressures etc. Control of gas flows will be carried out at the upstream Russkaya CS and the downstream Receiving Terminal in Bulgaria.

However, as the South Stream Offshore Pipeline (including landfall facilities) is operated by a different organisation from the Russkaya CS (Gazprom Invest) and Bulgarian Receiving Terminal (SSB), it is necessary that certain process isolation, vent and blow down features are included in the landfall facilities. This is to ensure that South Stream Transport has independent means to stop gas from entering / leaving the pipeline, or to vent gas, as and when required (for example in the case of an emergency situation such as a pipeline leak). The vent system also allows for the pipelines to be depressurised for maintenance activities to take place if necessary.

To ensure that the gas inventory requirements do not deviate from the low and high band volumes (for example 104 and 111 MMSCM at maximum throughput), low and high alarms will be installed at the landfall facilities. Should there be an irregularity (or deviation), this information will be transmitted to the CCR, the Russkaya CS, and the Receiving Terminal in Bulgaria where the operators can carry out balancing operations (i.e. increasing or decreasing the gas inventory), which, in turn, may lead to an operational decision to shut down the gas supply to the Pipeline. Alarms will also be installed to detect changes in the gas pressures and temperatures.

Further to the alarm systems, trip systems will be installed at the landfall facilities. The trip systems will be designed to automatically shut down the South Stream Offshore Pipeline if minimum or maximum design standards (for gas pressure, temperatures or flows) are detected by the SCADA system. The automatic (emergency) shut down will ensure that the South Stream Offshore Pipeline is protected from damage.

The safeguarding features to be installed at the landfall facilities for normal operating conditions are shown in Table 5.39. In general, alarms will initially inform the operator of a problem to allow them to take the necessary operational activities to address the issue; the alarm would not however initiate a shutdown of the pipelines. If the problem persists, and a calculated trip setting is reached, the pipelines will be shut down automatically via the SCADA system.

Table 5.39 Project Safeguarding Alarm and Trip Systems

Abnormal Pipeline Condition	Cause of Abnormal Pipeline Condition	Safeguarding Feature
High Pressure	High operating pressure	Alarm and trip system - alarm will be raised when the pipeline pressure reaches an operating pressure of 290 bar and the trip will occur if the pressure reaches the design pressure of 300 bar.
Low Pressure	Low operating pressure Leakage and/or rupture	Alarm and trip system - alarm will be raised when the pipeline pressure drops to 10 bar above the minimum operating pressure of 65 bar (i.e. 75 bar) and the trip will occur if the operating pressure drops to the minimum pipeline system pressure (i.e. 65 bar).
High Temperature	High ambient temperatures High operating temperatures	Alarm and trip system - alarm will be raised if the gas temperature reaches 5°C below the maximum design temperature of 55°C (i.e. 50°C) and the system will trip if the gas reaches the maximum design temperature.
Low Temperature	Low ambient temperatures Low operating temperatures High pressure drop (Joule-Thomson effect)	Alarm and trip system - the minimum design temperature of the landfall facilities is -40°C with the exception of the pipelines within the landfall facilities and vent system, which has a minimum design temperature of -25°C and -150°C, respectively. Alarms will be sounded if the temperature drops to 5°C above the minimum design temperature (-35°C landfall facilities and -20°C pipelines). The system will trip if the landfall facilities and pipelines temperature fall to the minimum design temperature of -40°C (landfall facilities) and -25°C (pipelines.) The minimum design temperature of the pipelines downstream of the landfall facilities is -10°C. The alarm will be raised and if the temperature drops to -5°C and the system will trip if the temperature falls to -10°C.

Continued…

Abnormal Pipeline Condition	Cause of Abnormal Pipeline Condition	Safeguarding Feature
High Flow	Abnormal operating condition Downstream pipeline leak / rupture	Two types of high flow alarms will be installed at the landfall facilities: Main flow meter - the maximum daily capacity of each individual pipeline is 47.9 MMSCM/d. The alarm will activate if a flow rate of 5% greater than the maximum capacity (50 MMSCM/d) is detected. FCV control loop - An FCV is installed for the operational pigging process. Operational pigging requires a reduced flow rate of approximately 28.7 MMSCM/d. A too high flow rate results in the PIGs being transported through the pipelines too fast, thus a high flow alarm is provided. The alarm set point will be at 10% above the required pigging flow rate (32 MMSCM/d).
Low Flow	Reduced / no flow at the Russkaya CS Accidental valve closure Hydrates Pipeline rupture Pipeline blockage (hydrate, PIG, flooding due to leak).	Two types of low flow alarms will be installed at the landfall facilities: Main flow meter - The alarm will activate if the flow rate falls to 10% of the daily flow rate capacity (approximately 5 MMSCM). FCV control loop - A low flow rate is an indication of an abnormal operating condition such as FCV controller failure or stuck pig. The alarm set point will be set at 10% below the required pigging flow rate (26 MMSCM/d).

Complete.

Leak Detection

The South Stream Offshore Pipeline will be monitored by a Leak Detection System that operates on the basis of flow, pressure and temperature monitoring, thereby detecting gas losses on an automatic basis. These parameters are measured in continuous real time via the SCADA system. If the system detects a potential leak by detecting changes in the aforementioned parameters it will automatically alert the operators at the CCR and BUCR, however, it will not necessarily initiate an automatic shutdown.

It will be possible to detect leaks down to approximately 1-2% of gas throughput. Very small leaks offshore might not be detected by the system when they are smaller than the accuracy of the measurement and calculations. Both will be fine-tuned constantly during operation so the accuracy will increase with time and operating experience.

Information on emergency shut downs as a result of a confirmed leak is provided in Section 5.6.2. The location of a leak may be calculated to within an accuracy of approximately 100 m using the measured flow, pressure and temperature data recorded at the landfall facilities.

5.6.2 Pipeline Shut Down and Restart Process

5.6.2.1 Pipeline Shut Down

During the operation of the South Stream Offshore Pipeline there may be a requirement to shut down the pipelines from time to time. Different types of pipeline shut down exist. These are:

- Process Shut Down (PSD), which corresponds to a stop of flow (closure of external ESD valves); and
- Emergency Shut Down (ESD), which applies to a F&G detection scenario (closure of external and internal ESD valves).

The shut down philosophy is based on the following principles:

- A constant gas inventory is to be maintained as much as possible so as to meet contractual requirements and also to allow a fast restart of the gas transport operations;
- Shut downs are to be performed in such a way so as to minimise the need for manned intervention for a restart;
- Best efforts will be used to minimise the need for shut downs for maintenance or modifications; and
- Gas will be vented only when a release is an absolute necessity.

The process safeguarding elements are used to shut down the South Stream Offshore Pipeline and, possibly, isolate the landfall facilities when there is an absolute necessity to do so. Some or all of the ESD/FCV valves which are not normally in use and are in the open position (or bypassed for the FCV) will close when a shut down occurs.

Process Shut Down

A PSD of the pipelines may be necessary during the lifetime of the South Stream Offshore Pipeline to carry out scheduled repairs or inspections. This is a planned event and will be undertaken under controlled conditions. The PSD will be carried out by operations at the Russkaya CS and at the Bulgarian Receiving Terminal. Normal shut down and ramp-down of gas flow is done by reducing the flow progressively to the required flow rate or by completely shutting down the flow in and out of the South Stream Offshore Pipeline at the Russkaya CS and Bulgarian Receiving Terminal.

Emergency Shutdowns

The landfall facilities will have local ESD and safety systems. Should there be an incident (unplanned event) such as those described in Table 5.39, the ESD system will be triggered and the pipelines will isolate themselves. The gas volume in the pipelines will then be automatically isolated from the landfall facilities, by closing the landfall facilities inlet and outlet ESD valves, thereby maintaining a constant gas inventory within the offshore pipeline.

During an ESD, the inlet ESD valve connected to the incoming 32-inch pipelines from the “Expansion of the United Gas Supply System” (within the landfall facilities), as well as the outlet ESD valves installed in the outgoing 32-inch pipelines are closed. The landfall facilities are kept pressurised during an F&G event to prevent further gas being potentially supplied to the location of the fire through venting.

The underlying principle is to stop the supply of gas to a fire (should there be one), and at the same time maintain a constant gas inventory within the pipeline. The inlet ESD valves in the incoming pipelines from "Expansion of the United Gas Supply System" as well as the outlet ESD valves in the outgoing pipelines from the landfall facilities will be closed.

Information on emergency pipeline repairs is provided in Section 5.6.5.

5.6.2.2 Restart Procedure

The restart procedure after a PSD or an ESD will depend on the pressure levels within the isolated systems. Pressure equalisation across the systems is planned to be achieved using bypass systems installed within the landfall facilities. The bypass systems consist of cast line heater (electric, in line circulation heaters that are designed to quickly and safely heat liquids and gases) to balance the temperature drop in the gas caused by choking, and a TCV that regulates the flow rate passing through the bypass line.

The restart can proceed if the following conditions are met:

- The cause of the ESD has been detected;
- The remedial actions have been completed (including eventual repairs and acceptance testing); and
- All safety related conditions have been met or exceeded.

After an ESD, the offshore pipelines settling out pressure is significantly lower than the pressure at the Russian landfall facilities and/or at the upstream Russkaya CS and is significantly higher than the pressure at the Bulgarian landfall facilities and/or at the downstream Bulgarian Receiving Terminal.

Before the gas transportation can be restarted by the upstream Russkaya CS in Russia and the downstream Receiving Terminal in Bulgaria, the ESD valves at the landfall facilities in Russia and Bulgaria will need to be reopened. The pressure equalising provisions (bypass system) are installed across each of the ESD valves (three per pipeline) for a quick restart. It is considered that it will take three days for pressure equalisation and ESD valve reopening at the landfall facilities in Russia and Bulgaria to be completed.

The general steps to be followed for a restart of the South Stream Offshore Pipeline for each shut down type are summarised in Figure 5.38. The restart procedure of the South Stream Offshore Pipeline will be completed when the pressure throughout the pipeline has equalised and when the ESD valves at the landfall facilities (both in Russia and Bulgaria) have been reopened.

Normal ramp-up of gas flow rate will be achieved by increasing the flow gradually until the targeted supply rate is reached. Such operation will be initiated and/or performed at the Russkaya CS and the Bulgarian Receiving Terminal simultaneously in order to maintain a constant gas inventory in the offshore pipelines. Such ramp-up will be driven by daily contractual supply requirements at the time.

5.6.3 Maintenance

5.6.3.1 External Pipeline Surveillance

Landfall Section Pipelines

Onshore cathodic protection monitoring will be undertaken manually with the monitoring undertaken at test posts distributed along the route of each pipeline at approximately 500-600 m intervals. The test stations will be on the centre line of each buried pipeline. At these test stations, a trained technician using a high impedance meter and copper sulphate half-cell will measure the cathodic protection potential. There will also be current measurement spans on each pipeline to measure current flow and direction for system balancing. At the transformer rectifier locations information on voltage and current may be collected manually or they may be connected to the Remote Terminal Unit (RTU) and SCADA.

Figure 5.38 Pipeline Restart Procedure

Restart Procedure from PSD

- Close the FCV, including the block valve parallel to this valve
- Turn on the heater in the bypass of the inlet ESD valve and wait for its temperature to reach 55 °C
- Open the ESD valve in the bypass of the inlet ESD valve
- Fill the piping section between the inlet ESD valve and the FCV with process gas through the TCV in the bypass
- Once the pressure has equalised, open the inlet ESD valve, turn off the heater and close the bypass
- Gradually increase the opening of the FCV until fully open and the pressure drop is minimised
- Open the block valve parallel to the FCV, and subsequently close the FCV

Restart Procedure from an ESD

Reopening of the Outlet ESD Valve

- Check the pipeline settle-out pressure
- Check that the FCV, including the block valve parallel to this valve are closed
- Open the BDV downstream of the FCV until the pressure has reduced to pipeline settle-out condition
- Once the pressure has equalised, close the BDV
- Open the outlet ESD valve
- Gradually increase the opening of the FCV until the pressure is equalised
- Open the block valve parallel to the FCV, and subsequently close the FCV

Reopening of the Inlet ESD Valve

- During ideal conditions, the inlet ESD valve does not need any equalisation. In this situation the inlet ESD valve can be reopened as soon as the outlet ESD valve is opened allowing the pressure differential to be held by the FCV
- Realistically, the 24-inch inlet ESD valve will close faster than the 32-inch outlet ESD valve, hence the pressure upstream of the inlet ESD valve will be slightly higher than the pressure downstream of the inlet ESD valve. The procedure presented to restart from a PSD is the basis for this situation

Nearshore and Offshore Pipeline Sections

The external condition of the subsea pipeline, including the condition of the cathodic protection system, will be monitored on a regular basis as set out in Table 5.40 using ROV or Autonomous

Underwater Vehicles (AUV) and inspection technologies including sonar scans to visual (camera) inspections.

In accordance with the requirements of the concession granted by DNV to waive the need for hydrotesting the South Stream Offshore Pipeline in water depth deeper than 30 m, an initial ROV subsea leak inspection survey will be carried out along the pipelines as soon as practicable once the pipelines become operational and sufficient gas flow rates are achieved.

Critical sections of the pipeline route will be surveyed at more frequent intervals, initially on an annual basis and subsequently more or less frequently, depending on actual findings (e.g. growth of free span). Critical sections of the pipeline route may include:

- Steep slopes;
- Continental shelf break;
- Buried or trenched sections of the pipelines; and
- Any areas where free spans or other seabed anomalies may occur (based upon earlier inspections).

Table 5.40 Proposed External Inspection Surveys of the Nearshore and Offshore Section Pipelines

External Inspection	Inspection Method	Proposed Frequency of Inspection	Survey Duration per Pipeline
Critical Pipeline Sections Survey	ROV	Annually	Approximately five days (allows for operational downtime and weather standby etc.)
Entire Pipeline Route Survey	ROV	Before start up or within one year of operation commencing	Approximately 30 days (allows for operational downtime and weather standby etc.)
	AUV	Every five years thereafter	Approximately 11 days (allows for operational downtime and weather standby etc.)
Cathodic Protection Survey	ROV	Before start up or within one year of operation commencing After five years of operation Every ten years thereafter	Approximately 30 days (allows for operational downtime and weather standby etc.)

It is anticipated that the offshore surveys would involve vessels of characteristics such as the GSP Prince. Details of this vessel are shown in Table 5.18

5.6.3.2 Internal Pipeline Surveillance

Following the completion of pipeline gauging during pre-commissioning tests, further internal inspections of the pipelines using PIGs are not expected to be required until approximately five years after initial start-up and operation. The frequency of testing can be increased or decreased depending on the results of previous inspection runs, survey information and regulatory requirements. The proposed frequency of internal pipeline inspections is shown in Table 5.41.

Table 5.41 Proposed Internal Pipeline Inspection Surveys

Internal Inspection	Inspection Method	Proposed Frequency of Inspection
Wall thickness measurement	Intelligent PIG	Before start up or within 1 year of operation commencing Every 5 years thereafter
Pipeline position	XYZ Mapping PIG	Before start up or within 1 year of operation commencing Every 5 years thereafter
Pipeline geometry	Gauging PIG	Before start up Prior to running calliper or intelligent PIGs
	Calliper PIG	Before start up Every 5 years thereafter

Internal pipeline cleaning is not anticipated to be required due to the composition of the dry gas that will be transported through the pipelines. However, any cleaning that may be required will be undertaken using cleaning PIGs transported using gas. Gas flow rates in the pipeline will be reduced to approximately 60% of the maximum flow rate during pigging activities. Furthermore, a Pipeline Integrity Management System (PIMS) will be developed to control on-going monitoring / maintenance during system operation, with a specific focus on corrosion control.

5.6.4 Landfall Facilities

Maintenance for the landfall facilities is equipment / vendor specific and therefore will not be confirmed until the detailed design phase is complete and contracts have been awarded for the provision of equipment. However, examples of the typical maintenance and frequency of maintenance and inspections is provided in Table 5.42.

Table 5.42 Typical Landfall Facilities Equipment Maintenance and Inspections

Maintenance Activity	Indicative Frequency of Inspection
Recalibration of safety metering system	Annual
Calibration of gas metering system	Monthly
Maintenance / replacement of main hydraulic packs / pumps	Two years (or as necessary)
Test of fire fighting systems / equipment	Monthly
Inspection of security systems (CCTV)	Monthly
Inspection of start-up heating system	Monthly

5.6.5 Emergency Pipeline Repair

Although the probability of failure of a properly designed and installed deepwater pipeline is negligible, South Stream Transport will employ an Emergency Pipeline Repair Strategy (EPRS) for the South Stream Offshore Pipeline to be utilised in the event of damage to any of the pipelines. A repair philosophy has been prepared by South Stream Transport, which has led to the planned development of the EPRS by the pipe-lay contractor. The pipe-lay contractor will make available procedures and undertake emergency pipeline repair (permanent and temporary works) during the execution of the Construction and Pre-Commissioning Phase and into the first two years of the Operational Phase (up to a maximum of three years in the event of a repair) warranty period. From the end of the warranty period the EPRS will be controlled by South Stream Transport. This will either be done using the same EPRS or a different one that South Stream Transport may choose to adopt.

A key objective of the EPRS is to have a Repair Plan in place which reinstates the pipeline integrity and ensures the earliest possible and safe commencement of gas throughput. The Repair Plan has been prepared to provide a high level overview into recommended repair procedures and the relevant hardware and tools.

Repairs

For different types of damage, different types of repair and re-commissioning methods are applicable. Preparation of a pipeline for repair will be aimed at minimising or avoiding any impact on pipeline integrity, therefore avoiding water ingress. If water ingress is inevitable, or has already occurred, then dewatering/replacing salt or contaminated water with chemically treated water will be essential to stabilise the pipeline condition and to minimise corrosion whilst a case specific Repair Plan is developed and executed. The preferred approach will be to isolate the defected area (using plugs if pigging is feasible) and create a safe work environment for repair. Prior to re-commissioning a repaired pipeline, the pipeline must be cleaned, dewatered and/or conditioned to ensure the pipeline is clean, without defect and free of water. After a repair is made, whether it is offshore or onshore, the pipeline will be commissioned through pigging and drying and then gas can be re-introduced into the pipeline, thereafter resuming normal operating conditions.

The unplanned events and potential associated damage, which may occur to the pipelines is described in more detail in **Chapter 19 Unplanned Events**.

5.6.6 Land Use during the Operational Phase

Land will be acquired for Project infrastructure and to allow for operations, maintenance and emergency access during the operational life of the Project. The land take is summarised in Table 5.43.

Table 5.43 Permanent Land Use during the Operational Phase

Component	Permanent Land Take Area (ha)
Landfall Facilities	4.85
Pipeline RoW	23.75
Engineered cut and fill slopes (surrounding Landfall Facilities)	4.83*
Varvarovka bypass road (used only during the Construction Phase of the Project)	2.6
Anode bed	0.05

* 1.3 ha of the engineered cut and fill slopes area is located within the Pipeline RoW, therefore the area of engineered cut and fill slope that adds to the total permanent landtake is 3.53 ha.

The permanent RoW will be approximately 95 m wide (19 m either side of the centreline of the outermost pipelines) and 2.5 km long (0.1 km upstream and 2.4 km downstream of the landfall facilities) and will result in a permanent land take of approximately 23.75 ha, of which 1.3 ha is also part of the engineered cut and fill slopes required for construction of the Landfall Facilities. The permanent RoW is illustrated in Figure 5.39 and shown in Figure 5.40.

The pipeline permanent RoW will be indicated by land and aerial markers. Warning signs to indicate the presence of the pipelines will also be erected at specific locations along the pipeline route. Deep rooting trees or permanent crops will not be allowed to grow, however bushes and other shallow rooted vegetation will be allowed to grow naturally or will be planted. A track suitable for 4x4 vehicles only, will be present within the RoW for inspection purposes of the pipelines.

5.6.6.1 Onshore Safety Exclusion Zones

In addition to the permanent RoW there will be three Safety Exclusion Zones for the protection of public health and infrastructure from the centreline of the outermost pipelines in line with the requirements of Gazprom Standard STO 2-2.1-249 – 2008 for Main Gas Pipelines and in accordance with the regulatory requirements set out for the Proekt (see **Chapter 2 Policy, Regulatory and Administrative Framework**). The proposed exclusion zones are as follows:

- Between 19 and 260 m from centreline of outermost pipeline: C- and E-class: no isolated buildings (1-2 levels), dachas, agricultural farms;
- Between 260 and 345 m from centreline of outermost pipeline: B-class: no cities, settlements, apartments of three levels or more, no developments / buildings with less than 100 people; and
- Between 345 and 410 m from centreline of outermost pipeline: A-class: no airports, railways station, no developments/buildings with population of more than 100 persons.

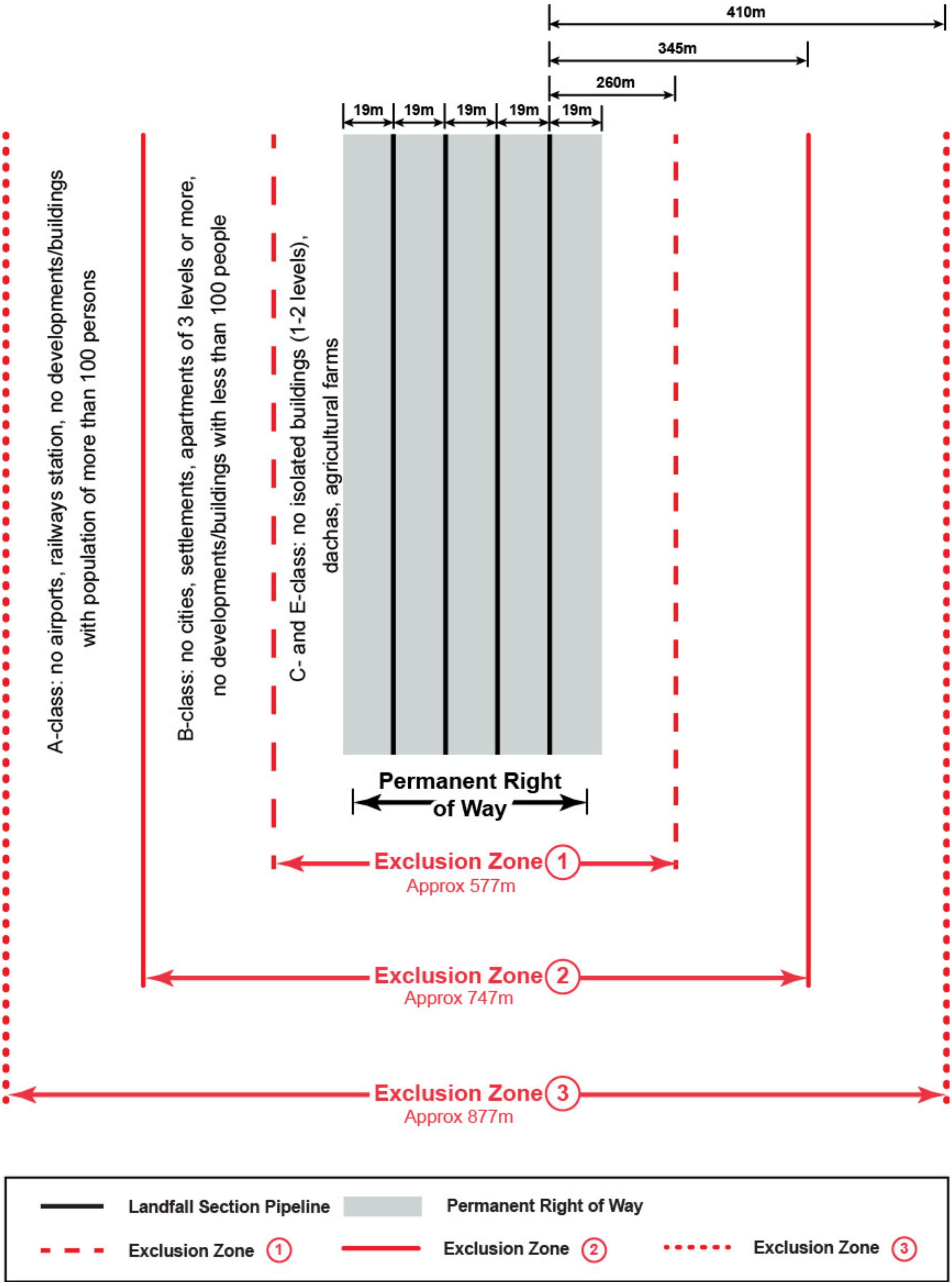
Operational environment and safety issues will be managed and monitored as part of the overall South Stream Offshore Pipeline Health, Safety, Security and Environmental Integrated Management System (HSSE-IMS). Further information on the HSSE-IMS is provided in **Chapter 22 Environmental and Social Management**.

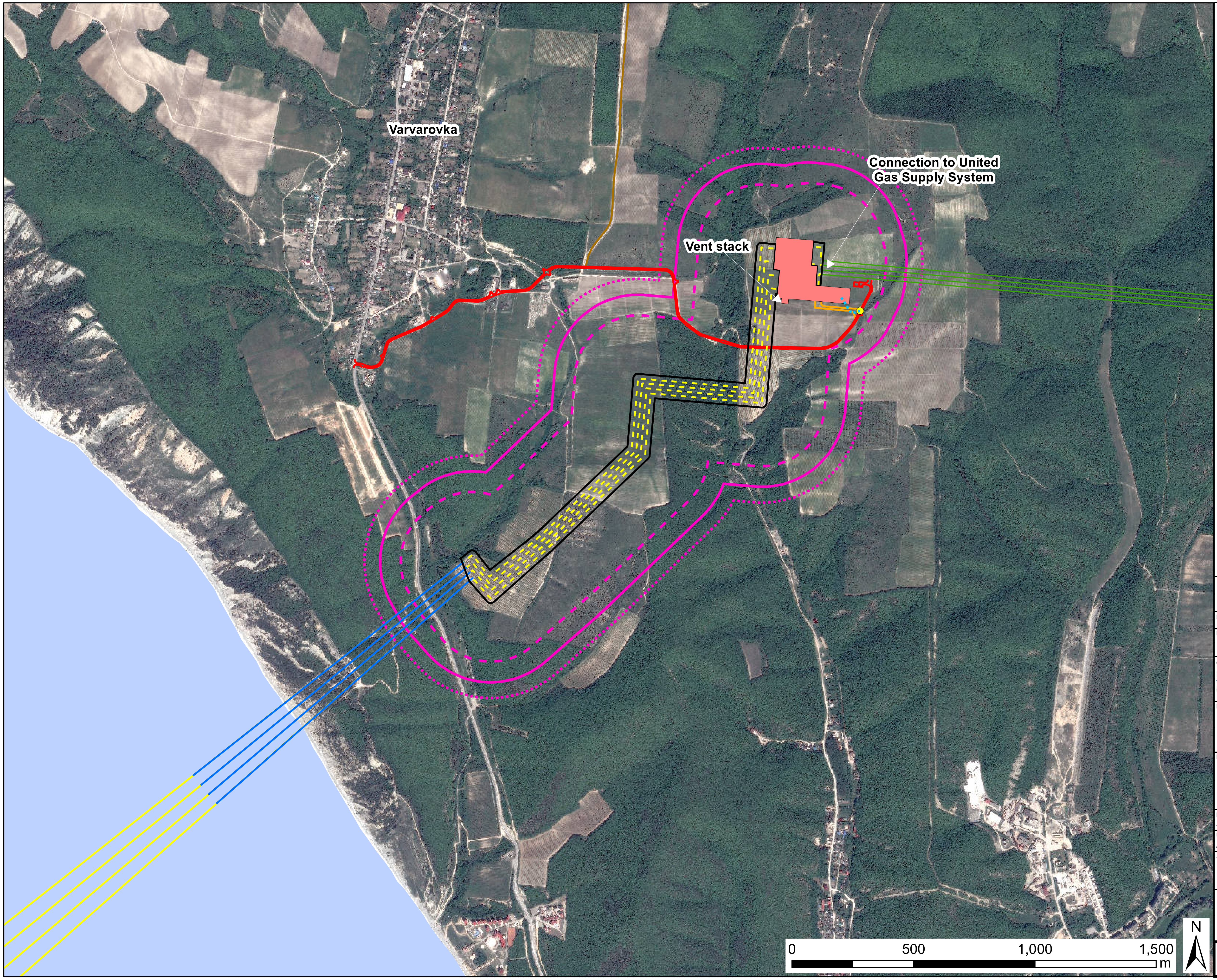
5.6.7 Offshore Exclusion Zones

To ensure that the subsea pipelines are not damaged by third party activities (e.g. dragged anchors, fishing gear, etc.) during the Operational Phase, exclusion zones will be put in place along the pipeline route to restrict activities that may damage the pipelines. These exclusion zones will reduce the potential impact on that part of the seabed, thereby they are a type of avoidance measure.

The proposed offshore exclusion zones will be agreed in consultation with the appropriate authorities. It is anticipated that the exclusion zone will extend to 0.5 km (0.3 NM) either side of the outermost pipelines from the microtunnel exit pit until the Russian / Turkish EEZ boundary (except for a section on the Russian continental slope where the pipelines diverge into two groups of two) as illustrated in Figure 5.41.

Figure 5.39 Permanent RoW and Safety Exclusion Zones, Russian Sector Operational Phase





LEGEND

Russian Sector of South Stream Offshore Pipeline

- Proposed landfall section pipelines
- Landfall facilities
- Anode ground bed for cathodic protection of pipelines
- Proposed microtunnels
- Proposed offshore pipelines
- Right-of-Way
- Anode ground bed connection to landfall facilities
- Permanent access road to be constructed by SSTTBV
- Varvarovka bypass road (used by Project during construction only)

Safety Exclusion Zones

- C- and E-class: no isolated buildings (1-2 levels), dachas, agricultural farms
- B-class: no cities, settlements, apartments of 3 levels or more, no developments/buildings with less than 100 people
- A-class: no airports, railways station, no developments/ buildings with population of more than 100 persons

United Gas Supply System

- United Gas Supply System pipelines
- Permanent access road to be constructed by Gazprom Invest

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

PERMANENT RIGHT-OF-WAY AND SAFETY EXCLUSION ZONES – PROJECT OPERATIONAL PHASE

Drawn	Checked	Approved	Date
AH	RW	MW	18 Feb 2014

URS Internal Project No.	Scale @ A3
46369082	1:15,000

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Drawing Number: Figure 5.40

Rev

Plot Date: 18 Feb 2014
File Name:I:\5004 - Information Systems\46369082_South_Stream\MXDs\Report Maps - Russia\Russian ESIA v2\Chapter 5 Project Description\Figure 5-40 Permanent RoW and Safety Exclusion Zones – Project Operational Phase.mxd

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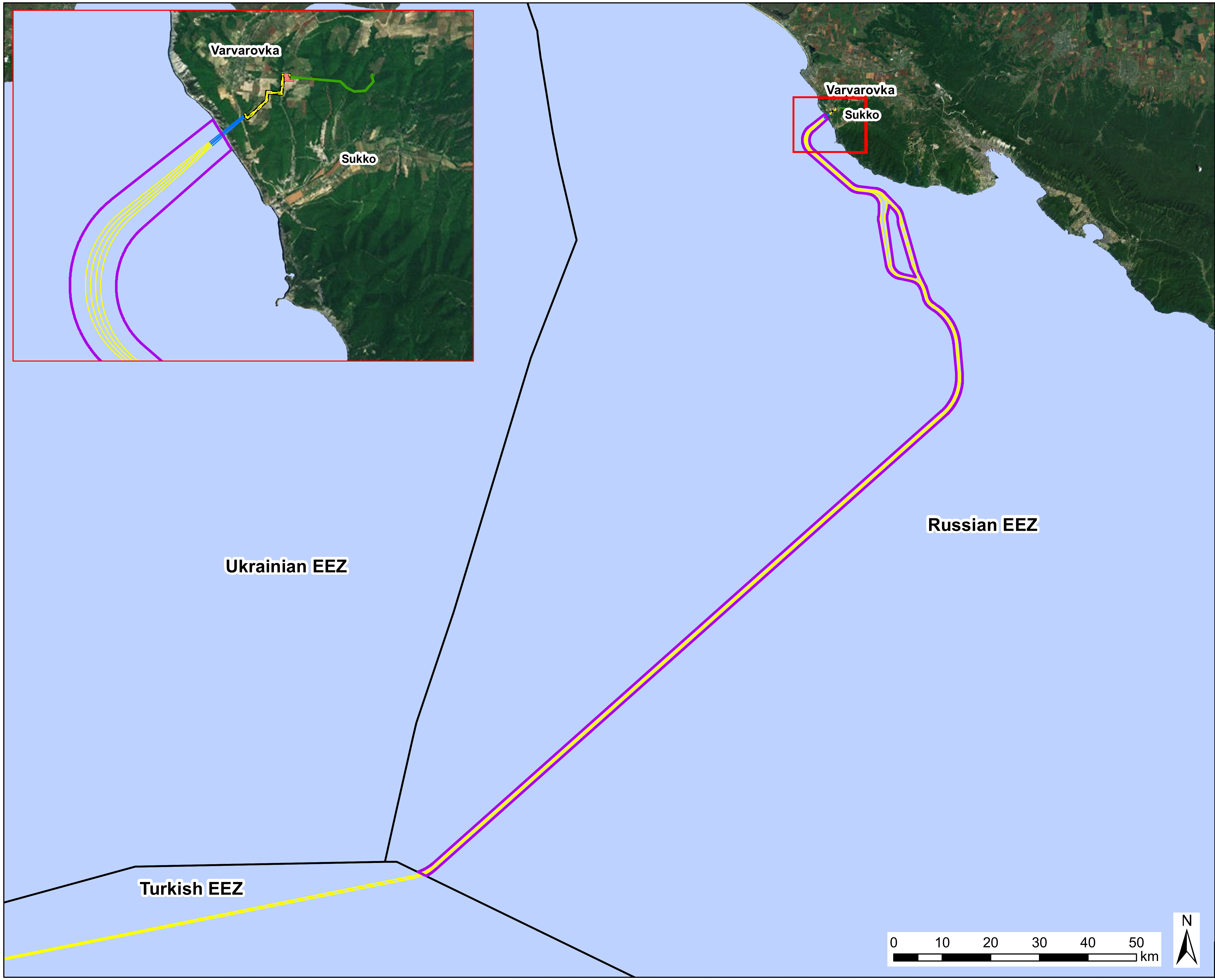
Plot Date: 18 Feb 2014
File Name:I:\5004 - Information Systems\46369082_South_Stream\MXDs\Report Maps - Russia\Russian ESIA v2\Chapter 5 Project Description\Figure 5-41 Offshore Permanent Exclusion Zones.mxd



LEGEND

Russian Sector of South Stream Offshore Pipeline

- Proposed landfall section pipelines
- Proposed offshore pipelines
- Landfall facilities
- Proposed microtunnels
- Right-of-Way
- Offshore safety exclusion zone

United Gas Supply System

- United Gas Supply System pipelines
- Exclusive Economic Zone boundary

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South Stream
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EXCLUSION ZONES

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Figure 5.41	

5.7 Pipeline Design Safety and Risk Assessment

An integrated HSSE-IMS has been developed in accordance with GIIP and in line with the requirements of ISO 14001:2004 (environmental management system) and OHSAS 18001:2007 (health and safety management system), as well as the Environmental and Social Management System requirements of the Project standards (principally the Equator Principles and the IFC Performance Standards). The main objective of the HSSE-IMS is to provide a robust framework for meeting the Project's HSSE objectives during the entire Project lifecycle. The following section describes the approach to safety issues, a key component of the HSSE-IMS relating to the installation and operation of the South Stream Offshore Pipeline.

5.7.1 Construction, Installation and Operational Safety

Safety is a key priority for the Project during construction, installation and operation. Accordingly, a Health and Safety Plan will be prepared in order to reduce all risks to "as low as reasonably practicable" (ALARP).

Design hazards have been identified and assessed using internationally recognised tools throughout the FEED process. These tools include:

- Hazard Identification (HAZID);
- Environmental Issues Identification (ENVIID);
- Quantified Risk Assessment (QRA);
- Hazard and Operability (HAZOP);
- Hazard Construction (HAZCON); and
- Bowtie Analysis.

HAZID is a tool for safety hazard analysis used at an early stage of the Project to inform the FEED study. Risk workshops and HAZID studies have been held covering different aspects of the Project. The risks that have been identified have been addressed through design measures aimed at reducing either the likelihood or the consequences (or both) of the risks. Such measures have been developed during FEED and will be further developed during the detailed design phase of the Project. The HAZID is updated as the design evolves and develops, and when key design decisions are made and/or technology is selected. The risks identified as a result of the workshops and studies have been assessed qualitatively and this assessment will be followed by an overall risk assessment that will cover design, construction, installation, operations and simultaneous operations (SIMOPS), as required.

ENVIID is a tool for environmental issues identification and analysis used at an early stage of the Project to inform the FEED study. The ENVIID process aids the FEED study in identifying any significant impacts of the Project and the associated controls and mitigation measures to be implemented into the design to remove or reduce the impact.

QRA is a tool for calculating the individual and societal/group risks from major accidents or adverse events. QRA is used to establish the potential consequences of catastrophic events, such as fires, explosions and gas releases, and the dimensions of exclusion zones and/or restricted areas where construction/building and occupation of land needs to be controlled.

HAZOP is a tool for the identification of process hazards in the design and operation of a facility or infrastructure. The HAZOP process comprises the systematic application of combinations of parameters (e.g. flow, pressure, temperature) and guide words (e.g. no, more, less) to produce deviations (no flow, less pressure) from the design intent or intended operational mode of the installation. Credible causes of these deviations are identified for each process section (node) and consequences of the deviations are assessed. The assessment consists of an examination of the pipeline design to determine whether the safety measures included in the design are sufficient to ensure that the pipelines are safe to operate, even under extreme or unusual conditions.

HAZCON is a safety study to identify and assess hazards before start of construction works. HAZCON 1 is generally carried out early in the project, prior to construction, to identify major hazards to client and contractor personnel, site visitors or the general public. HAZCON 2 is carried out to provide a detailed assessment of construction hazards, based on a significant completion of engineering design, engineering drawings, details of the RoW, construction implementation plan, landfall layout drawings and details of the marine/diving spread.

Bowtie analysis is part of the identification and management of key risks, and is used to identify risk controls, their effectiveness and corrective actions required. Before defining where to focus effort within the analysis, key risk areas are identified via other risk assessments and risk registers. The understanding of key risks highlights areas for which Bowtie analysis will be developed.

During the FEED process, design approaches and methods that minimise risk to personnel (construction, installation and operations personnel) as well as to the local community have been developed based on the results of the various risk assessment studies.

A FEED/Technical Risk Register is used to record all significant design HSSE risks, as well as technical risks related to construction and operations identified by the FEED study. The FEED/Technical Risk Register is established, managed and maintained by South Stream Transport, utilising inputs related to FEED risks from the FEED Contractor, and forms part of the overall Project Risk Register.

Major accident hazards (MAHs) during construction, installation and operation of the Project, in relation to the local community are addressed in **Chapter 14 Socio-Economics**. Plans for dealing with the effects on the community of construction, installation and operation of the Project such as increased traffic, transportation of hazardous substances, waste water discharge; solid waste disposal etc. will be managed by South Stream Transport and the respective contractors through a number of CMPs. Further information on the various Project CMPs to be implemented can be seen in **Chapter 22 Environmental and Social Management** of this ESIA Report.

5.7.1.1 Security of the Operational Facilities

As the landfall facilities are unmanned during the Operational Phase, security of the landfall facilities is primarily provided by perimeter security fencing, intruder alarms and the surveillance of the real time CCTV by staff based in the CCR. The CCR will also have a constant and secure communication link with operational staff located at the Russkaya CS to be operated by Gazprom who may be alerted to an incident if necessary.

A Security Plan is currently being developed by South Stream Transport and a specialist company will be employed to advise South Stream Transport on a corporate level on security matters. South Stream Transport will appoint a security coordinator within the South Stream Transport Operations Team. The Security Plan will define the management and security measures to be employed for the Project. Further information on the management plans to be employed for the Project is provided in **Chapter 22 Environmental and Social Management**.

5.8 Labour and Procurement

5.8.1 Construction Phase

At the time of preparing this ESIA Report it was not possible to estimate the exact numbers of workers that will be employed during the construction of the Project. This information will become available when the detailed design of the Project has been completed. However, the maximum numbers of workers anticipated (at this present time) to be working on the Project during the peak of construction activity is presented in Table 5.44.

Table 5.44 Estimated Employment Levels during the Construction Phase

Project Section	Peak Worker Numbers
Landfall	330
Nearshore	544
Offshore	1,211

5.8.1.1 Hours of Working

In the landfall section it is anticipated that the standard working hours will be 0700 – 1900 Monday to Friday and 0700 – 1400 on Saturdays. However, for certain activities (for example pre-commissioning, commissioning and microtunnelling) there will be periodic requirements to work outside of these hours. Careful consideration will be given to the impacts of noise and vibration for any activities planned outside the normal working hours and no work will proceed without the necessary permits.

For construction and installation of the nearshore and offshore sections of the pipeline it is anticipated that work will be carried out 24 hours per day, seven days per week.

The majority of the construction work force required will be highly skilled and is anticipated to come from outside the local area. They will be lodged in the nearby towns and villages or on the vessels that they work. Further information on the proposed workforce is provided in **Chapter 14 Socio-Economics**.

Workers will be transported to the landfall section construction sites by mini buses if required to reduce traffic movements and routes will be coordinated with local authorities. A number of cars and vans are also anticipated to be utilised to transport workers. These traffic movements are included in Table 5.8. The transport routes and potential impacts of traffic travelling to the landfall construction site will be managed through the Russian Landfall CMP, which will form part of South Stream Transport's ESMP.

5.8.1.2 Worker Health and Safety

Occupational Health and Safety (OHS) for procurement, construction, installation and operations will be managed by South Stream Transport and their respective contractors. Internationally recognised procedures to assure the OHS of the workforce will be adopted along with the necessary equipment and training to make these effective.

The health risks to which workers are exposed are determined by a Health Risk Assessment (HRA). The HRA is the Hazards and Effects Management Process (HEMP) for health hazards, and identifies the health hazards and risks (physical, chemical, biological, ergonomic and psychological) in the workplace, and facilitates an occupational health needs analysis. The HRA determines if medical health surveillance is required for a job position that includes exposure to potentially harmful conditions or risks.

OHS procedures to be adopted by the Project include:

- Fitness-to-work Assessment;
- Management procedures; and
- First aid and medical emergency response.

Further information on OHS of the workforce is provided in Appendix 15.1 Occupational Health and Safety.

5.8.2 Operational Phase

There will be no full time workers employed for the Project during the Operational Phase of the Project, other than a workforce stationed permanently at the CCR and BUCR to operate the South Stream Offshore Pipeline. There will also be occasional periods when workers will be onsite during pigging operations and maintenance. Pigging operations will be undertaken by specialist contractors, whilst more general maintenance of electrical and monitoring systems is anticipated to be undertaken by employees based at the Russkaya CS being developed by Gazprom as part of the "Expansion of the UGS to provide gas to South Stream pipeline". The operational performance of the South Stream Offshore Pipeline (including the Project pipelines and landfall facilities) will be monitored in real-time using SCADA from the CCR and BUCR in Amsterdam as described in Section 5.6.1.1.

5.9 Decommissioning

The expected service lifetime of the South Stream Offshore Pipeline is 50 years. The decommissioning program will be developed during the Operational Phase of the Project. It is likely that the technological options and preferred methods for decommissioning of such gas transportation systems as the South Stream Offshore Pipeline will be different in 50 years' time. The decommissioning program will be developed during the Operational Phase of the Project. The status of the South Stream Offshore Pipeline at the time of decommissioning will also impact on the chosen decommissioning methods.

Under all circumstances, decommissioning activities will be undertaken in accordance with the international and national legislation and regulations prevailing at that time, and in liaison with the relevant regulatory authorities.

A review, and relevant studies if necessary, will be undertaken during the Operational Phase to confirm that the planned decommissioning activities utilise GIIP and are the most appropriate to the prevailing circumstances and future land use. The review will outline management controls and demonstrate that the decommissioning activities will not cause unacceptable environmental and social impacts. The decommissioning activities will also require all relevant approvals and authorisations from the Russian Government departments responsible at the time.

5.9.1 Decommissioning of the Landfall Section of the Project

During the Decommissioning Phase, activities on site associated with the removal of infrastructure will increase in intensity relative to those occurring during the Operational Phase of the Project. Of particular note are the potential environmental and social impacts associated with the following activities:

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

An environmental assessment will be conducted before decommissioning commences in order to confirm that the planned activities are the most appropriate to the prevailing circumstances. This assessment would aim to demonstrate that the decommissioning activities would not cause unacceptable environmental and social impacts and would lead to the development of specific management controls. Potential impacts associated with decommissioning activities may include the following:

- Erosion and sedimentation;
- Dust generation;
- Increased pressure on waste disposal facilities;
- Spills of hazardous substances;
- Disturbance to habitats; and
- Noise disturbance.

To what extent the following activities are undertaken will depend upon the agreed final use of the landfall section development areas, which will be defined in consultation with the relevant national and local authorities:

- Landfall facilities shall be removed;
- Access roads may be left in place depending upon the subsequent use of the land;
- Shallow foundations for infrastructure may be excavated, demolished and disposed of;
- Where piled foundations exist, these may be excavated to a depth of 1 m below the existing ground level and removed;
- Excavations resulting from the removal of foundations will be backfilled;
- Landfall section pipeline sections may be cleaned and re-used in connection with the offshore pipeline sections;
- For the pipelines within the microtunnels; if re-use is not feasible then they will most likely be cleaned, filled with inhibited sea water (seawater that has been treated with additives to inhibit its corrosiveness), sealed and left in place; and
- If re-use of the landfall section pipelines is not feasible then they will most likely be recovered and the steel recycled and the trenches backfilled and reinstated.

Prior to undertaking decommissioning activities, South Stream Transport will undertake a review of historical monitoring data and incidents on site that might have caused contamination.

Depending on the final land use agreed with the authorities for the landfall section area, all or part of the site may need to be rehabilitated. In such circumstances, South Stream Transport will also develop a monitoring program for completion criteria to verify that the sites are being returned to the agreed representative state. Completion criteria will be included for vegetation community composition, extent of weed infestation, erosion control and visual amenity of the site. These completion criteria will be determined in consultation with the local and national authorities.

In the event that the landfall section areas require to be returned to their original state (i.e. before the Project was constructed), stable landforms will be established and the site will be rehabilitated to an agreed level of representation of the pre-project plant communities based on agreement between South Stream Transport and the relevant authorities on these levels.

5.9.2 Decommissioning of the Nearshore and Offshore Sections of the Project

Current practices for the decommissioning of subsea pipelines involve either removing the pipeline or leaving the pipeline on the seabed after cleaning and filling it with water in combination with a program of planned monitoring to ensure safety for other users of the sea. The prevailing opinion is that leaving the pipeline in place results in the least environmental impact as over time the pipelines will become integrated within the seabed environment and their removal would disturb the habitats that have generated in the vicinity of the pipelines. A summary of the activities involved with the two options are described below.

Leaving the pipelines on the seabed will typically involve the following types of activities:

- Filling the pipeline with water;
- Pipeline cleaning by flushing with water and associated water displacement, collection and disposal;
- Sealing of the pipeline ends; and
- Monitoring surveys following decommissioning.

Removal of the pipelines from the seabed will typically involve the following types of activities:

- Vessel operations similar in nature to those required for construction of the pipeline;
- Seabed intervention works;
- Pipeline removal, recycling and disposal;
- Disturbance of the seabed and aquatic environment as the pipeline is recovered; and
- Logistics support offshore and onshore.

Factors to be considered when taking the decision on decommissioning methods for the Project include:

- The potential for re-use of the pipeline in connection with further developments will be considered before decommissioning, together with other existing projects (such as hydrocarbon storage, water outfall). If re-use is considered viable, suitable and sufficient maintenance of the pipeline will be investigated and ensured;
- All feasible decommissioning options shall be considered and a comparative assessment made;
- Any removal or partial removal of a pipeline shall be performed in such a way as to minimise the potential for any significant adverse effects on the marine environment;
- Any decision that a pipeline may be left in place should have regard to the likely deterioration of the material involved and its present and possible future effect on the marine environment; and
- Account shall be taken of other users of the sea.

Where it is proposed that a pipeline should be decommissioned by leaving it on the seabed for natural degradation (referred to as in situ decommissioning), either wholly or in part, the decommissioning program will be supported by a suitable study that addresses the degree of past and likely future burial/exposure of the pipeline and any potential effect on the marine environment and other users of the sea. The study will include the survey history of the pipeline, using appropriate data to confirm the current status of the pipeline, including the extent and depth of burial, trenching, spanning and exposure.

Determination of any potential effect on the marine environment at the time of decommissioning will be based upon scientific evidence. The factors to be taken into account will include the effect on water quality and geological and hydrographical characteristics, the presence of endangered or threatened species, existing habitat types, local fishery resources and the potential for pollution or contamination by residual products from, or deterioration of, the pipeline.

The above serves as an example of general principles that should be applied during the decommissioning options decision-making process. It is foreseen that more directly applicable international or national guidelines are likely to be developed before the end of the lifetime of the Project (approximately 50 years) and that these will specify additional options that may need to be considered. The applicable regulations at the time of decommissioning will be adhered to.

5.9.3 Decommissioning Planning

It is envisaged that the process of developing detailed decommissioning management plans may be staged, initially outlining potential options and studies required for discussion with the regulatory authorities, and finally leading to agreed plans prior to the commencement of decommissioning. The content of the final plans will be dependent on the anticipated future land use. The plans will include methods and activities associated with the decommissioning of the offshore, nearshore and landfall sections infrastructure, including the transportation and final disposal or re-use strategy for Project components and wastes. Completion criteria will be detailed in the management plans. These completions criteria will be determined in consultation with the respective national and local authorities.

Documentation or processes addressing the issues outlined below will be developed to further support the implementation of detailed decommissioning management documentation:

- Incident reporting, recording and investigation;
- Chemical and hazardous substance management;
- Waste management;
- Dust management;
- Traffic management;
- Soils management;
- Health, safety and environmental site induction; and
- Spill contingency.

5.10 Summary of Total GHG Emissions to Atmosphere

Table 5.45 provides the total GHG emissions for the Project, the Turkish Sector of the South Stream Offshore Pipeline and the Bulgarian Sector. The total GHG emissions for the entire South Stream Offshore Pipeline are also shown. The methodology used to estimate these GHG emissions is contained within Appendix 9.4 of **Chapter 9 Air Quality.**

Table 5.45 Total Greenhouse Gas Emissions during Construction and Pre Commissioning Phase for all 4 pipelines (tonnes CO_2e)

Russian Sector	Turkish Sector	Bulgaria Sector	Total South Stream Offshore Pipeline System
674,853	94,061	1,003,787	1,772,701

5.11 Management of Change Process

During the detailed design, Construction and Pre-Commissioning, and Operational Phases of the Project, there may be a requirement to amend design elements or processes which results in a deviation from that presented in this Project Description. The Project has a management of change process to manage and track any such amendments, and to:

- Assess their potential consequences with respect to environmental and social impact; and
- In cases where a significant impact is likely to arise as a consequence of the amendment or change, to inform and consult with relevant parties on the nature of the impact and on proposed mitigation measures, where practical and appropriate.

All design changes will be added to a register of changes, which will summarise the change, the assessment, and the justification for South Stream Transport's actions.

The management of change process will be incorporated into the HSSE Management of Change Procedure, which is an integral part of the HSSE-IMS described in more detail in **Chapter 22 Environmental and Social Management**.

References

Number	Reference
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Ref. 5.2	Expansion of United Gas Supply System for Providing Gas into the "South Stream" Gas Pipeline, Stage 1 (West Corridor) Ensure supply of gas at a rate of 31.5 billion m³/year, Design Document, Section 7 - Environmental Protection Measures, Part 2 – Environmental Impact Assessment for Compressor Station, Book 7 KS Russian 6976.211.002.21.14.07.02.13(1)-OOC pages 1-323, Volume 7.2.13 by Fedorenko A. V. (Head of Industrial and Environmental Protection Department) et al. 2012.
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Ref. 5.5	Red Data Book of the Russian Federation (animals). Moscow. AST; Astrel. 2001. 863 p.
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