Chapter 8: Soils, Groundwater and Surface Water

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8 Soils, Groundwater and Surface Water

8.1 Introduction

This chapter presents the baseline characteristics of terrestrial soils, surface water and groundwater regimes within the terrestrial part of the landfall section of the South Stream Offshore Pipeline – Russian Sector (also referred to as 'the Project'). It describes the impacts that the Construction and Pre-Commissioning Phase, Operational Phase (including Commissioning Phase and Full Operational Phase), and Decommissioning Phase of the Project may have on these environments. It also identifies mitigation measures required in order to remove and/or minimise potentially adverse impacts to the environment.

The environmental attributes of the terrestrial part of the landfall section discussed in this chapter comprise:

- Soils;
- Groundwater; and
- Surface water.

Impacts to soils are assessed because vegetation will be cleared and topsoil removed during construction which increases the potential for soil erosion by wind and by surface runoff. There is also the potential to encounter existing soil contamination associated with past land use or for new contamination to occur through accidental leaks or spills, which could result in impact on soils and mobilisation of soil contamination into groundwater or surface water. In addition, the stockpiling of topsoil and subsequent re-profiling may result in change to the soil structure.

Impacts to groundwater and to surface water are assessed as there is the potential for water quality and quantity to be affected. For example, elevated levels of suspended solids may occur in runoff during construction or accidental leaks or spills may occur.

Where possible, the physical and chemical characteristics of the terrestrial soils and groundwater regime that are described in this chapter apply to the terrestrial part of the landfall section. Where specific soil, groundwater or surface water characteristics were observed to be variable across the terrestrial part of the landfall section, descriptions have been provided in further detail for localised zones.

8.2 Scoping

The scope of the soil and water impact assessment for the Project was defined through a scoping process which identified soil and water receptors and potentially significant impacts related to the Project. Baseline information which informed the scoping process largely drew on information gathered from studies undertaken for the South Stream Offshore Pipeline, including feasibility, engineering and environmental surveys carried out since 2008. Key steps in the scoping process for soil and water comprised the following:

- The Project description was reviewed to identify activities with the potential to significantly affect soil and water receptors;

- Soil and water receptors within the Project's Area of Influence (see Section 8.3.1 for definition) were identified through a process of secondary data review (see Section 8.4.2 for further detail), stakeholder consultation regarding abstractions, previous studies undertaken for the South Stream Offshore Pipeline and professional expertise; and
- A review of relevant national and international legislative requirements and lender requirements.

An Environmental Issues Identification (ENVIID) workshop, which involved Environmental and Social Impact Assessment (ESIA) specialists, South Stream Transport representatives and project engineers, was undertaken to assist in the identification of impacts and receptors. During this workshop, each activity was examined, drawing upon the experience of the technical specialists and their understanding of the extent and nature of the Project Activities and the natural environment, to understand:

- How activities were expected to interact with soil and water receptors, and whether this is likely to result in a beneficial or adverse impact (pertinent activities are described in Section 8.6.1.1); and
- Which receptors will potentially be impacted by each activity and the potential significance of those impacts (key receptors are described in Section 8.6.1.2).

The outcome of the ENVIID workshop was the production of an ENVIID register which identified the various elements of the Project and their interaction or potential impact on sensitive ecological receptors.

The assessment below has therefore been informed through this process of impact and receptor identification.

8.3 Spatial and Temporal Boundaries

8.3.1 Project Area

The Project Area (as described in **Chapter 1 Introduction**) is subdivided into three sections: the landfall, nearshore and offshore sections. This chapter assesses only the terrestrial part of the landfall section of the Project Area. This extends from the shoreline to the permanent landfall facilities including the Pipeline route (both buried and microtunnelled sections).

8.3.2 Study Area

The Study Area is a terrestrial zone extending up to approximately 1.5 km either side of the centreline of the Pipeline route (Figure 8.1) and landfall facilities boundary. The Study Area has been assessed within a regional context with respect to the geology and river catchments.

8.3.3 Survey Areas

The Survey Area for soil and water is the same as the Study Area and is the area in which surveys were undertaken for the Project.

8.3.4 Zone of Influence

The Zone of Influence has been assumed to be approximately equivalent to the Study Area plus the downstream stretches of the watercourses and the area around the abstraction well at Sukko.

The Zone of Influence includes new roads constructed or upgraded for the Project but not existing roads that extend outside the areas defined above.

The Study Area and Zone of Influence are the same for each Project phase i.e. Construction and Pre-Commissioning Phases; Operational Phase; Decommissioning Phase; and for the assessment of unplanned events (discussed in **Chapter 19 Unplanned Events**).

8.4 Baseline Data

8.4.1 Methodology and Data

In order to assess potential impacts on soil, groundwater and surface water, secondary (i.e. existing data based on desk-based research) and primary data regarding the relevant baseline characteristics have been identified and assessed. Following this, a gap analysis was undertaken to inform the need for additional primary data sources to fill the data gaps. Primary data was then collected during field surveys.

Data have been collected and presented at different spatial levels as appropriate according to the nature of the potential impact to be assessed and the baseline indicator in question.

The baseline characterisation considered:

- Soil:
  - Soil types; and
  - Soil chemistry.
- Groundwater:
  - Aquifer characteristics;
  - Groundwater levels; and
  - Groundwater chemistry.
- Surface Water:
  - Watercourse characteristics;
  - Surface water chemistry; and
  - Stream bed sediment chemistry.

8.4.2 Secondary Data

Contextual information on the regional setting with respect to soil and water was obtained through literature review. Published geological and topographical maps were reviewed to characterise the ground conditions and local geomorphological and hydrological setting. Meteorological data was based on published datasets.

Consultations with regulators and other stakeholders were undertaken as part of the initial assessment for the Study Area (Ref. 8.1 to 8.7). The consultees included:

- Kuban Basin Water Agency, regarding water consumers;
- Russian Ministry of Natural Resources, regarding sanitary protection zones;
- Russian Ministry of Public Health and Social Development, regarding sanitary protection zones;
- Russkaya Compressor station, regarding water supply;
- Supsekh Administration, regarding water supply; and
- Ministry of Defence regarding the existing water well at Sukko.

8.4.3 Data Gaps

The secondary (existing) data research exercise revealed that there were a number of data gaps. The data gaps were most acute in respect of the following themes:

- Soil characteristics and distribution at the Project-scale;
- Baseline soil, groundwater and surface water chemistry, including potentially existing contamination;
- Groundwater levels; and
- Details of nearby water abstractions, including locations, usage and abstraction rates.

These data gaps have been addressed through field surveys, the details of which are set out in Section 8.4.4.

8.4.4 Primary Data/Baseline Surveys

8.4.4.1 Overview

A number of baseline surveys have been undertaken in relation to soil and water.

Environmental surveys were undertaken in the Survey Area in 2010, 2011 and 2013 (Refs. 8.1, 8.8), and covered the following disciplines relevant to this chapter:

- Landscape;
- Soils;
- Groundwater;
- Surface water;
- Geomorphological geohazards; and
- Contamination.

The field surveys included mapping of soil, geomorphological and hydrogeological features. Samples were obtained of soil, groundwater, surface water and stream bed sediments for laboratory analysis to characterise their physico-chemical properties.

In addition to the environmental surveys described above, engineering surveys have been undertaken (Refs. 8.9, 8.10, 8.11 and 8.12) which included intrusive and non-intrusive geotechnical investigation. These geotechnical investigations included boreholes and geophysical profiling. This has provided additional information on local ground conditions, depth to bedrock, groundwater levels and geomorphology.

The baseline data presented in this chapter is predominantly based on information gathered during the environmental surveys (Ref. 8.1, 8.8).

The survey locations within the Study Area are shown in Figure 8.1.

8.4.4.2 Soil Survey

The purpose of the soil surveys (Ref. 8.1, 8.8) was to:

- Determine the soil spatial distribution, revealing the full range of dominant and associated soils,
- Assess the natural variation of their morphogenetic properties; and
- Assess the agro-chemical soil properties where applicable.

The soil studies were carried out according to requirements Russian standard SanPiN 11-207-97 and the All Union Instruction on Soil Investigation 1973 given in the Peter Gaz survey reports (Ref. 8.1).

The soil survey in the Study Area was undertaken along three linear survey lines oriented roughly perpendicular to the coast with a small number of additional sites in other areas. In total, 65 soil profile sections were undertaken using pits excavated to a depth of approximately 0.9 m.

The geomorphology of the Study Area was assessed by field mapping and profiling at selected locations. The geomorphological survey identified and assessed geomorphologically active features.

8.4.4.3 Soil Quality

The purpose of the soil quality surveys was to determine the baseline soil chemistry.

During the 2010 investigation (Ref. 8.1), 30 soil samples were collected from 16 locations at varying depths. During the 2013 investigation (Ref. 8.8), 10 soil samples were collected from five locations. Samples underwent laboratory analysis of physico-chemical properties and agrochemical nutrient levels.

To evaluate the potential for chemical contamination of soils, sampling was carried out on test plots within the Survey Area. Forty two composite soil samples were prepared by mixing equal volumes of not less than five samples taken from the test plot (no smaller than 5×5 m) uniformly throughout the depth of the layer 0 to 0.1 m. During collection, odour, texture, presence of films, oil stains, inclusions and organic content (presence of peat) were noted. Sampling, preservation, storage and transportation were carried out in accordance with the requirements of Russian standards; GOST 17.4.3.01-83 and GOST 17.4.4.02.84 (Ref 8.1).

8.4.4.4 Groundwater Quality

During the 2010 investigation a total of three water samples were collected from springs within the Survey Area in accordance with Russian standard SP 11-102-97. During the 2013 investigation a further three water samples were collected from additional springs in accordance with Russian standard SP 11-102-97. Sampling, preservation, storage and transportation of water samples were carried out in accordance with the requirements of Russian standards GOST 17.1.5.05-85 and GOST R 51592-2000 (Ref 8.1). The water was collected by hand in disposable plastic containers and glass bottles.

Air and water temperature were measured and field observations of colour, odour, turbidity, and taste were made. Immediately following sampling, the pH and dissolved oxygen content were determined. Samples were refrigerated (temperature 2 to 5°C) and delivered to the laboratory.

8.4.4.5 Surface Water Quality

During the 2010 investigation a total of four surface water samples were collected within the Survey Area in accordance with Russian standard SP 11-102-97 (Ref. 8.1). During the 2013 investigation a further two water samples were collected in accordance with SP 11-102-97. Sampling, preservation, storage and transportation of the samples were carried out in accordance with the requirements of Russian standards GOST 17.1.5.05-85 and GOST R 51592-2000 (Ref. 8.1). Water samples were collected at a depth of 0.2 to 0.5 m by hand in disposable plastic containers and glass bottles.

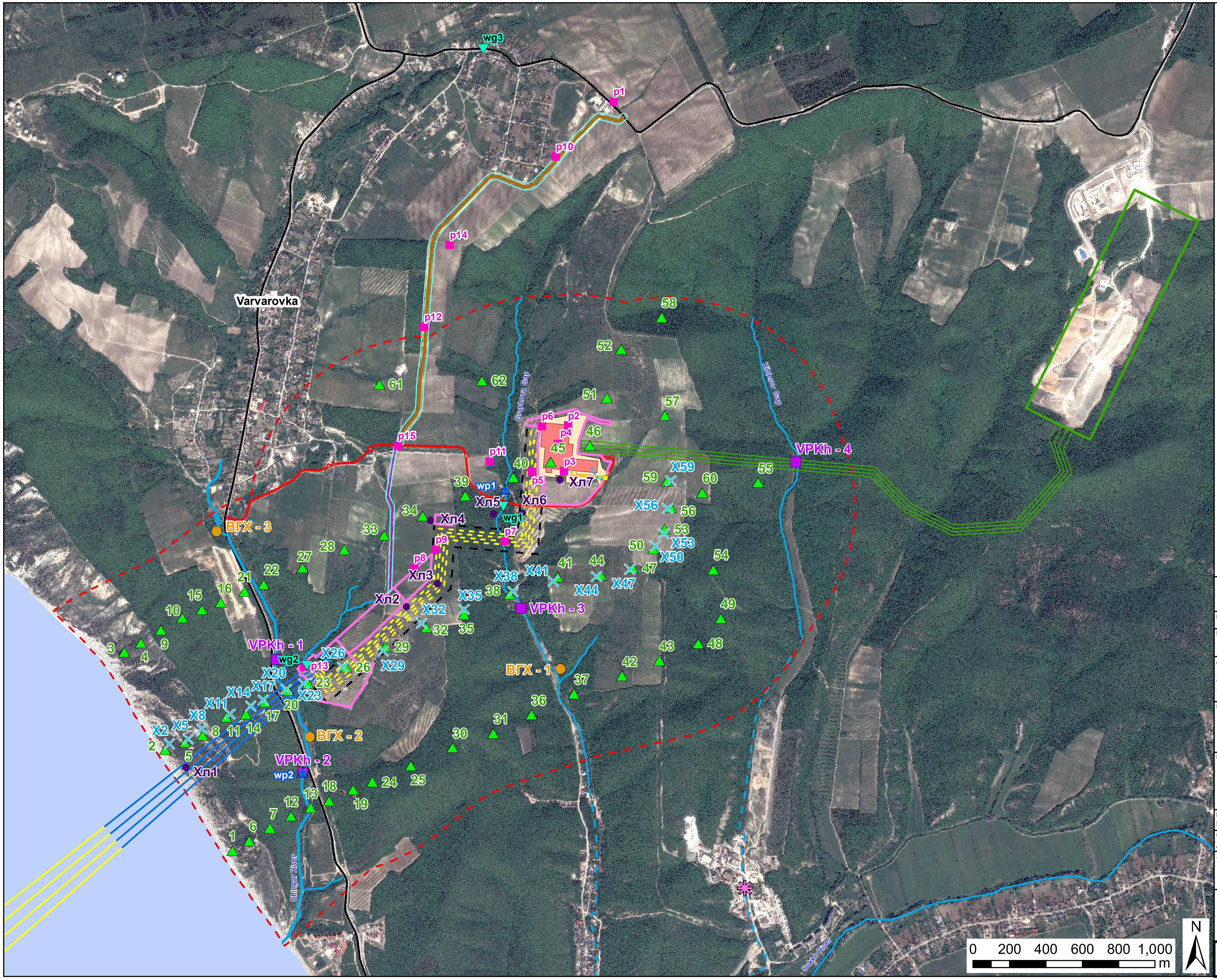
Air temperature, water temperature, water depth and water clarity were measured and field observations of colour, odour and turbidity were made. Immediately following sampling, the pH and dissolved oxygen content were determined. Samples were refrigerated (temperature 2 to 5°C) and delivered to the laboratory.

8.4.4.6 Stream Bed Sediment Analysis

Within the Survey Area a total of six stream bed samples were collected at the same locations as the surface water quality samples. Sampling, preservation, storage and transportation of the samples were carried out in accordance with the requirements of Russian standards GOST 17.1.5.01-80 and RD 52.24.609-99 (Ref. 8.1). The sediments were sampled from the depth 0 to 5 cm. During collection, odour, texture, presence of films, oil stains, inclusions and organic content were noted.

8.4.4.7 Laboratory Analysis

The laboratory analysis for the Survey Area soil and water samples was undertaken in the: Test Laboratory Centre (TLC GC RES LLC), the Environmental Analytical Laboratory of Peter Gaz, and the laboratory of the RSC Kurchatovskiy Institute.



LEGEND

- Proposed water supply well

2011 Survey

- Xл1 - Soil Sampling Point

2010 Survey

- 1- Soil and geomorphology survey point
- X1 - Soil quality sampling point
- B?X-1 - Groundwater sampling point
- VPKh-1 - Surface water sampling point

2013 Survey

- wp1 - Surface water sampling point
- wg1 - Groundwater sampling point
- p1 - Soil quality sampling point
- Rivers
- Inferred watercourses
- Main roads
- Study Area

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
- Anode ground bed connection to landfall facilities
- Construction corridor
- Cut and fill side slopes
- Temporary construction area for road construction
- Construction sites
- Permanent access road to be constructed by SSTTBV
- Temporary access road 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

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

SURVEY LOCATIONS IN STUDY AREA

Drawn	Checked	Approved	Date
DH	RW	MW	18 Feb 2014

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

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Drawing Number

Figure 8.1

Rev

Plot Date: 18 Feb 2014
File Name: I:\5004 - Information Systems\46369082_South_Stream\MXDs\Report Maps - Russia\Russian ESIA v2\Chapter 8 Soil and Groundwater\Figure 8-1 Survey Locations in Study Area (landfall section).mxd

8.4.5 Data Assumptions and Limitations

The available soil, water and sediment data are sufficient to inform the baseline of the study in order to determine the potential for impacts and undertake the assessment.

The following limitations apply to the baseline dataset:

- There is limited soil data on the exact route of the permanent and temporary access roads. However, it is considered there is sufficient data from the Survey Area as a whole to infer likely ground conditions along the new access roads;
- Groundwater and surface water quality was sampled on two occasions. However, groundwater and surface water quality may be subject to fluctuations and a single sampling event may not be fully representative of long-term water quality patterns. Parameters such as suspended solids and dissolved oxygen may vary naturally in response to flow rates and following rainfall events;
- Groundwater was sampled from springs rather than boreholes;
- There are limited hydrological flow regime measurements. The flow regimes of the surface watercourses vary in response to rainfall. Hydrological modelling based on catchment size and run-off estimates in small catchments with permeable bed sediments that are partially fed by springs tends to give results with a high degree of uncertainty. However, further quantification of the flow regime would not alter the outcome of the impact assessment;
- There is uncertainty over the exact locations of nearby abstractions (Refs. 8.3, 8.5). The nearest confirmed groundwater abstraction (which is associated with the Russkaya Compressor station) is understood to be at more than 5 km to the northeast of the Study Area; the Project does not lie within a sanitary protection zone of this abstraction (Ref. 8.3). Anapa Administration have confirmed there are no licensed abstractions in the vicinity of the Project Area (Ref. 8.7);
- The closest surface water abstractions to the Study Area are reported to be upstream of the Pipeline route (Ref. 8.5). There is a potential abstraction point from surface water upstream of the road crossing on Graphova Gap but there is no information as to the volumes or timings of abstraction at this location; and
- Information is available on the Russian Ministry of Defence water supply well located in Sukko proposed to be used by the Project but there is limited information on any other groundwater abstractions in and near Sukko. It has been assumed that the current abstraction licence limits for the proposed water source is adequately protective of other abstractors in the region.

8.5 Baseline Characteristics

This section first introduces the policy, regulatory and administrative frameworks and goes to identify the national and international standards relevant to soils, groundwater, surface water, and sediment. It provides a description of the baseline, i.e., "pre-existing" environment conditions, compares those conditions against the national and international standards, and then describes the existing status with respect to administrative frameworks.

8.5.1 Applicable Standards

The legal framework of relevance to the Project is outlined in **Chapter 2 Policy, Regulatory and Administrative Framework**. Additional, more specific regulations of relevance to soils, groundwater, surface water and sediment conditions include the following Russian national standards on soil and water quality:

- Russian standard GN 2.1.7.2041-06, on maximum permissible concentrations (MPCs) of chemical substances in the soil (Ref. 8.13);
- Russian standard GN 2.1.7.2511-09, on approximate permissible concentrations (APCs) of chemical substances in soil (Ref. 8.14);
- Russian standard GN 1.2.2701-10, on hygienic regulations of pesticides in the environment (list) (Ref. 8.15);
- Russian standard SanPiN 2.1.4.1175-02, on hygiene requirements for quality of water from non-centralised water supply systems. Sanitary protection of water sources (Ref. 8.16);
- Russian standard GN 2.1.5.1315-03, on MPCs of chemical substances contained in water of water bodies for economic-potable and social-domestic water use (Ref. 8.17);
- Russian standard SanPiN 2.1.5.980-00, on hygienic requirements for surface waters protection (Ref. 8.18);
- Order of the Federal Fisheries Agency No. 20 dated 18.01.2010, on approving the standards for water quality in fishing water bodies, including standards for maximum permissible concentrations of harmful substances in the water of fishing water bodies (Ref. 8.19);
- Russian standard SanPiN 2.1.4.1110-022.1.4 on drinking water and water supply of populated areas, zones of sanitary protection of water sources (Ref. 8.20);
- Article 65 of the Water Code of the Russian Federation (Ref. 8.21); and
- Russian standard SanPiN 2.1.7.1287 -03. Soil quality sanitary epidemiological requirements for industrial sites (Ref. 8.22).

Table 8.1, Table 8.2, Table 8.3 and Table 8.4 present the respective relevant soil, groundwater, surface water quality and sediment limits for the Project, based on the regulations detailed above and the World Health Organisation (WHO) Water Quality Guidelines (Ref. 8.23) as recommended by the International Finance Corporation (IFC) Environmental, Health and Safety General Guidelines (Ref. 8.24).

Russian national standards take precedence over international standards because they are generally more stringent and therefore national standards will be used to assess current baseline conditions.

The assessment criteria for soil quality have been based on the following guidance:

- The soil quality assessment has been made using Russian standard GN 2.1.7.2041-06 and Russian standard GN 2.1.7.2511-09. These standards define the MPCs and APCs respectively for various chemical substances permitted to occur in soils; and
- MPC levels specify the concentration of a harmful substance within soil below which there are no significant adverse impacts upon human health and which will not cause detrimental impacts to soil quality. Where MPC levels are not provided for specific pollutants, APC levels are typically used to determine upper limits for contaminants in the soil.

Table 8.1 Relevant Soil Quality Limits

Parameter	Unit	Russian National Limits for Chemicals in Soil*	
		MPC level (Ref. 8.13)	APC (Ref. 8.14)
pH	pH units	-	-
Arsenic, As	Milligrams per kilogram (mg/kg)	2	-
Cadmium, Cd	mg/kg	-	2
Copper, Cu	mg/kg	-	132
Chromium, Cr**	mg/kg	-	-
Nickel, Ni	mg/kg	-	80
Lead, Pb	mg/kg	32	-
Zinc, Zn	mg/kg	-	220
Mercury, Hg	mg/kg	2.1	-
Manganese, Mn	mg/kg	1,500	-
Iron, Fe[†]	mg/kg	-	-
Benzo(a)pyrene	mg/kg	0.02	-
Total Polychlorinated biphenyl (PCB) ±	mg/kg	-	0.06
Oil Product††	mg/kg	1,000	1,000
Phenols±±	mg/kg	-	-

Continued...

Parameter	Unit	Russian National Limits for Chemicals in Soil*	
		MPC level (Ref. 8.13)	APC (Ref. 8.14)
Hexachlorobenzene, HCB***	mg/kg	0.03	0.03
Hexachlorocyclohexane, HCH***	mg/kg	0.1	0.1
Heptachlor***	mg/kg	0.05	0.05
Total DDT (including DDD and DDE)***	mg/kg	0.1	0.1

* Russian APC levels vary depending on the soil type encountered (e.g. APC levels may vary depending on whether soils are silty-sandy and sandy soils, sandy loamy soils or loam soil etc.). APC levels presented in Table 8.1 above are representative of clayish and loamy soils with pH>5.5 which are representative of soils in the landfall section (Ref. 8.13).
** In the absence of a soil standard for chromium, the sediment standards (Table 8.4) shall be adopted.
† Soil standards are not applicable for iron as concentrations are primarily controlled by the underlying geology rather than reflecting anthropogenic influences.
± APC levels for total PCBs are taken from the Russian Order of the State Committee for Ecology of Russian Federation from 13.04.99 No. 165 (taken from Ref. 8.25).
†† Permissible Levels of Oil Products are taken from a Letter of the Ministry of Environment and Natural Resources (Ref. ±±8.2, provided within Peter Gaz report Ref. 8.1).
In the absence of a soil standard for phenols, the sediment standards (Table 8.4) shall be adopted. However, it is also*** noted that phenol in soil may be derived from natural materials as well as or instead of anthropogenic sources.

Complete.

The assessment criteria for groundwater quality have been based on the following guidance:

- Russian standard GN 2.1.5.1315-03, Russian standard SanPiN 2.1.4.1175-02, and WHO Water Quality Guidelines. These standards define the recommended maximum concentrations for various chemical substances in groundwater. These concentrations are based on human health considerations where groundwater is used for potable supply.

Table 8.2 Relevant Groundwater Quality Limits

Parameter	Unit	Russian National Limit Values		WHO Guidelines (Ref. 8.23)
		Sanitary Rules Standard value (Ref. 8.16)	MPC for Potable and Domestic Use (Ref. 8.17)	
Calcium, Ca^{2+}	Milligrams per litre (mg/l)	-	-	-
Magnesium, Mg^{2+}	mg/l	-	50	-
Potassium, K^{+}	Mg/l	-	-	-

Continued…

Parameter	Unit	Russian National Limit Values		WHO Guidelines (Ref. 8.23)
		Sanitary Rules Standard value (Ref. 8.16)	MPC for Potable and Domestic Use (Ref. 8.17)	
Sodium, Na^+	mg/l	-	200	-
Ammonium, NH_4^+	mg/l	-	1.5	-
Chloride, Cl^-	mg/l	350	-	-
Sulphate, SO_4^{2-}	mg/l	500	-	-
Phosphate, PO_4^{2-}	mg/l	-	3.5	-
Nitrate, NO_3^-	mg/l	45	-	50
Nitrite, NO_2^-	mg/l	-	3.3	3
Hydrogen carbonate, HCO_3-	mg/l	-	-	-
pH	pH units	6 – 9	-	-
Permanganate oxygen demand	mg/l	5 – 7	-	-
Total salinity level	mg/l	1,000 – 1,500	-	
Chemical Oxygen Demand (COD)	mg O_2/l	-	-	-
Dissolved O_2	mg/l	-	-	-
Mercury, Hg	µg/l	-	0. 5	6
Arsenic, As	µg/l	-	10	10
Chromium, Cr	µg/l	-	50	50
Silica, Si	mg/l	-	10	-
Cadmium, Cd	Micrograms per litre (µg/l)	-	1	3
Lead, Pb	µg/l	-	10	10

Continued...

Parameter	Unit	Russian National Limit Values		WHO Guidelines (Ref. 8.23)
		Sanitary Rules Standard value (Ref. 8.16)	MPC for Potable and Domestic Use (Ref. 8.17)	
Nickel, Ni	µg/l	-	20	70
Iron, Fe	mg/l	-	0.3	-
Manganese, Mn	µg/l	-	100	400
Copper, Cu	µg/l	-	1,000	2,000
Zinc, Zn	µg/l	-	1,000	-
Benzo(a)pyrene	µg/l	-	0. 01	7
Oil products	µg/l	-	0.3	(0.01)*
Organochlorine pesticides (OCPs)	µg/l	-	-	(0.03)**
Anionic surfactant	mg/l	-	0.5	-
Phenols	µg/l	-	100	-
Total polychlorinated biphenyl (PCBs)	µg/l	-	-	-
Hexachlorobenzene (HCB)	µg/l	-	1	-
Gamma-hexachlorocyclohexane (γ-HCH)	µg/l	-	20	2†
Dichlorodiphenyltrichloroethane (DDT) compounds (including dichlorodiphenyldichloroethylene (DDE) and dichlorodiphenyldichloroethane (DDD)	µg/l	-	100	1

* There is no WHO standard specified for petroleum hydrocarbons. The adopted value presented here is based on the WHO standard for Benzene (a common component found in petroleum hydrocarbons) and guidance on acceptability for potable supply based on taste and odour.
** There is no WHO standard specified for total organochlorine pesticides. The adopted value presented here is based on the WHO standard for Aldrin and Dieldrin, which is the most stringent of the available WHO standards for organochlorine pesticide compounds.
† WHO value for γ-HCH. No values for α-HCH or β-HCH given in WHO standards.

Complete.

The assessment criteria for surface water quality have been based on the following guidance:

- Russian standard SanPiN 2.1.5.980-00, Russian standard GN 2.1.5.1315-03, Order of the Federal Fisheries Agency No. 20, and WHO Water Quality Guidelines. These standards define the recommended maximum concentrations for various chemical substances in surface waters. These concentrations are based on human health, amenity and ecological considerations.

Table 8.3 Relevant Surface Water Quality Limits

Parameter	Unit	Russian National Limit Values			WHO Guidelines (Ref. 8.23)
		Permissible Level for Hygienic Requirements (Ref. 8.18)	MPC level for Potable and Domestic Use (Ref. 8.17)	MPC level Fishery Water Bodies (Ref. 8.19)	
Calcium, Ca^{2+}	mg/l	-	-	180	-
Magnesium, Mg^{2+}	mg/l	-	50	40	-
Potassium, K^+	mg/l	-	-	50	-
Sodium, Na^+	mg/l	-	200	120	-
Ammonium, NH_4^+	mg/l	-	1.5	0.5	-
Chloride, Cl^-	mg/l	-	350	300	-
Sulphate, SO_4^{2-}	mg/l	-	500	100	-
Phosphate, PO_4^{3-}	mg/l	-	3.5	0.15	-
Nitrate, NO_3^-	mg/l	-	45	40.0	<50
Nitrite, NO_2^-	mg/l	-	3.3	0.08	<3
Hydrogen carbonate, HCO_3^-	mg/l	-	-	-	-
pH	pH units	6.5 - 8.5	-	-	-
Permanganate demand	mg O_2/l	-	-	-	-
COD	mg O_2/l	15.0 - 30.0	-	-	-

Continued...

Parameter	Unit	Russian National Limit Values			WHO Guidelines (Ref. 8.23)
		Permissible Level for Hygienic Requirements (Ref. 8.18)	MPC level for Potable and Domestic Use (Ref. 8.17)	MPC level Fishery Water Bodies (Ref. 8.19)	
Dissolved O_2	mg O_2/l	>4	-	-	-
Total salinity level	mg/l	1,000	-	-	
Biological oxygen demand (BOD)	mg/l	2.0 – 4.0		-	-
Mercury, Hg	µg/l	-	0.5	0.01	6
Arsenic, As	µg/l	-	10	50	10
Chromium, Cr	µg/l	-	50	20	50
Silica, Si	µg/l	-	10	-	-
Cadmium, Cd	µg/l	-	1	5	3
Lead, Pb	µg/l	-	10	6	10
Nickel, Ni	µg/l	-	20	10	70
Iron, Fe	mg/l	-	0.3	0.1	-
Manganese, Mn	µg/l	-	100	10	400
Copper, Cu	µg/l	-	1,000	1	2000
Zinc, Zn	µg/l	-	1,000	10	-
Oil products	mg/l	-	0.3	0.05	(0.01)
OCPs	µg/l	-	-	-	(0.03)
Anionic surfactant	mg/l	-	0.5	0.5	-
Phenols	µg/l	-	100	1	-
Benzo(a)pyrene	µg/l	-	0. 01	0. 01	<7

Continued…

Parameter	Unit	Russian National Limit Values			WHO Guidelines (Ref. 8.23)
		Permissible Level for Hygienic Requirements (Ref. 8.18)	MPC level for Potable and Domestic Use (Ref. 8.17)	MPC level Fishery Water Bodies (Ref. 8.19)	
HCB	µg/l		-	1	-
HCH compounds	µg/l		-	20	2*
DDT compounds (including DDE and DDE)	µg/l		-	100	1

* Based on value for γ-HCH. No values for α-HCH or β-HCH given.

Complete.

In the absence of official Russian standards for stream bed sediments, the standards for the streambed sediments have been based on the current Dutch and Canadian guidelines (Refs. 8.26, 8.27 and 8.28). The Dutch guidelines apply to both soils and aquatic sediments and were derived primarily on human toxicological grounds; these values are widely used throughout Europe. It should be noted that these values are based on standard soil comprising 10% organic matter and 25% clay; the target values may be factored according to the measured organic matter and clay content of the individual sediment samples where sediments differ substantially from the assumed standard soil. The values based on the Canadian interim sediment quality guidelines apply solely for aquatic sediments and are derived primarily on ecotoxicological grounds. Using both standards allows characterisation of baseline sediment quality in the context of the environment in the Study Area.

Table 8.4 Adopted Stream Bed Sediment Quality Limits

Parameter	Unit	Target Level (Ref. 8.26)	Guideline Level (Ref. 8.28)
Arsenic, As	mg/kg	29	5.9
Cadmium, Cd	mg/kg	0.8	0.6
Lead, Pb	mg/kg	85	35
Mercury, Hg	mg/kg	0.3	0.17
Zinc, Zn	mg/kg	140	123
Chromium, Cr	mg/kg	100	37.3

Continued…

Parameter	Unit	Target Level (Ref. 8.26)	Guideline Level (Ref. 8.28)
Copper, Cu	mg/kg	36	35.7
Nickel, Ni	mg/kg	35	NA
Benzo(a)pyrene*	mg/kg	1	0.0319
Oil products	mg/kg	50	NA
Phenol	mg/kg	0.05	NA
Total PCBs	mg/kg	0.02	0.0341
Hexachlorobenzene, HCB	mg/kg	0.03	NA
α-HCH	mg/kg	0.003	0.00094
β-HCH	mg/kg	0.009	0.00094
γ-HCH	mg/kg	0.00005	0.00094
Heptachlor	mg/kg	0.0007	4
Aldrin	mg/kg	0.00006	NA
Dieldrin	mg/kg	0.0005	0.00285
DDT (total, including DDD and DDE)	mg/kg	0.01	0.00119

* The published sediment standard does not include specific limits for Benzo(a)pyrene. Therefore, the limits for Total Polycyclic aromatic hydrocarbons (PAHs) have been adopted here.

Complete.

8.5.2 Soils

8.5.2.1 Soil Types

Soil types in the survey area have been categorised according to the World Reference Base for Soil Resources (WRB) published by the Food and Agricultural Organisation of the United Nations, International Union of Soil Sciences and the International Soil Reference and Information Centre (Ref. 8.29). The soil types include: cambisols, phaeozems, arenosols, fluvisols, abrazems/regosols and anthropogenic soils, as described in Table 8.5. The soil cover is typically formed through the degradation of the underlying geology. **Chapter 7 Physical and Geophysical Environment** describes the geology and geomorphology of the Study Area.

The distribution of soil cover within the Study Area is presented in Figure 8.2 the distribution has been assessed through field mapping and soil logging. Locations of the soil survey points are shown on Figure 8.1. Bedrock is locally exposed on the steeper slopes of the river valleys and along the coast.

Agricultural areas (principally vineyards) in the Study Area are predominantly located on arenosols and abrazem/regosols. Vineyard development usually involves one-time ploughing to around 0.6 m followed by annual tillage to 0.3 m (Ref. 8.1).

Table 8.5 Summary of Soil Types within Study Area

Soil Type	Comments
Cambisols	Cambisols originate from the weathering of underlying parent rock material and form a residual weathered soil that comprises sandy silts and clays. Cambisols still retain some of the original rock structure (e.g. bedding or evidence of jointing/fracturing).
Phaeozem Soils	Phaeozem soils comprise a dark organic (humus) rich topsoil layer, covered in vegetation, including grass, plants and trees. These soils are typically 0.3 to 0.35 m thick in the Study Area (Figure 8.2) and have a high water absorption capacity and low permeability. Eluvial Phaeozem soils are derived from either the in-situ weathering of underlying bedrock or the weathering of bedrock combined with limited movement or accumulation of the soils due to gravitational creep on gently inclined slopes. Diluvial-Colluvial Phaeozem soils are derived from the erosion and removal of underlying bedrock by flood or landslide events. Diluvial deposits comprise soils which are deposited on alluvial floodplains as a result of sudden flood events, and colluvial deposits comprise typically loose, unconsolidated soils deposited in accumulation fans at the base of hill slopes by run-off, landslides or slope creep.
Arenosols	Arenosol soils are predominantly sandy in composition (typically >65%) and lack any substantial soil profile and structure. In the Study Area these are typically concentrated in areas associated with flat or gentle terrace slopes located between watercourses.
Fluvisols	Fluvisols soils are typically located on alluvial floodplains, river fans, valleys and tidal marshes. They form on alluvial soils and can be mixed in with flood surge deposits. Deposits include loam, silts and sandy clays to clayey sands.
Abrazems/Regosols	Abrazem soils are a poorly developed, unconsolidated (loose) soil, which exhibit no diagnostic horizons. Abrazems are formed as a result of erosion of loose rocks (such as loess, alluvium or sand deposits). Soils are typically formed through landslide and flooding events.

Continued…

Soil Type	Comments
Anthropogenic Soils	Anthropogenic soils are soils that have been modified by human activity. Within the Study Area, these include soils that have been reworked (not including agricultural activity like ploughing), imported man-made fill and other materials (such as pavements and hard-standing). These soils are typically confined to areas of urban construction and activity, such as the town of Varvarovka (to the north of the Pipeline route), and the coastal access road. No substantial areas of anthropogenic soils have been identified within the Study Area to date.

Complete.

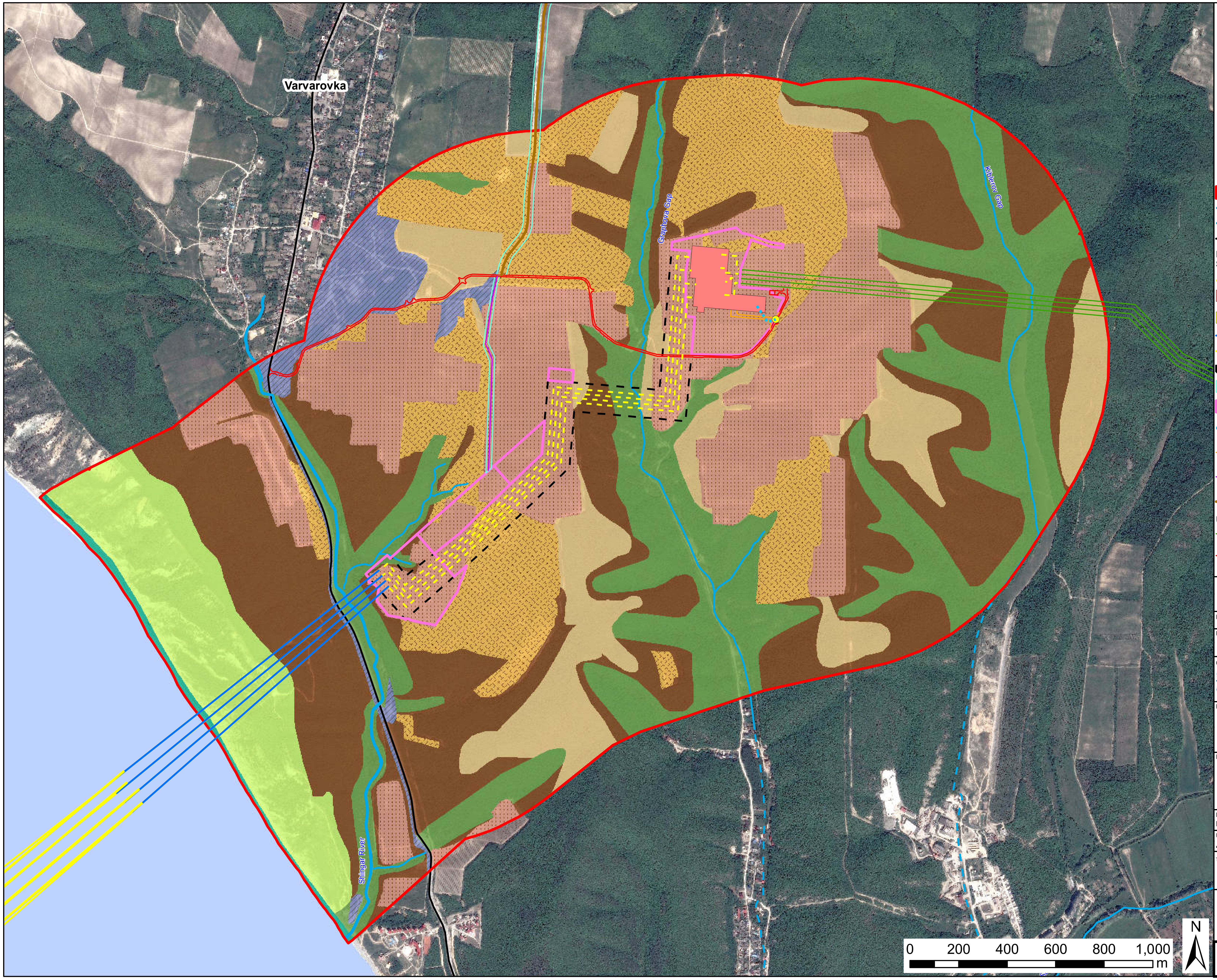
8.5.2.2 Soil Quality

The agrochemical assessment of soils in the Survey Area (Ref. 8.1, 8.8) included the testing of 40 samples from 21 locations. The soils are alkaline, with pH values ranging from 7.22 to 8.8. There was limited variation in soil salinity observed. The soils were typically loams, with fine-grained (<0.01 mm) sediment contents in the range 2.6 to 79.5% but typically around 50 to 75%; the agricultural soils tended to have lower clay contents.

The soils in the agricultural areas had humus content ranging from 1.8 to 6.62%. The phaeozems had humus contents of 3.8 to 7.42%. The fluvisols had humus contents of 3.07 to 5.82%. The soils are characterised by reasonably high nutrient levels (Ref. 8.1, 8.8).

During the 2010 and 2011 surveys, a total of 27 soil samples were also collected for laboratory testing of potential contaminants (Ref. 8.1). During the 2013 survey an additional 15 composite samples were also collected for laboratory testing (Ref. 8.8).

All soil samples were analysed to determine the presence and concentration of a suite of potential contaminants. The results of the analysis were compared with Russian MPC (Ref. 8.13) and APC (Ref. 8.14) levels (Table 8.1). The results of the laboratory analysis are shown in Table 8.6 and the locations of exceedances are shown on Figure 8.3.



LEGEND

Soil Type *

- Diluvial-Colluvial Phaeozems
- Eluvial Phaeozems
- Cambisols
- Anthropogenic Soils
- Fluviosols
- Seashore Deposits

Agricultural Soils

- Arenosols
- Abrazem/Regosol

* Majority of agricultural soils are arenosols and abrazem/regosols.

- Study Area
- Rivers
- Inferred watercourses
- Main roads

Russian Sector of South Stream Offshore Pipeline

- Proposed landfall section pipelines
- Landfall facilities
- Anode bed for cathodic protection of landfall section pipelines
- Proposed microtunnels
- Proposed offshore pipelines
- Construction corridor
- 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)

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
DISTRIBUTION OF SOILS
IN THE STUDY AREA

Drawn	Checked	Approved	Date
DH	RW	MW	18/02/2014

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

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Drawing Number
Figure 8.2
Rev

Plot Date: 18 Feb 2014
File Name:I:\5004 - Information Systems\46369082_South_Stream\MXDs\Report Maps - Russia\Russian ESIA v2\Chapter 8 Soil and Groundwater\Figure 8-2 Distribution of Soils in the Study Area (landfall section).mxd

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Table 8.6 Soil Survey Results

Parameter	Unit	Range of concentrations recorded (minimum – maximum) (Ref. 8.1)	No. of exceedances of National Limit Values (Ref. 8.13 and 8.14)
pH	-	7.1 – 8.07	0
Arsenic, As	mg/kg	0.8 – 2.4	2 samples exceeded MPC levels (2 mg/kg)
Cadmium, Cd	mg/kg	0.14 – 1.03	0
Copper, Cu	mg/kg	12.2 – 194.0	3 samples exceeded APC levels (132 mg/kg)
Chromium, Cr	mg/kg	5.4 – 43	No soil standard but 2 samples exceed adopted sediment standard (37.3 mg/kg)
Nickel, Ni	mg/kg	10 – 31.7	0
Lead, Pb	mg/kg	3.6 – 380	1 sample exceeded MPC level (32 mg/kg)
Zinc, Zn	mg/kg	25 – 250	1 sample exceeded APC level (220 mg/kg)
Mercury, Hg	mg/kg	0.01 – 0.05	0
Manganese, Mn	mg/kg	140 – 409	0
Iron, Fe	mg/kg	6,500 – 15,580	n/a
PCB	mg/kg	<0.0005 – 1.2392	5 samples exceeded APC levels (0.06 mg/kg)
Phenols	mg/kg	0.17 – 25.34	No soil standard but all samples exceed adopted sediment standard (0.05 mg/kg)
Benzo(a)pyrene	mg/kg	<0.0012 – 0.025	4 samples exceeded MPC levels (0.02 mg/kg)
Oil Product	mg/kg	7 - 59	0

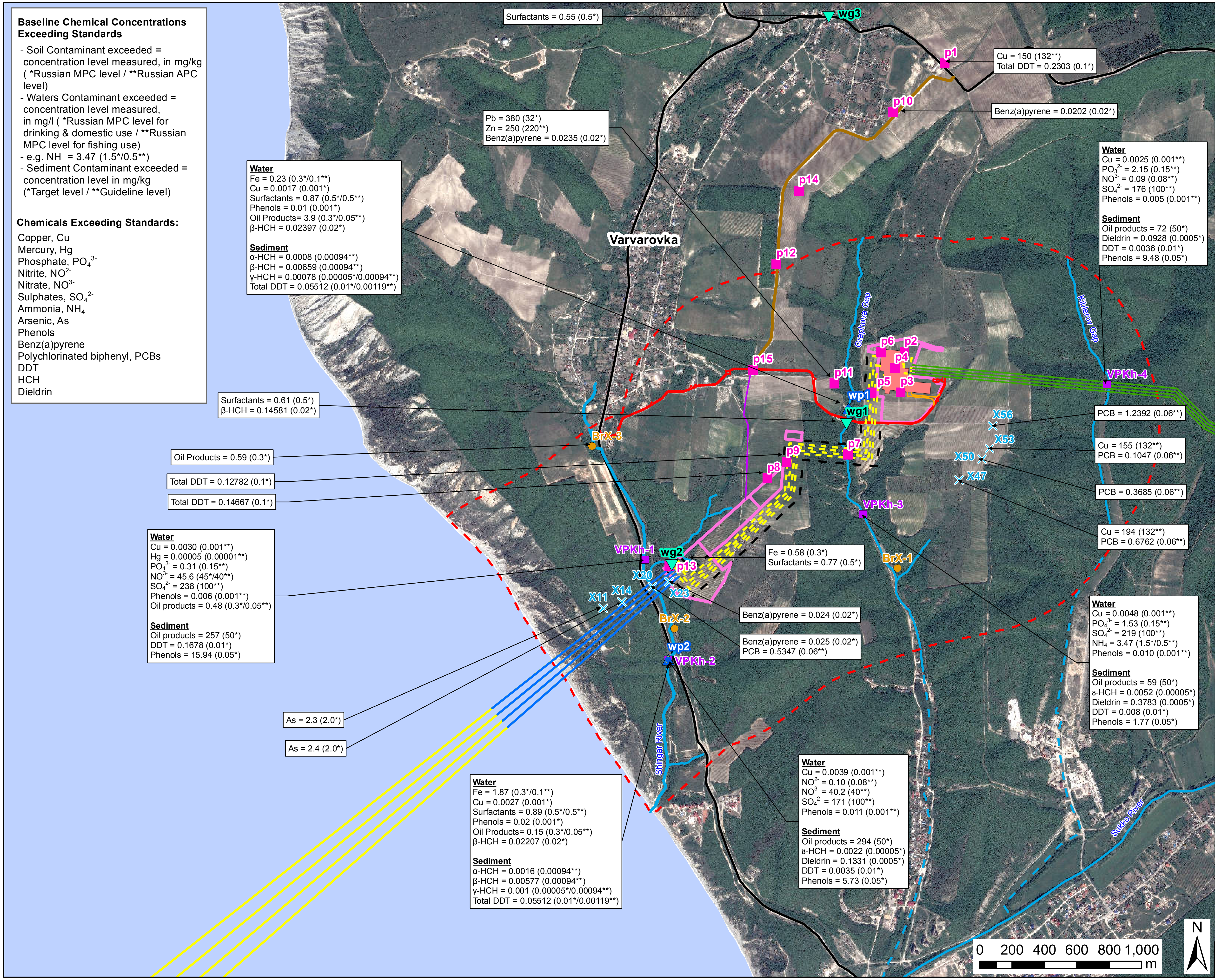
Continued...

Parameter	Unit	Range of concentrations recorded (minimum – maximum) (Ref. 8.1)	No. of exceedances of National Limit Values (Ref. 8.13 and 8.14)
HCB	µg/kg	<0.05 – 1.21	0
α-HCH	µg/kg	<0.05 – 3.16	0
β-HCH	µg/kg	<0.05 – 43.68	0
γ-HCH	µg/kg	<0.05 – 2.01	0
Total DDT (including DDD and DDE compounds)	µg/kg	0.006 – 0.230	3 samples exceeded MPC levels (0.1 mg/kg)

Complete.

The general pre-existing characteristics of the terrestrial soils in the Study Area are as follows:

- Elevated copper levels were measured in excess of the APC threshold in reworked soils. This may be associated with the use of agrochemicals in vineyard areas (in the northeast of the Survey Area, to the south of the connection pipes linking the onshore pipelines to the Russkaya Compressor station);
- Arsenic levels exceeded MPC thresholds in soil samples taken adjacent to the coastal road. A definitive source for the elevated arsenic has not been identified but a plausible mechanism is surface deposition associated with motor vehicle emissions;
- Benzo(a)pyrene levels exceeded MPC thresholds adjacent to the coastal road. Again this may be as a result of motor vehicle emissions;
- PCB levels exceeded the APC threshold level in the vineyard area in the northeast of the Survey Area, and in a single sample taken at the location of where the pipelines cross the Shingar River. A definite on-site source for the PCBs has not been identified, although the location of the exceedances suggests it may relate to agricultural activities;
- Lead and zinc exceeded the MPC and APC threshold, respectively, in a single sample taken from west of the landfall facility and Graphova Gap. Elevated levels of benzo(a)pyrene were also found in the same location;
- Pesticides were detected in three soil samples, all located in agricultural areas;
- It should be noted that the contamination concentrations for soil samples collected in valley bottoms may not necessarily be due to an immediately adjacent source but, may reflect transport of soils from upstream in the catchment through surface run-off or flood events; and
- In addition to the chemical testing above, local areas of informal waste deposition ('flytipping') have been observed, including an in-filled ditch (Ref. 8.30). The materials observed include demolition wastes. There is a potential for contaminants including asbestos to be present in these materials.



LEGEND

2013 Survey
- wp1 - Surface water sampling point
- wg1 - Groundwater sampling point
- p1 - Soil quality sampling point

Soil
- X1 - Soil sampling point (2010 survey)
- БГХ-1 - Groundwater sampling point
- VPKh-1 - Surface water sampling point
- Study Area
- Rivers
- Inferred watercourses
- Main roads

Russian Sector of South Stream Offshore Pipeline
- Proposed landfall section pipelines
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Projection: Lambert Conformal Conic

Revision Details	By Check	Check Date	Suffix

Purpose of Issue: For Information

Client: South Stream Offshore Pipeline — Energising Europe

Project Title: SOUTH STREAM OFFSHORE PIPELINE

Drawing Title: LOCATION OF SOIL, GROUNDWATER, SURFACE WATER AND SEDIMENT SAMPLES EXCEEDING QUALITY STANDARDS

Drawn	Checked	Approved	Date
AH	RW	MW	18/02/2014

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Drawing Number	Rev
Figure 8.3	

Plot Date: 18 Feb 2014
File Name:I:\5004 - Information Systems\46369082_South_Stream\MXDs\Report Maps - Russia\Russian ESIA v2\Chapter 8 Soil and Groundwater\Figure 8-3 Location of Soil, Groundwater, Surface Water and Sediment Samples Exceeding Quality Standards.mxd

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8.5.3 Groundwater

8.5.3.1 Hydrogeological Regime

The hydrogeology of the Study Area is characterised by local shallow alluvial aquifers overlying a carbonate aquifer within the bedrock (Ref. 8.1, 8.12).

The alluvial aquifer is present along the narrow (typically less than 200 m wide) river valleys of the Shingar River and an unnamed tributary of the Sukko River. The extent of the alluvial aquifers, in plan view, i.e. looking from above not in cross-section, is anticipated to broadly mirror the distribution of fluvisols (Figure 8.2).

The carbonate aquifer extends across the entire Study Area and beyond into the wider region. The aquifer may be locally subdivided by changes in lithology and faulting. The bedrock strata are locally exposed in the valley walls. The groundwater may be locally at or close to ground level at the base of the valleys. This is implied by the presence of springs. Borehole drilled along (Ref. 8.10, 8.12) the alignment of the proposed microtunnels confirmed that groundwater within the alluvial aquifers is within 10 m of ground level and is sometimes at or near ground level.

The hydraulic conductivity of the alluvium is up to 40 metres per day (m/d) and the saturated thickness of the alluvial aquifer in the Study Area is typically in the order of 4 to 6 m, but may be significantly thicker locally (Ref. 8.10, 8.12). Groundwater recharge to the alluvial aquifer is via rainfall and discharge from surface watercourses along their upper reaches. The alluvial aquifer is anticipated to be in at least partial hydraulic connection with the carbonate aquifer given the bedrock is locally at or near surface. The degree of connection will vary spatially and potentially also seasonally.

Groundwater flow within the underlying carbonate aquifer is controlled by a network of fractures within folded and fractured sedimentary bedrock deposits. The geology is dominated by marls[1] but there are also limestone and sandstone beds. Owing to the nature of the local geology, it is likely that the carbonate aquifer comprises a multi-layered aquifer system with varying permeability in the different lithologies present. Groundwater flow is likely to be predominantly through the more permeable horizons such as the sandstones and limestones compared with the lower permeability marls and argillaceous strata. Faults and fracture zones have been mapped within the Study Area as described in **Chapter 7 Physical and Geophysical Environment**; key areas include around the Marfovsky Fault, which crosses the Graphova Gap near the proposed road crossing, and around the Shingar valley (the valley is aligned with the Shingarsky Fault). Additional zones of higher permeability and of increased hydraulic connectivity between individual geological units may occur in these faults and the associated fracture and fissure zones. No evidence of karstic features, i.e. area of limestone in which erosion has produced fissures or caverns, has been observed in the Study Area (Ref. 8.1).

[1] Assumed from description as "chalky clay"

The anticipated depth to the water table varies between ground level to a few metres deep along the valley floors (where groundwater is in hydraulic continuity between the alluvium and carbonate aquifers) and up to 100 m beneath the higher areas along the interfluves (Ref. 8.12). Water levels measured during drilling (Ref. 8.12) included strikes at multiple depths within the same borehole; this is consistent with a layered aquifer system.

Recharge to the aquifers is via rainfall, through groundwater flow from up-hydraulic gradient and recharge from the watercourses in the base of the valleys.

Groundwater discharges to the surface watercourses via ephemeral springs.

8.5.3.2 Abstractions

The groundwater abstraction associated with the proposed Russkaya Compressor station is located approximately 5 km to the northeast of the landfall section (Ref 8.3). The abstraction is used for drinking water and industrial purposes for the Russkaya compressor station. The Project does not lie within the designated sanitary protection zone for this abstraction.

The nearby vineyard, Agrofirma Kavkaz, sources the majority of its water from the Supsekh municipal water supply system with the remainder of the water being obtained from the unlicensed surface water abstraction (Section 8.5.5.3) (Ref. 8.4). This abstraction is understood to be upstream of the Project Area (Ref. 8.4).

The majority of the water supply for the neighbouring residential area of Varvarovka is sourced from the Supsekh[2] municipal water supply system with the remainder being supplied by the Kavgaz water supply system (Ref. 8.4).

The terrestrial part of the landfall section does not lie within a source (sanitary) protection zone associated with a groundwater abstraction.

The proposed source of potable water for the Project is from an existing water supply at Sukko. This water supply is understood to be owned by the Russian Ministry of Defence but is also utilised by third parties.

Information has been provided (Ref. 8.7) for three boreholes, named operational borehole No.2P (also referred to as No.2), No.4D (also referred to as No.4) and No.4P. The boreholes are located within the Kiblerova valley in the northern part of the town of Sukko; the bores are located is approximately 2 km south of the proposed landfall facilities. Records indicate that No.2P is furthest south, with No.4P and No.4D located further to the north. The boreholes are close to the unnamed tributary of the Sukko River and are about 600 m from the main Sukko River. There is a 50 m radius protection zone around the borehole.

The operational borehole, No.2P (Reference code 34629), was drilled to a depth of 60 m in 2003. The geological log indicates that the upper 32 m comprised clay loam, overlying 6 m of poorly sorted cobbles, gravel and sand (probably weathered and fractured bedrock or scree

[2] Supsekh is located to the north of Varavrovka

deposited during the original erosion of the valley), in turn overlying 22 m interbedded mudstones, marls and fractured sandstones of Upper Cretaceous age. The geology is consistent with the conceptual model of the regional hydrogeology of alluvial aquifer in valleys over sedimentary bedrock aquifer.

The borehole construction of No.2P consists of 219 millimetres (mm) solid casing to a depth of 33 m, with a 4.5 m screened section to a depth of 37.5 m. The borehole is 190.5 mm diameter open hole from a depth of 38 m to the base of the hole at 60 m depth. Therefore, the water is abstracted primarily from the bedrock aquifer. Hydraulic testing of the borehole was undertaken in February 2003. Borehole No.2P was airlifted for 48 hours at a flow rate of 1.5 litres per second (l/s), around 130 cubic metres per day (m^3/day), which, created a drawdown of 8 m from the rest groundwater level of 13 m depth i.e. a pumping groundwater level of 21 m depth. Therefore the specific capacity of the borehole was estimated to be 0.19 litres per second per metre (l/s/m). It was recommended that the pump should be set at a depth between 25 and 30 m depth i.e. within the solid casing. However, it is uncertain if the current pump is installed within that depth range.

Borehole No.4D is an exploration borehole that was drilled in 1996; it is assumed that this borehole still exists. It had a diameter of 324 mm to 19 m depth and then a 219 mm diameter to the end of the borehole at 60 m depth, with screened horizons between 25 to 30 m and 52 to 57 m depth. The rest groundwater level before pumping was recorded as 0.3 m depth and the pumping water level as 15.5 m depth. However, the abstraction rate was not recorded.

Borehole No.4P is an exploration borehole for fresh water that was drilled in 1981; it is assumed that this borehole still exists. It has a diameter of 325 mm to 22.8 m depth and a 168 mm diameter to the end of the borehole at 27 m depth, with a screened horizon between 22.8 and 27.0 m. The rest groundwater level before pumping was 0.6 m depth and the pumping water level was 12.9 m depth. However, the abstraction rate was not recorded.

Abstraction from the Sukko source is seasonally restricted. Water may only be abstracted between October and April; it is understood that the restriction on summer abstraction is in place to prevent derogation of the aquifer.

8.5.3.3 Groundwater Quality

During the 2010 survey, groundwater samples were taken from three ephemeral springs (one sample per spring), the locations of which are shown in Figure 8.1[3]. During the 2013 survey, groundwater samples were taken from three additional springs, the locations of which are also shown on Figure 8.1. The springs are located in the valleys. There is uncertainty as to whether the groundwater emerges from the alluvial or bedrock aquifers; this may vary from spring to spring and may also change seasonally. The groundwater samples were analysed to determine the presence and concentration of a range of major ions, metals and organic compounds. The results were compared with Russian water quality standards for potable and amenity use (in Section 8.5.1); the results were subsequently compared with the WHO standards, where appropriate. The groundwater quality results are summarised in Table 8.7.

[3] The groundwater samples are labelled ВГХ on the figure for ease of comparison with survey data and with EIA.

Table 8.7 Groundwater Quality Results

Parameter	Unit	Range of concentrations recorded (minimum – maximum) 2010 (Ref. 8.1)	Range of concentrations recorded (minimum – maximum) 2013 (Ref. 8.8)	No. of exceedances of Quality Limit Values (Ref. 8.16, 8.17, 8.23)
Calcium, Ca^{2+}	mg/l	71.0 – 99.2	88.2 – 155	n/a*
Magnesium, Mg^{2+}	mg/l	10.44 – 22.94	12.7 – 19.8	0
Potassium, K^{+}	mg/l	2.7 – 11.6	-	n/a
Sodium, Na^{+}	mg/l	4.29 – 9.81	1.6 – 120**	0
Ammonium, NH_4^{+}	mg/l	0.15 – 0.17	0.21 – 0.81	0
Chloride, Cl^{-}	mg/l	55 – 103	41 – 106	n/a
Sulphate, SO_4^{2-}	mg/l	142 – 187	25 – 48	0
Phosphate, PO_4^{3-}	mg/l	0.31 – 0.92	<0.01	0
Nitrate, NO_3^{-}	mg/l	2.6 – 29.6	1.4 – 4.9	0
Nitrite, NO_2-	mg/l	0.06 – 0.07	<0.01 – 0.026	0
Hydrogen carbonate, HCO_3-	mg/l	378.2 – 463.6	376 – 429	n/a
pH	pH units	6.8 – 6.9	6.8 – 7.7	0
Permanganate demand, MnO4-	mg O2/l	4.7 – 5.5	1.03 – 3.1	0
COD	mg O2/l	<10	9.4 – 35	n/a
Suspended solids	mg/l	7.9 – 128.6	n/a	0
Dissolved O_2	mg/l	5.6 – 6.9	4.5 – 7.35	n/a
Mercury, Hg	µg/l	<0. 05	<0.01	0
Arsenic, As	µg/l	<5	<2	0
Chromium, Cr	µg/l	<1 –1	<0.3	0

Continued…

Parameter	Unit	Range of concentrations recorded (minimum – maximum) 2010 (Ref. 8.1)	Range of concentrations recorded (minimum – maximum) 2013 (Ref. 8.8)	No. of exceedances of Quality Limit Values (Ref. 8.16, 8.17, 8.23)
Silica, Si	mg/l	5.23 – 7.05	4.67 – 5.38	0
Cadmium, Cd	µg/l	0. 14 – 0. 23	<0.07 – 0.18	0
Lead, Pb	µg/l	<1	<1	0
Nickel, Ni	µg/l	<1	<3	0
Iron, Fe	mg/l	<0.05	0.12 – 0.58	1 sample exceeds domestic drinking and amenity MPC levels (0.3 mg/L)
Manganese, Mn	µg/l	<1 –6	<0.6	0
Copper, Cu	µg/l	0. 8 – 2.6	2.2 – 3.5	0
Zinc, Zn	µg/l	<55	<0.5 – 1.7	0
Oil products (hydrocarbons)	mg/l	0.08 – 0.59	0.17 – 0.27	1 sample exceeds domestic drinking and amenity MPC levels (0.3 mg/L)
Anionic surfactant	mg/l	<0.1	0.55 – 0.77	3 samples exceed domestic drinking and amenity MPC levels (0.5 mg/L)
Phenols	µg/l	3 –5	8 – 24	0
PCBs	µg/l	<0. 01	0.0013 – 0.00255	n/a
Benzo(a)pyrene	µg/l	<0. 0005 – 0. 001	<0.001 – 0.002	0
Total Salinity / Mineralisation	mg/l	656 - 764	n/a	0
α-HCH	µg/l	-	0.22 – 4.59	n/a

Continued…

Parameter	Unit	Range of concentrations recorded (minimum – maximum) 2010 (Ref. 8.1)	Range of concentrations recorded (minimum – maximum) 2013 (Ref. 8.8)	No. of exceedances of Quality Limit Values (Ref. 8.16, 8.17, 8.23)
β-HCH	µg/l	-	8.1 – 145.81	1 sample exceeded domestic drinking and amenity MPC (20 µg/L)
γ-HCH	µg/l	-	0.19 – 2.67	2 samples WHO standard (2 µg/L)
HCB	µg/l	-	0.2 – 0.26	0
2,4-DDE	µg/l	-	0.06 – 0.13	0
4,4-DDE	µg/l	-	0.95 – 8.65	2 samples WHO standard (1 µg/L)
2,4-DDD	µg/l	-	<0.05	0
4,4-DDD	µg/l	-	<0.05 – 2.09	2 samples WHO standard (1 µg/L)
2,4-DDT	µg/l	-	0.16 – 0.31	0
4,4-DDT	µg/l	-	0.84 – 1.21	2 samples WHO standard (1 µg/L)
Individual Pesticides†	µg/l	-	<0.05	None detected±
Total OCPs	µg/l	<0.01	-	0

* n/a: Not assessed, as no value provided in relevant standards.
** n/a: Total of potassium and sodium.
† Pentachlorobenzene, Heptachlor, Aldrin, Heptachlor Epoxy, Methoychlor, Trans-chlordan, Cis-chlordan, Trans-nonachlor and Mirex.
± Detection limit exceeded OCP standard of 0.01 µg/L.

Complete.

The general pre-existing characteristics of groundwater from the sampled springs in the Study Area are as follows:

- Typically clear in colour, pH neutral (pH 6.8 to 6.9), and is fresh in composition (salinity content 656 to 764 mg/l);
- Groundwater has a strong calcium hydrocarbonate chemical signature, indicating aquifers in the Survey Area typically comprise soils or rock rich in calcium carbonate;

- A single sample exceeded the iron MPC for drinking and domestic water quality standards (Ref. 8.17), where a level of 0.58 mg/l was recorded compared to a threshold value of 0.3 mg/l. No other heavy metals were detected at elevated concentrations;
- A single sample (taken 0.2 km south of Varvarovka) exceeded the hydrocarbon MPC for drinking and domestic water quality standards (Ref. 8.17), where a level of 0.59 mg/L was recorded compared to a MPC threshold value of 0.3 mg/l. All three samples exceed the WHO standard for benzene (0.01 mg/l), which has been applied as a surrogate standard in the absence of a WHO standard for petroleum hydrocarbon. Petroleum hydrocarbons at the measured concentrations may also not be suitable for potable supply on the grounds of taste and odour;
- All three 2013 survey samples exceeded the anionic surfactant MPC for drinking and domestic water quality standards;
- Pesticides were detected in two samples during the 2013 survey. These reflect the agricultural nature of the catchment; and
- There were no other exceedances where screening criteria are available (Refs. 8.16, 8.17 and 8.23). PCBs were detected, albeit in low concentrations, during the 2013 survey.

Water quality samples from operational borehole No. 2P at Sukko were recently tested to check for compliance against drinking water standards[4] (Ref. 8.6). Samples were collected from the "clear water reservoir" in May and July 2013. Additionally a sample was obtained from the "communal (network)" in July 2013. No groundwater quality data from July 2013 was provided. However, according to the data table for the May 2013 sample, the water quality measurements were within the acceptable range for potable use. The groundwater was slightly alkaline (pH 7.5), mineralised (838 mg/l) and of calcium bicarbonate type; the water quality was similar to that measured within the Survey Area[5]. The water quality at the Sukko water supply source is required to be monitored at least annually.

8.5.4 Surface Water

8.5.4.1 Surface Water Bodies

Two watercourses, the Shingar River and an unnamed tributary of the Sukko River that drains the Graphova Gap, will be crossed by the proposed Pipeline route within the Study Area. The locations of these surface watercourses are shown on Figure 8.4. Photographs of the Shingar River and the Graphova Gap are shown in Figure 8.5.

The Shingar River flows south across the Study Area and enters the Black Sea to the south-southwest of the microtunnel entry shaft site. The Shingar River is aligned with the Shingarsky Fault (**Chapter 7 Physical and Geophysical Environment**). The pipelines will be

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[4] SanPin 2.1.4.1074-01 "Drinking water. Health and safety requirements on water quality of centralised water supply systems. Quality control"

[5] Note that the water quality testing for the Sukko borehole did not include testing for some of the types of contaminants detected in the Survey Area such as pesticides or oil products.

microtunnelled beneath the Shingar River. There is a tributary on the eastern side, immediately to the north of the microtunnel entry shaft site and adjacent to the temporary access road route.

The unnamed watercourse in the Graphova Gap runs south across the Study Area then continues to flow south until its confluence with the Sukko River in the town of Sukko. The pipeline will cross this watercourse in open-cut. The watercourse will also be crossed by an access road.

A third watercourse, a tributary which drains the Kiblerova Gap (referred to as the Kiblerova Gap) is located in the Study Area to the east of the landfall facilities. This watercourse does not cross the Project Area but crosses the connection pipeline route to the Russkaya compressor station. The tributary in the Kiblerova Gap enters the Sukko River upstream of the confluence with the Shingar River. The tributary runs close to the water abstraction source in Sukko.

A 50 m wide sanitary protection zone (Ref. 8.20) extends around each of the above watercourses. Within the protection zone all activities are controlled to prevent contamination and silting of the water body, and to conserve the habitat for aquatic biological resources and other flora and fauna.

In accordance with Paragraph 15 and Paragraph 16 of Article 65 of the Water Code of the Russian Federation, the following is prohibited within the borders of water protection zones:

- Use of sewage to fertilise soils;
- Cemeteries, animal burials, production and consumption waste disposal sites, chemical, explosive, toxic, poisonous and toxic substances, radioactive waste disposal facilities;
- Use of aviation to combat pests and plant diseases; and
- Traffic or parking of vehicles (except for special vehicles), with the exception of traffic on the roads and parking on the roads and in specially equipped paved areas.

8.5.4.2 Hydrological Regime

Limited information is available regarding flooding and hydrology associated with the watercourses within the Study Area. There is no long-term monitoring flow or level data. Anecdotal evidence and inferences based on topography and geomorphology have been used to assess the flow regimes.

The Shingar River is approximately 5.5 km long and flows into the sea to the southwest of the landfall section. The source of the river is a spring within the town of Varvarovka, to the north of the proposed Pipeline route. The catchment area upstream of the Pipeline crossing is estimated to be around 9.35 km^2 (Ref. 8.31). The average slope of the catchment is 176% and the slope of the channel in the landfall section is 15% (Ref. 8.31). In the area of the proposed Pipeline crossing, the Shingar River is approximately 1.5 to 3.5 m wide. The valley in the vicinity of the Pipeline route is around 55 to 65 m wide with a floodplain around 1 to 1.5 m above the bank of the river. The river has a weakly meandering form in this area; faulting in the area has influenced erosion patterns and thus the route of the river. The Shingar River has low flow during the summer and autumn months and a more substantial flow during the winter months.

Measured water depths were 0.6 m in December 2010 (Ref. 8.1) and 0.15 m in July 2011 (Ref. 8.31).

Downstream of the landfall section, the Shingar River passes beneath the road to Anapa. The crossing comprises a reinforced concrete overflow structure (4 m wide and 2.4 m high) (Ref. 8.31). The estimated mean low water flow rate is 0.004 cubic metres per second (m^3/s) whereas the estimated high flows are 29.03 m^3/s (10% occurrence) and 39.23 m^3/s (1% occurrence) (Ref. 8.31).

An unnamed tributary of the Sukko River is located 1.5 km to the east of the Shingar River in the Graphova Gap. This watercourse is approximately 2 to 4 m wide, and has ephemeral flow during the summer months and more substantial flow during the winter months. The Pipeline crossing at Graphova Gap is upstream of the mapped floodplain (Ref. 8.1). The catchment upstream of the Pipeline crossing is 1.8 km^2 (Ref. 8.31). The average slope of the catchment is 201% and the slope of the channel where the Pipeline route crosses the watercourse is 55% (Ref. 8.31). The measured water depth was 0.1 to 0.3 m in December 2010; in summer the watercourse is reported to be predominantly dry. The watercourses in the Study Area are typically ephemeral, which means they have a flow regime which is variable and directly related to rainfall patterns, with very low flows during periods of little or no rainfall. The ephemeral nature is primarily due to the small catchment size of the area and the seasonal patterns of precipitation. In addition, surface waters are partly recharged from high groundwater tables, often associated with springs that are encountered across the Study Area. There are springs upstream and downstream of the landfall section.

In addition to the natural watercourses, there are artificial drainage ditches locally within the Study Area. These are understood to be used to manage flood risk locally (Ref. 8.1).

Average annual rainfall in Anapa[6] is 539 mm. December, January and February are typically the wettest months, with precipitation occurring typically 15 days a month. Average monthly rainfall is less than 50 mm even in winter. The majority of precipitation falls as rain. Precipitation may include snow in winter, particularly between November and April. In contrast the monthly average rainfall in August is 15 mm and rain falls on average on six days of the month. The maximum recorded daily precipitation in Anapa is 85.9 mm.

During summer months when precipitation is less and evapotranspiration is higher, most surface water infiltrates the underlying soils with low flows being observed in the watercourses. This typically results in watercourses becoming dry or the formation of discrete pools of water within the river bed.

Surface water flows typically peak during winter months when rainfall is highest. Under extreme rainfall events, flash flooding may occur.

Both surface watercourses flow approximately north to south across the proposed Pipeline route. The route of the proposed Pipeline crosses the watercourses at right angles. The Pipeline will pass beneath the Shingar River in microtunnels; no surface works are planned at the river.

[6] The closest meteorological station to the Study Area, located about 10 km to the northwest

The watercourse in the Graphova Gap will be crossed by the Pipeline using open-cut construction techniques, as well as by the proposed access road to the construction site of the landfall facilities, as shown in Figure 8.4.

There are no licensed surface water abstractions for drinking water supply within the Study Area (Ref. 8.7). There is a small impoundment on the watercourse in the Graphova Gap located immediately upstream of the proposed access road crossing (Figure 8.5). This impoundment structure retains surface water flows to enable abstraction; it is probable the choice of location reflects the likely presence of springs[7] in this area.

8.5.4.3 Surface Water Quality

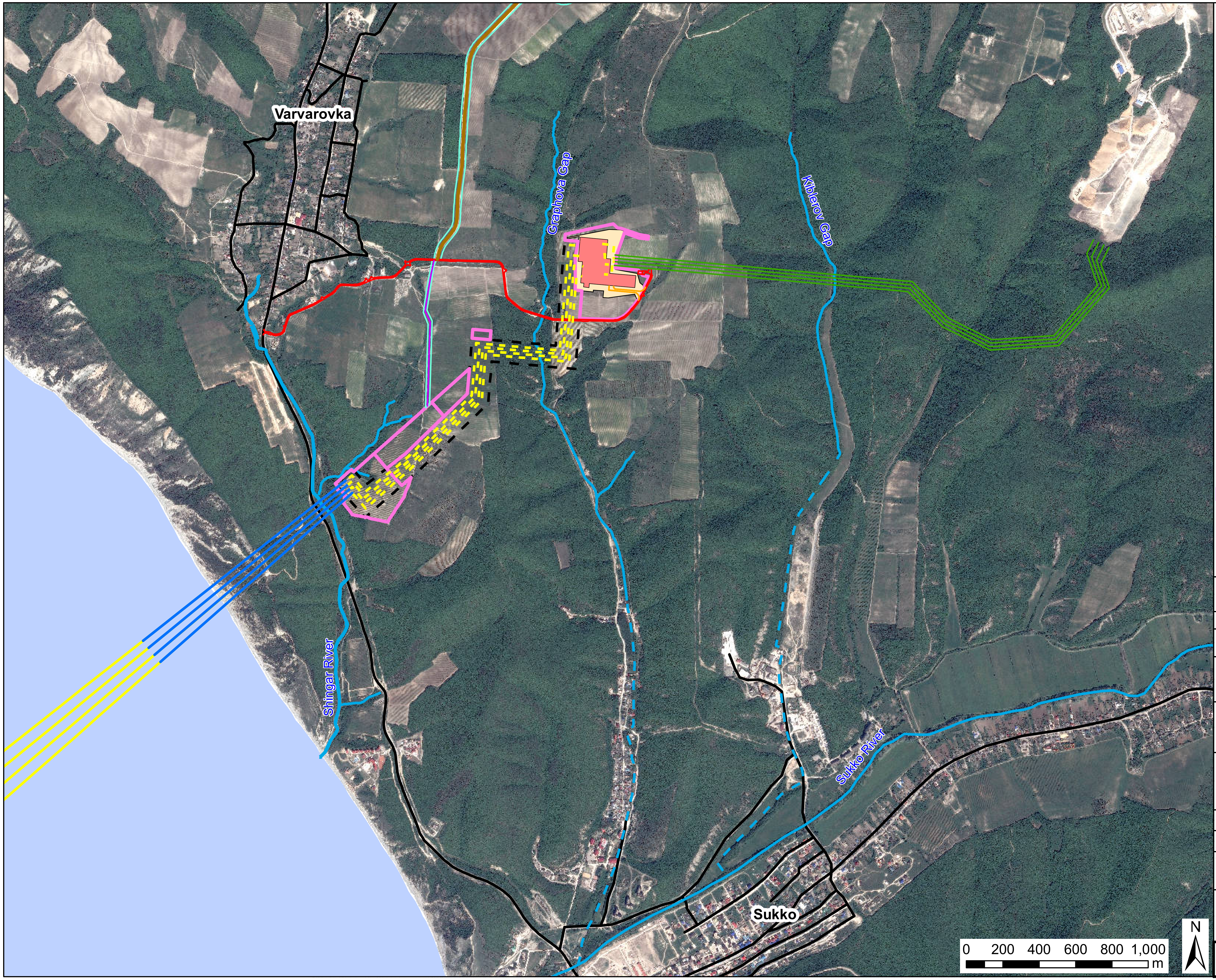
There are no long-term data available on surface water quality in the Survey Area. Spot sampling information on water quality has been obtained through the environmental monitoring undertaken in December 2010 (Ref. 8.1) and in June 2013 (Ref. 8.8). It should be noted that it was raining at the time the samples were collected in 2010. During the 2010 survey, four surface water samples were collected and analysed: two samples from the Shingar River (one sample taken from upstream (VPKh-1) and the other taken from downstream (VPKh-2) of the proposed Pipeline crossing), one taken from the Graphova Gap (VPKh-3) and one from the Kiblerova Gap (VPKh-4). Sampling locations are shown on Figure 8.1. Further details of the 2010 survey surface water sample points are given in Table 8.8.

Table 8.8 Surface Water Sampling Locations in 2010* (Ref. 8.1)

Sample	Location	Width of Watercourse (m)	Water Depth (m)	Estimated Flow Rate (m/s)	Water Temperature (°C)
VPKh-1	Shingar River (upstream of crossing)	1.5	0.6	0.2	9.1
VPKh-2	Shingar River (downstream of crossing)	1.5	0.6	0.2	9.0
VPKh-3	Graphova Gap	0.7	0.2	0.1 - 0.3	6
VPKh-4	Kiblerova Gap	1.2	0.4	0.3	7

* Similar water level and flow data was not reported from the 2013 survey (Ref. 8.8)

[7] The Marfovsky Fault crosses the Graphova Gap in this area. There may be springs in this area associated with fracturing within the fault zone.



LEGEND

Russian Sector of South Stream Offshore Pipeline

- Proposed landfall section pipelines
- Proposed microtunnels

United Gas Supply System

- United Gas Supply System pipelines
- Landfall facilities
- Proposed offshore pipelines
- Varvarovka bypass road (used by Project during construction only)
- Permanent access road to be constructed by SSTTBV
- Temporary access road constructed by SSTTBV
- Permanent access road to be constructed by SSTTBV
- Permanent access road to be constructed by Gazprom Invest
- Construction corridor
- Cut and fill side slopes
- Temporary construction area for road construction
- Construction sites
- Inferred watercourses
- Rivers
- Existing roads

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: MAJOR SURFACE WATER FEATURES IN THE STUDY AREA

Drawn	Checked	Approved	Date
DH	RW	MW	18/02/2014

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

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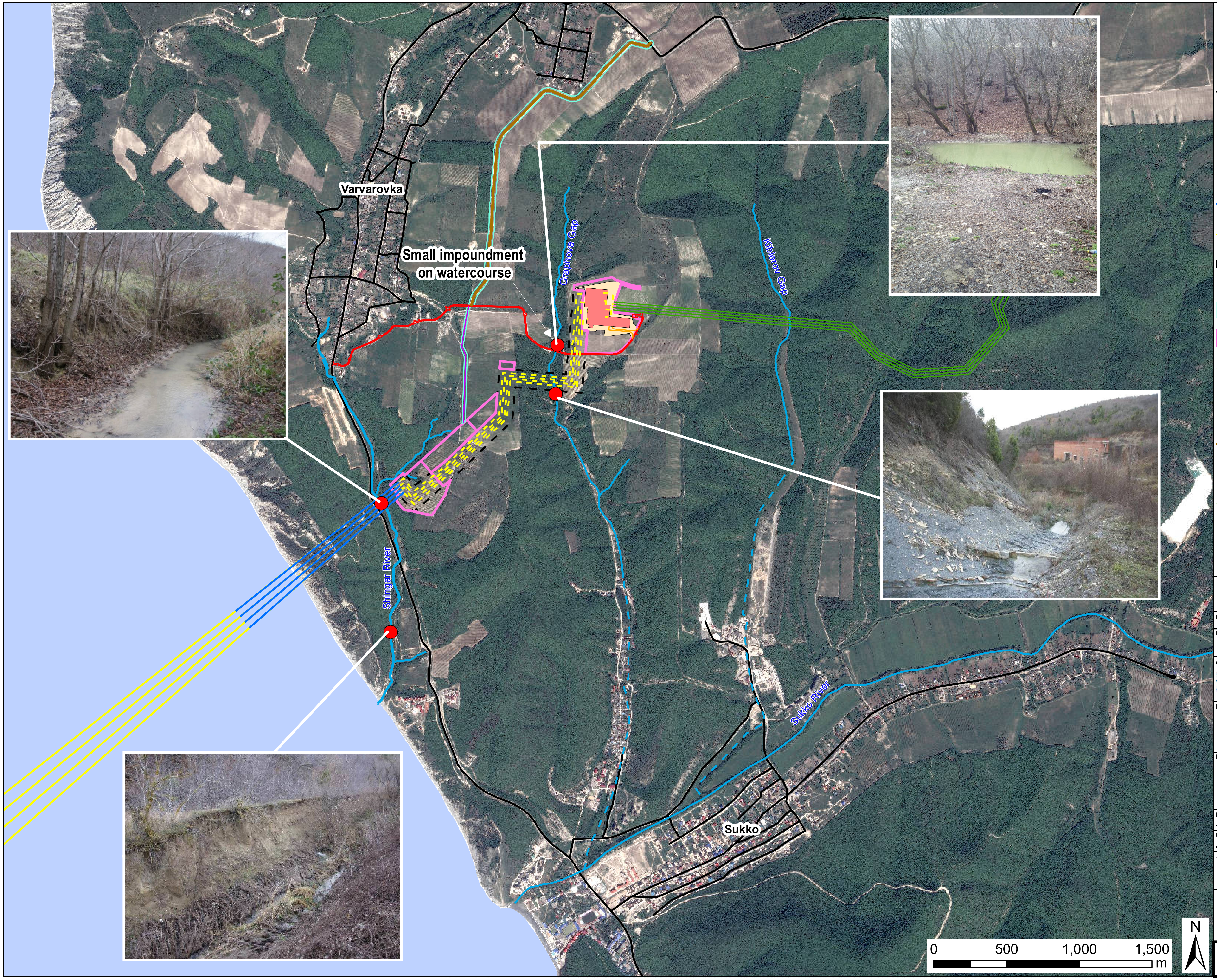
Drawing Number: Figure 8.4

Rev:

Plot Date: 18 Feb 2014
File Name:I:\5004 - Information Systems\46369082_South_Stream\MXDs\Report Maps - Russia\Russian ESIA v2\Chapter 8 Soil and Groundwater\Figure 8-4 Major Surface Water Features.mxd



LEGEND

- Photo locations
- Inferred watercourses
- Rivers
- Existing roads

Russian Sector of South Stream Offshore Pipeline

- Proposed landfall section pipelines
- Landfall facilities
- Proposed microtunnels
- Proposed offshore pipelines
- Construction corridor
- Cut and fill side slopes
- Temporary construction area for road construction
- Construction sites
- Permanent access road to be constructed by SSTTBV
- Temporary access road constructed by SSTTBV
- Varvarovka bypass road (used by Project during construction only)

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 — Stream ENERGISING EUROPE

Project Title: SOUTH STREAM OFFSHORE PIPELINE

Drawing Title: PHOTOGRAPHS AND LOCATION PLAN

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JM	IS	MW	18/02/2014

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Drawing Number: Figure 8.5
Rev

Plot Date: 18 Feb 2014
File Name:I:\5004 - Information Systems\46369082_South_Stream\MXDs\Report Maps - Russia\Russian ESIA v2\Chapter 8 Soil and Groundwater\Figure 8-5 Photographs and Location Plan.mxd

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During the 2013 survey (Ref. 8.8) two surface water samples were collected and analysed: one sample from the tributary running through Graphova Gap at the approximate location of the access road crossing (wp1) and the other taken from the Shingar River (wp2) in approximately the same location as VPKh-2, downstream from the Pipeline.

The surface water samples underwent field and laboratory analysis to assess water quality. The results were compared with Russian National Limit Values for surface water (Refs. 8.17, 8.18 and 8.19); where appropriate the results were also compared with the WHO guidelines (Ref. 8.23) (Table 8.3). The results of the water quality survey are shown in Table 8.9.

Table 8.9 Surface Water Survey Results

Parameter	Unit	Range of concentrations recorded (minimum – maximum) 2010 (Ref. 8.1)	Range of concentrations recorded (minimum – maximum) 2013 (Ref. 8.18)	No. of exceedances of Water Quality Limit Values (Ref. 8.17, 8.18 and 8.23)
Colour Index*	-	10 - 15	20 -41	n/a
Calcium, Ca_2+	mg/l	95.5 – 116.1	127 – 148	0
Magnesium, Mg_2+	mg/l	11.1 – 24.1	22.2 – 25.9	0
Potassium, K+	mg/l	3.2 – 15.5	-	0
Sodium, Na+	mg/l	8.78 – 11.08	0.75 – 68	0
Ammonium, NH_4+	mg/l	0.12 – 3.47	0.14 – 0.29	1 sample exceeds both domestic drinking and amenity MPC (1.5 mg/L) and Fisheries MPC levels (0.5 mg/L)
Chloride, Cl-	mg/l	106 – 108	40 – 125	0
Sulphate, SO_4^{2-}	mg/l	171 - 238	43 – 71	4 samples exceeded Fisheries MPC levels (100 mg/L)

Continued…

Parameter	**Unit**	**Range of concentrations recorded (minimum – maximum) 2010 (Ref. 8.1)**	**Range of concentrations recorded (minimum – maximum) 2013 (Ref. 8.18)**	**No. of exceedances of Water Quality Limit Values (Ref. 8.17, 8.18 and 8.23)**
Phosphate, PO_4^{3-}	mg/l	0.1 – 2.2	<0.01	3 samples exceeded Fisheries MPC levels (0.15 mg/L)
Nitrate, NO_3	mg/l	5.5 – 45.6	7.26 – 26.12	2 samples exceeded Fisheries MPC levels (40 mg/L), with 1 sample also exceeding domestic drinking and amenity MPC levels (45 mg/L)
Nitrite, NO_2-	mg/l	0.07 – 0.10	0.043 – 0.046	2 samples exceeded Fisheries MPC levels (0.08 mg/l)
Hydrogen carbonate, HCO_3-	mg/l	134.2 – 317.2	374 – 441	n/a
pH	pH units	7.0 - 7.1	7.2 – 7.5	0
Permanganate demand	mg O2/l	5.5 - 7.8	2.69 – 2.83	n/a
Chemical oxygen demand, COD	mg O2/l	<10	22 – 27	0
Dissolved O_2	mg/l	6.5 - 8.5	6.7	0
Dissolved O_2	%	58.4 - 76.4	-	0
Total mineralisation	mg/l	408 - 756	720 - 830	0
Suspended solids	mg/l	17.7 - 85.1	121-108	0

Continued...

Parameter	Unit	Range of concentrations recorded (minimum – maximum) 2010 (Ref. 8.1)	Range of concentrations recorded (minimum – maximum) 2013 (Ref. 8.18)	No. of exceedances of Water Quality Limit Values (Ref. 8.17, 8.18 and 8.23)
Biological oxygen demand, BOD	mg/l	0.7 - 1.1	0.95 – 2.9	0
Mercury, Hg	µg/l	<0.05 – 0.05	<0.01	1 sample exceeded Fisheries MPC levels** (0.01 µg/l)
Arsenic, As	µg/l	<5	<2	0
Chromium, Cr	µg/l	<1 - 5.8	<0.3	0
Silica, Si	mg/l	2.1 - 6.5	5.04 – 6.1	0
Cadmium, Cd	µg/l	0.12 - 0.26	<0.07	0
Lead, Pb	µg/l	<1 – 1.4	<1	0
Nickel, Ni	µg/l	<1 - 1.9	<3	0
Iron, Fe	mg/l	<0.050	0.23 – 1.87	2 samples exceeded Fisheries MPC levels (0.1 mg/L) 1 sample exceeded domestic drinking and amenity MPC (0.3 mg/L)
Manganese, Mn	µg/l	2.5 – 6.9	<0.6	0
Copper, Cu	µg/l	2.5 – 4.8	1.7 – 2.7	6 sample exceeded Fisheries MPC levels (1 µg/L)
Zinc, Zn	µg/l	<5 – 9.4	<0.5	0

Continued...

Parameter	Unit	Range of concentrations recorded (minimum – maximum) 2010 (Ref. 8.1)	Range of concentrations recorded (minimum – maximum) 2013 (Ref. 8.18)	No. of exceedances of Water Quality Limit Values (Ref. 8.17, 8.18 and 8.23)
Oil products	mg/l	0.05 – 0.48	0.15 – 3.9	3 sample exceeded Fisheries MPC levels (0.05 mg/L) 1 sample exceeded domestic drinking and amenity MPC (0.3 mg/L)
Anionic surfactants	mg/l	<0.1	0.87 – 0.89	2 samples exceeded Fisheries MPC levels (0.5 mg/L)
Phenols	µg/l	5 - 11	10 - 20	6 samples exceeded Fisheries MPC levels (1 µg/L)
PCBs	µg/l	<0.01	0.00208 – 0.00699	0
Benzo(a)pyrene	µg/l	<0. 0005 – 0. 0008	0.001 – 0.002	0
α-HCH	µg/l	-	2.01 – 3.43	0
β-HCH	µg/l	-	22.07 – 23.97	2 samples exceeded domestic drinking and amenity MPC (20 µg/L) and the WHO limit (2 µg/L)
γ-HCH	µg/l	-	0.26 – 1.38	0
HCB	µg/l	-	0.21 – 0.52	0
2,4-DDE	µg/l	-	<0.05 – 0.05	0

Continued...

Parameter	Unit	Range of concentrations recorded (minimum – maximum) 2010 (Ref. 8.1)	Range of concentrations recorded (minimum – maximum) 2013 (Ref. 8.18)	No. of exceedances of Water Quality Limit Values (Ref. 8.17, 8.18 and 8.23)
4,4-DDE	µg/l	-	1.09 – 2.25	2 samples exceeded the WHO limit (1 µg/L)
2,4-DDD	µg/l	-	<0.05 – 0.26	0
4,4-DDD	µg/l	-	<0.05 – 5.14	2 samples exceeded the WHO limit (1 µg/L)
2,4-DDT	µg/l	-	0.95 – 0.55	0
4,4-DDT	µg/l	-	1.49 – 2.11	2 samples exceeded the WHO limit (1 µg/L)
Individual Pesticides†	µg/l	-	<0.05	None detected±
Total OCPs	µg/l	<0.01	-	0

* Platinum-cobalt scale
** Level of detection for other two samples exceeded Fisheries MPC level, which constrains comparison of the results with the standard.
† Pentachlorobenzene, Heptachlor, Aldrin, Heptachlor Epoxy, Methoychlor, Trans-chlordan, Cis-chlordan, Trans-nonachlor and Mirex.
± Detection limit exceeded OCP standard of 0.01 µg/L.

Complete.

The general pre-existing characteristics of surface waters in the Study Area are as follows:

- Surface water colour is predominantly due to the presence of high concentrations of degraded organic material (humus) and the iron content of the soils;
- The surface waters are generally pH neutral (7.0 to 7.1);
- The surface waters are mineralised. The water quality data is consistent with a significant proportion of the observed surface water flow being derived from groundwater;
- The surface water quality contains evidence of anthropogenic pressures on the local water environment, predominantly relating to agricultural activity in the catchment;
- For all surface waters, elevated copper levels exceeded the standards for fisheries water bodies; elevated copper may be associated with surface water runoff from vineyard areas

(where copper-based agrochemicals are potentially used for controlling parasites). Copper levels were within the Russian standards for amenity and general use;

- Water in the Shingar River exceeded the relevant standards for several parameters including: phosphate, iron, copper, nitrites, nitrates, sulphates, mercury, phenols, oil products, pesticides and surfactants;
- Water sampled from the unnamed tributary running through the Graphova Gap exceeded the relevant standards for several parameters including: phosphate, iron, copper, sulphate, ammonia, phenols, oil products, pesticides and surfactants;
- Water sampled from the unnamed tributary running through the Kiblerova Gap exceeded the relevant standards for several parameters including: phosphate, copper, nitrite, sulphate and phenols;
- Water quality in 2010 and 2013 was broadly similar. The surface water was slightly more mineralised and alkaline in 2013. The 2013 samples were collected in summer whereas the 2010 samples were obtained in winter. Seasonal variations in baseflow component may have caused the variation in mineralisation;
- In the 2013 survey, water in the Shingar River and tributary running through the Graphova Gap had elevated concentrations of pesticides present. No pesticides were detected in 2010[8]. The difference may relate to the seasonal variations in agricultural activity in the catchment;
- PCBs were detected in the surface water samples in the 2013 survey. However, the measured concentrations were below the relevant standards;
- Some of the observed elevated concentrations, such as iron, sulphate and phenols, may be due to natural processes rather than to anthropogenic contamination; and
- Water quality, particularly with respect to parameters such as dissolved oxygen and suspended solids, is likely to vary in response to seasonal fluctuations in flow rates and in response to rainfall events.

The locations of known exceedances of surface water quality limits for both drinking and domestic use and fishery water bodies are shown on Figure 8.3.

8.5.4.4 Stream Bed Sediment Quality

Stream bed sediment samples were collected at the same locations as the surface water quality samples in 2010 and 2013 (Ref. 8.1, Ref. 8.8).

The samples were taken from the top 5 cm of the sediments. No visual or olfactory evidence of contamination was observed in the sediment during sampling. The sediments ranged from sands to silty clays. The proportion of fine-grained sediment (<0.01 mm) in the stream bed sediments ranged from 6.9 to 48.9%. The proportion of humus ranged from 3.3 to 8.9%.

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[8] Note that the analytical methodology varied between the two monitoring rounds.

The stream bed sediment samples underwent laboratory analysis to assess sediment quality. The results were compared with the adopted guidelines (Table 8.4). The results of the stream bed sediment survey are shown in Table 8.10.

Table 8.10 Stream Bed Sediment Survey Results

Parameter	Unit	Range of concentrations recorded in 2010 (minimum – maximum) (Ref. 8.1)	Range of concentrations recorded in 2013 (minimum – maximum) (Ref. 8.18)	No. Samples Exceeding Standards (Ref. 8.26, 8.28)
pH	pH unit	6.9 – 7.1	7.35 – 7.40	n/a
Arsenic, As	mg/kg	0.9 – 1.6	1.1 – 1.3	0
Cadmium, Cd	mg/kg	0.67 – 0.70	0.19 – 0.25	4 samples exceeded the Guideline value (0.6 mg/kg)
Lead, Pb	mg/kg	6.1 – 14.8	6.1 – 9.7	0
Mercury, Hg	mg/kg	<0.02 – 0.03	0.016 – 0.021	0
Zinc, Zn	mg/kg	48.4 – 72.5	39 - 52	0
Chromium, Cr	mg/kg	25.2 – 27.6	6.6 – 9.2	0
Copper, Cu	mg/kg	44.2 – 97.5	30 - 33	4 samples exceeded the Target and Guideline values (36 and 35.7 mg/kg)
Nickel, Ni	mg/kg	21.2 – 22.8	14 - 18	0
Manganese, Mn	mg/kg	172.4 – 296.8	180 - 200	n/a
Iron, Fe	mg/kg	11530 - 13060	6900 - 9400	n/a
Benzo(a)pyrene	mg/kg	<0.005	0.0021 – 0.0092	0
Oil products	mg/kg	59 – 294	<5 - 21	4 samples exceeded the Target value (50 mg/kg)
Phenol	mg/kg	1.77 – 15.94	0.15 – 2.44	6 samples exceeded the Target value (0.05 mg/kg)

Continued...

Parameter	Unit	Range of concentrations recorded in 2010 (minimum – maximum) (Ref. 8.1)	Range of concentrations recorded in 2013 (minimum – maximum) (Ref. 8.18)	No. Samples Exceeding Standards (Ref. 8.26, 8.28)
Total PCBs	mg/kg	0.0094 – 0.2161	0.00145 – 0.00187	2 samples exceeded the Target value (0.02 mg/kg) and the Guideline value (0.0341 mg/kg)
Hexachlorobenzene	mg/kg	<0.0005 – 0.0012	0.00074 – 0.00105	0
α-HCH	mg/kg	<0.0005	0.0008 – 0.0016	1 sample exceeded the Guideline value (0.00094 mg/kg)
β-HCH	mg/kg	<0.0005	0.00577 – 0.00659	2 samples exceeded the Guideline value (0.00094 mg/kg)
γ-HCH	mg/kg	<0.0005 – 0.0011	0.00078 – 0.001	6 samples exceeded the Target value (0.00005 mg/kg) 1 sample exceeded the Guideline value (0.00094 mg/kg)
Heptachlor	mg/kg	<0.0005	<0.00005	0
Aldrin	mg/kg	<0.0005	<0.00005	0
Dieldrin	mg/kg	<0.0005 – 0.0805	-	3 samples exceeded the Target value (0.0005 mg/kg)
DDT (total, including DDD and DDE)	mg/kg	0.0009 – 0.0883	0.0055 – 0.1398	6 samples exceeded the Target value (0.01 mg/kg) and the Guideline value (0.00119 mg/kg)

Complete.

The general pre-existing characteristics of stream bed sediments in the Study Area are as follows:

- The stream bed sediments show evidence of anthropogenic impacts. Pesticides, PCBs, and oils have been detected in all samples at concentrations that exceed the adopted standards;

- Phenols were detected in the stream bed sediments at concentrations that exceeded the adopted standard. It is possible that the phenol concentrations are due, at least in part, to natural organic material in the sediment;
- Metals are also present in the stream bed sediments. Cadmium and copper are present in concentrations that exceed the adopted standards; and
- Comparison of the surface water quality and stream bed sediments suggests that some contaminants, such as PCBs, may be present at elevated levels in the sediments without necessarily adversely impacting water quality.

The locations of known surface water pollution exceedances in stream bed sediments in the Study Area are shown on Figure 8.3.

8.5.5 Baseline Summary

8.5.5.1 Soils

Soils in the Study Area comprise cambisols, phaeozems, arenosols, fluvisols, abrazems/regosols and anthropogenic soils.

Soils used for existing agricultural purposes, predominantly arenosols and abrazem/regosols, are important to local land users. The soils provide a substrate that has the physical qualities and/or degree of productivity to support agricultural use.

Of the soil types that will be crossed by the proposed Pipeline route, phaeozem soils are of particular note given that they are structurally prone to compaction and erosion, and vulnerable to contamination through surface spills. The soils typically comprise a soft organic rich topsoil layer, covered in vegetation. It is also noted that phaeozem soils have a high water absorption capacity and play a key role in water regulation.

Fluvisols are present in the valley bottoms and play a role in the hydrological cycle. As they are associated with watercourses and valley bottoms they may be in continuity with shallow groundwater and can act as pathways for movement of chemical contaminants into groundwater and surface water.

The other soil types (cambisols and anthropogenic soils) are less likely to be used for agriculture and are not typically as rich in organic materials as phaeozem soils.

Pre-existing elevated concentrations, i.e., above MPC thresholds, of arsenic, copper, lead, zinc, benzo(a)pyrene, PCBs and pesticides were measured in the soil.

8.5.5.2 Groundwater

The hydrogeology of the Study Area is characterised by shallow alluvial aquifers overlying a carbonate aquifer.

The alluvial aquifer is present along the narrow river valleys of the Shingar River and an unnamed tributary of the Sukko River located in the Graphova Gap. Groundwater flow within the underlying carbonate aquifer is controlled by a network of fissures within folded and fractured sedimentary bedrock deposits. There is the potential for a hydraulic connection between the alluvial groundwater and the carbonate aquifer.

Recharge to the carbonate aquifer is via rainfall, groundwater flow from up-hydraulic gradient and recharge from the shallow alluvial aquifers.

In the lower reaches of the valleys, groundwater is likely to discharge to the river system and ephemeral springs during periods of high rainfall and corresponding groundwater levels within the alluvium.

The groundwater abstraction associated with the proposed Russkaya compressor station is located approximately 5 km to the northeast of the landfall section (Ref. 8.3). The Project does not lie within the designated sanitary protection zone for this abstraction.

The nearby vineyard, Agrofirma Kavkaz, and the residential area of Varavrovka source the majority of their water from the Supsekh water supply system with the remainder of the water being obtained from the unlicensed surface water abstraction, located upstream of the Project Area (Ref. 8.4).

There is a groundwater source at the Russian Ministry of Defence site in Sukko about 2 km south of the landfall facilities. This abstracts groundwater from three boreholes in the bedrock aquifer. The water is fresh and potable. No abstraction from this source is permitted from May to September.

During the 2010 and 2013 surveys groundwater samples were taken from springs within the Survey Area. The groundwater is fresh and mineralised. Elevated concentrations of iron, oil, surfactants and pesticides have been detected.

8.5.5.3 Surface Water

Watercourses in the Study Area include two watercourses crossed by the proposed Pipeline route, the Shingar River and an unnamed tributary of the Sukko River within the Graphova Gap. There is a third watercourse within the Study Area, which is another tributary of the Sukko River within the Kiblerova Gap, but this is located outside the Study Area.

Watercourses in the Study Area are predominantly precipitation fed, with frequent and short floods. In addition, surface waters are partly recharged from high groundwater tables during the winter months. Surface water flows typically peak during winter months when rainfall is highest. During summer months watercourses may become dry or form discrete ponds or small lakes of water within the river bed. Flood events occur in response to storm events. Flooding may trigger geomorphological features such as mudflows and landslides.

There are no licensed abstractions from surface water in the Study Area. There is a small impoundment on the watercourse in the Graphova Gap immediately upstream of the proposed access road crossing. From consultation meetings held with Kavkaz Winery, it is understood that the impounded water is used to irrigate the winery.

Surface water quality samples were taken in 2010 and 2013 (Ref. 8.1 and Ref. 8.8). The water was fresh and mineralised, indicating a significant groundwater baseflow component. Elevated concentrations of contaminants have been detected in the surface waters, including ammonia, sulphate, phosphate, nitrate, nitrite, mercury, iron, copper, oil, surfactants, phenols and pesticides. Stream bed sediment samples were collected at the same locations as the surface water quality samples. Elevated concentrations of contaminants have been detected in the sediments, including cadmium, copper, oil, phenols, PCBs and pesticides.

8.6 Impact Assessment

8.6.1 Impact Assessment Methodology

The impact assessment methodology is based on the principles of source-pathway-receptor. The source in this context has been identified in relation to the planned project Activity. Owing to the complexity of the Project, there are multiple sources. The receptors under consideration relate to soil, groundwater and surface water. Indirect receptors that use soil, groundwater and surface water have also been considered. Pathways that could link the sources and receptors have been identified. Only where the complete linkage of source, pathway and receptor are present can impacts potentially occur.

An overview of the process followed in compiling the ESIA Report and the general methodology adopted in assessing impact significance is presented in **Chapter 3 Impact Assessment Methodology**.

While there are a number of national and international soil, water and sediment quality standards applicable to the Project, there is relatively little guidance available describing how the significance of potential impacts on soil, water and sediment should be assessed. Based on the general methodology outlined in **Chapter 3 Impact Assessment Methodology**, on professional judgement and experience, and on the applicable Project standards and regulations, a series of impact significance criteria were developed to assess potential impacts on soil, water and sediment. A summary of the receptor sensitivity and impact magnitude criteria used in the assessment is presented below.

The combination of the magnitude of impact and receptor sensitivity criteria is assessed in a sensitivity matrix within **Chapter 3 Impact Assessment Methodology** to generate impact significance categories (**High**, **Moderate**, **Low** or **Not Significant**).

Measures to avoid or reduce any **Moderate** or **High** category (significant) impacts are then developed (where such measures are practical) and any residual impacts of the Project are reported.

8.6.1.1 Project Activities

The potential impacts are derived through the activities of the Project. These are described in detail in **Chapter 5 Project Description**. Table 8.11 outlines the key activities that are likely to interact with the existing soil, sediment, groundwater and surface water receptors.

Table 8.11 Key Activities likely to interact with Soil, Groundwater and Surface Water conditions

Phase	Activity
Construction	Pre-construction surveys
	General construction activities, including: • Plant mobilisation to site; • Vehicle and plant operations on site; • Delivery of fuel and other hazardous substances; • Refuelling of plant and machinery; • Storage of fuel and hazardous materials including wastes; • Maintenance of plant and machinery; • Use of power generation sets; and • Water supply from Sukko well.
	Preparation of access road or upgrades to junctions of existing roads, including: • Land take and vegetation clearance; • Diversion or protection of existing utilities and drainage infrastructure; • Preparation of drainage; • Delivery of material for road surface; and • Surfacing of road.
	Establishment of temporary construction areas, including: • Land take and vegetation clearance; • Diversion of existing utilities and drainage infrastructure; • Preparation of temporary drainage; • Delivery, use and removal of temporary pre-fabricated facilities; • Generation of wastes and wastewaters; • Use of construction materials; and • Restoration.
	Microtunnel construction, including: • Excavation of microtunnel shaft; • Tunnelling using a tunnel boring machine (TBM) equipped with slurry pipe system and lubrication system; • Insertion of pre-fabricated concrete jacking pipes with use of crane and hydraulic jacks to line tunnel; and • Removal of drill cutting from slurry.

Continued…

<table>
<tr><th>Phase</th><th>Activity</th></tr>
<tr><td></td><td>Pipeline pull-in through microtunnels, including:
Excavation of foundation area for pipe pull winches or sheaves within microtunnel construction area;
Shore pull of Pipeline from offshore pipe-lay vessel;
Welding of tie-in at microtunnel reception pit; and
Grouting of annular gap between Pipeline and tunnel case following pipeline installation and pre-commissioning tests.</td></tr>
<tr><td></td><td>Open trench pipe-laying activities – from microtunnel entry shafts to landfall facilities, including:
Land clearance, grading, topsoil stripping;
Diversion of existing utilities and drainage infrastructure;
Excavation of trench and storage of excavated materials;
Padding of trench bottoms;
Dewatering of trench (if required);
Stringing of Pipeline;
Line up and bending of pipe;
Welding of pipe sections and coating of welding joints;
Pipe lowering in trench;
Backfill of trench; and
Restoration.</td></tr>
<tr><td></td><td>Construction of landfall facilities, including:
Land clearance, grading, topsoil stripping;
Diversion of existing utilities and drainage infrastructure;
Excavation of foundations, underground chambers and areas for hardstanding formation;
Delivery of construction materials;
Formation of concrete structures and hardstanding areas;
Erection of buildings and structures;
Mechanical assembly and connections;
Welding of pipe sections and coating of welding joints;
Site surfacing;
Painting of infrastructure;
Restoration; and
Generation of wastes and wastewaters.</td></tr>
<tr><td>Pre-Commissioning</td><td>Pre-commissioning activities associated with pipeline testing, including:
Receipt of pipeline inspection gauges (PIGs); and
Hydro-testing of pipelines.</td></tr>
</table>

Continued…

Phase	Activity
Pre-Commissioning	Pre-commissioning activities associated with cleaning, gauging and drying Pipeline, including: • Insertion of PIG trains; and • Compressor operation.
Commissioning	Commissioning activities include: • Heating of the gas; • Injection of gas with and without a PIG; and • Pipeline pressurisation. The injection of gas and Pipeline pressurisation has no potential to impact soil, groundwater or surface water during this phase. Heating of the gas is necessary as the pressure of the gas from the Russkaya compressor station is much higher than that required for transport in the Pipeline. Hence, the gas is a lower temperature (see **Chapter 5 Project Description** for more details). During commissioning, the temperature of gas in the Pipeline will not be any higher than during operation. As such, no impact from this activity is anticipated on soil, groundwater or surface water and commissioning activities are not considered in the assessment.
Operational	General activities, including: • Maintenance of mechanical equipment; • Clearance of vegetation from permanent Right of Way (RoW) over Pipeline; and • Generation of wastes and wastewaters.
	Pigging
	Presence of access roads, landfall facilities, microtunnels and buried pipeline.
Decommissioning	General construction activities
	Establishment of Temporary Construction Areas
	Open trench pipe removal activities – from microtunnel entry shafts to landfall facilities
	Decommissioning of landfall facilities
Unplanned Events	Emergency events

Complete.

A number of design controls have been incorporated into the Project design which, reduce the potential impacts from a given Project Activity. Potential Construction and Pre-Commissioning Phase impacts are assessed on this basis. Additional mitigation and monitoring measures are then identified that can further reduce impacts to as low as reasonably practicable (ALARP), and the residual impact is identified.

Design controls are presented in **Chapter 5 Project Description**. Those of particular relevance to soil and water include:

- Microtunnelling below the Shingar River;
- Deepening of the Pipeline below the Graphova Gap to maintain sufficient Pipeline depth below the valley floor;
- Construction of a level platform for the landfall facilities, which will include stabilisation of the surrounding slopes;
- Drainage to manage surface run-off, which will be constructed along access roads and at the landfall facilities;
- The use of geotextiles in the construction of permanent and temporary access roads;
- Stripping and stockpiling topsoil (stockpiles will normally be less than 2 m in height) for later use during reinstatement;
- Backfilling of trenches, which will normally occur immediately after the Pipeline has been lowered;
- Reinstatement of the proposed Pipeline corridor, which will include restoration of original land contours as closely as possible, except grading of slopes at the Graphova Gap to manage slope stability;
- Dedicated mobile plant and refuelling areas. Fuel storage tanks will be double-walled. Secondary containment by bunding will surround the tanks;
- Provision of water storage facilities so that seasonal constraints on abstraction of groundwater at Sukko can be accommodated;
- Provision of wastewater collection systems and offsite disposal by licensed waste management operators;
- Chemical storage areas, which will be constructed on hardstanding with bunding; and
- Benching or grading along trench to enable safe working.

8.6.1.2 Impact Assessment Criteria

Receptors

A summary of the most sensitive soil, groundwater and surface water receptors is provided below.

Table 8.12 presents a summary of the identified receptors together with the respective sensitivity ranking. The justification for these sensitivity levels is presented in subsequent sections of this chapter.

Table 8.12 Summary of Receptor Sensitivity

Receptor Type	Receptor Name	Sensitivity
Soil	Agricultural Soils (arenosols and abrazems/regosols)	Moderate
	Phaeozems	High
	Fluvisols	High
	Other Soils (cambisols and anthropogenic soils)	Low
Groundwater	Alluvial (Superficial) Aquifers	Moderate
	Carbonate Aquifer	Moderate
	Sukko Groundwater Resource	High
	Russkaya abstraction	Negligible
Surface Water	Shingar River	Moderate
	Unnamed tributary of the Sukko River in Graphova Gap	Moderate
	Existing unlicensed surface water abstraction	Moderate
Human Health	Construction Workers	High*

* Human health sensitivity was not calculated based on the criteria given in this chapter. It is assumed that human health is highly sensitive to contamination impacts from soil, groundwater and surface water

Soil and water receptors cannot be considered in isolation as they are interdependent; for example:

- Groundwater and surface water may experience secondary impacts associated with primary impacts to soils;
- Surface waters may experience secondary impacts associated with primary impacts to groundwater; and
- Soil and groundwater may experience secondary impacts associated with primary impacts to surface water.

Humans may experience secondary impacts associated with primary impacts to groundwater or surface water that subsequently affect abstractions. Note that where substances measured in water meet the respective drinking water standards, the health of existing or potential abstractors is not considered to be at significant risk.

Ecological receptors may experience secondary impacts associated with primary impacts on soil or water. The impacts to ecological receptors are assessed in **Chapter 11 Terrestrial Ecology**.

Pathways

Pathways are the means by which an activity can affect a receptor. In some cases this may be a physical migration pathway, such as a movement of contamination through a drain connecting two water features, or it may be the inherent nature of the activity itself; for example, excavation of soil will have a physical impact on the soil. For the purpose of this assessment some activities (such as excavation) are considered as an activity and a pathway.

Only where an activity, a pathway and receptor are present can an impact occur. The pathways considered in the ESIA process are summarised below:

- Physical disturbance of soils;
- Erosion and transport of soils by surface run-off;
- Changes to groundwater levels, for example, by forming lower permeability barriers or higher permeability preferential pathways;
- Groundwater and surface water interaction;
- Run-off into surface water;
- Movement of sediment within surface watercourses;
- Deposition of sediment onto soils adjacent to watercourses during flood events;
- Direct release of contaminants to soil and surface water;
- Leaching of contaminants from soils into groundwater;
- Migration of contaminants in groundwater;
- Migration of contaminants (in water and/or sediment) in surface water; and
- Ingestion, dermal contact and inhalation of contaminants in soil and sediment by construction workers.

Receptor Sensitivity

A series of impact significance criteria were developed to assess potential impacts on soil, water and sediment based on the general methodology outlined in **Chapter 3 Impact Assessment Methodology**, on professional judgement and experience, Good International Industry Practice (GIIP), and on the applicable Project standards and regulations.

The sensitivity of a soil or water receptor is a reflection of how vulnerable that receptor is to changes in chemical or physical attributes. The less sensitive receptors are those that are more resilient (less vulnerable) to change.

The concept of sensitivity also considers receptor value by capturing how important the receptors are to users of the environment (e.g. sustaining of ecosystems and humans via ecosystem services).

Sensitivity assessment criteria have been developed, using four categories of high, moderate, low and negligible.

Where the value and vulnerability assumptions are markedly different for an individual receptor, the more conservative category has been adopted.

Soil Receptor Sensitivity

Receptor sensitivity of soils is primarily related to the geochemical nature of the soils and the hydrological and nutrient cycling process of which they are a part (e.g. whether the soils are prone to erosion, fertility of soils, etc.). Similarly, the sensitivity depends on land-uses and ecosystems present. Soil sensitivity is also related to the presence of contaminants in the soil. This chapter focuses on the impacts to the soil baseline conditions. The associated risks to human health from baseline soil characteristics have also been assessed, as a link between humans and unknown soil contamination could be introduced by the Project.

The associated potential impacts of soil as a pathway upon land usage, ecology and ecosystems services are assessed in detail in the relevant chapters of this ESIA Report, specifically **Chapter 11 Terrestrial Ecology**, **Chapter 13 Landscape and Visual** and **Chapter 17 Ecosystem Services**.

Table 8.13 presents the receptor sensitivity criteria adopted for soils. In the absence of defined national guidance, the definitions for sensitivity criteria were informed by the GIIP US Guidelines for Soil Quality Assessment in Conservation Planning (United States Department of Agriculture) (Ref. 8.32).

Table 8.13 Soil Receptor Sensitivity

Sensitivity	Description
High	Highly vulnerable to physical disturbance, structurally prone to compaction or erosion, and taking >10 years to recover. Highly leachable and amenable to contamination. The soil provides a substrate that has the physical qualities and/or degree of productivity to support the development of important (in terms of nature conservation or concentration of biomass) and/or indigenous species of flora and fauna. The soil is intrinsically linked to the hydrological cycle; water is fundamental to its structure; and the soil plays a key ecosystem role in water regulation.

Continued…

Sensitivity	Description
Moderate	Vulnerable to physical disturbance but able to recover by mitigation measures within a period of 10 years. Moderately leachable. The soil provides a substrate that has the physical qualities and degree of productivity to support the development of species of flora and fauna in some abundance and levels of diversity. The soil has some capacity for water retention and regulation and plays some role in the hydrological cycle in terms of a degree of water regulation and as a substrate for channelling run-off.
Low	Resilient to physical disturbance and/or impermeable to contamination. The soil constitutes no particular favourable substrate for the development of floral habitats, invertebrates and other fauna. The soil plays little or no role in the hydrological cycle or regulation of water.
Negligible	This category is included in **Chapter 3 Impact Assessment Methodology** but is considered not applicable to soil quality.

Complete.

Soils used for existing agricultural purposes, predominantly arenosols and abrazems/regosols, are a moderate sensitivity receptor due to their importance to local land users, although they may be resilient to physical disturbance from construction activities. The soils provide a substrate that has the physical qualities and/or degree of productivity to support agricultural development.

Phaeozem soils are a high sensitivity receptor. These soils are soft and are structurally prone to compaction or erosion, and prone to contamination through surface spills. Subsequently, they have a low resilience to impacts, and do not readily return to their natural state. It is also noted that phaeozem soils have a high water absorption capacity and play a key role in water regulation.

Fluvisols are a high sensitivity receptor as they play a role in the hydrological cycle and support the highly sensitive Nikolski's tortoise (refer to **Chapter 11 Terrestrial Ecology**).

Within the Study Area, cambisols are only present above the microtunnel route and anthropogenic soils are locally present above the microtunnel route and beneath the access road route. Neither soil type is important for agriculture. These soils are low sensitivity receptors.

Existing unstable geomorphic features (**Chapter 7 Physical and Geophysical Environment**) are also a high sensitivity receptor. As active geomorphological features (erosion gullies, landslides and floodplains, etc.) typically already involve processes of physical disturbance to soils, they will continue to be highly vulnerable to further physical disturbance from activities associated with the Project.

Human Receptor Sensitivity

Construction workers are a high sensitivity receptor. As mentioned in Table 8.12, human health sensitivity was not calculated based on the criteria in this chapter; humans are considered highly sensitive to contamination from soil, groundwater and surface water.

Groundwater Receptor Sensitivity

The sensitivity of a groundwater body (the receptor) is typically based on three aspects: chemical quality, quantity and use of the groundwater resource. For example, a groundwater body may be valuable as a source of drinking water or as an integral part of a groundwater dependent ecosystem.

Table 8.14 presents the criteria used to classify groundwater receptor sensitivity based on the quantity and/or use of the resource, using the categories high, moderate, low, and negligible. It is noted that, based on the groundwater data currently available (Section 8.4.4), for conservatism the groundwater has been assumed to be a potential potable resource and to meet chemical quality criteria for potential potable use.

Table 8.14 Groundwater Receptor Sensitivity

Sensitivity	Description
High	Productive strata of high conductance and good chemical quality with significant resource availability, or being within source (sanitary) I or II of a drinking water supply sanitary protection zone. Presence of a groundwater dependent ecosystem of national and international importance within 1 km of the Project Area. The water resource is highly vulnerable to leaching and transportation of contaminants.
Moderate	Productive strata of medium conductance with limited resource availability and good chemical quality, or being within source (sanitary) III of a drinking water supply sanitary protection zone. Presence of a groundwater dependent ecosystem of national and international importance within 1 km of the Project Area. The water resource is vulnerable to leaching and transportation of contaminants.
Low	Unproductive strata of low conductance with low resource availability and good quality. No designated groundwater fed ecosystems within 1 km of the Project Area The water resource has low vulnerability to contamination.
Negligible	Aquifer with negligible vulnerability and resource availability.

The groundwater receptors within the Study Area are the shallow superficial aquifers, and the underlying carbonate aquifer (**Chapter 7 Physical and Geophysical Environment)**.

The aquifers are potentially potable water resources despite oil products being detected.

The superficial aquifer is of moderate sensitivity because the aquifer is vulnerable to pollution, the aquifer is relatively thin and thus vulnerable to changes in the flow regime, and the aquifer is expected to be in hydraulic connection with surface water, and in place, the deeper carbonate aquifer.

The sensitivity of the carbonate aquifer is moderate as it has the potential to be productive but is not currently exploited for the supply of its water within the Study Area. Elsewhere in the region, such as at Sukko, the bedrock aquifer is utilised for water supply. The carbonate aquifer may feed surface watercourses and the shallow alluvial aquifer via springs.

Mesophilic forest is present in the river valleys. The habitat is located adjacent to ephemeral watercourses; when surface water is absent in dry weather, groundwater will be of greater importance to this habitat. Springs also contribute towards the aquatic ecology associated with the watercourses. Fish and invertebrate species have been identified as being present in the watercourses when flowing. The sensitivity of the mesophilic forest habitat and the aquatic ecology within the watercourses, and the potential impacts on these ecological receptors due to the Project are assessed in **Chapter 11 Terrestrial Ecology**.

The groundwater abstraction for the Russkaya compressor station has negligible sensitivity because the Project does not lie within the designated sanitary protection zone for this abstraction (Ref. 8.3).

The source aquifer from which the Sukko wells abstract water has seasonal restrictions on its use and for this reason this groundwater resource is of high sensitivity.

Surface Water Receptor Sensitivity

The surface water receptors comprise the surface water bodies. This includes both the water and the stream bed sediments. The quality and abundance of water resources affects a wide variety of ecological habitats and ecosystem services. This section focuses primarily on the impacts to the surface water body baseline conditions. Associated potential impacts on ecological and anthropological systems are assessed, where appropriate, in the relevant chapters of this ESIA Report including **Chapter 11 Terrestrial Ecology**.

However, as there are secondary impacts associated with changes to the baseline conditions, these need to be considered in assessing the sensitivity of the primary surface water receptors. Table 8.15 presents a description of receptor sensitivity for surface water.

Table 8.15 Surface Water Receptor Sensitivity

Sensitivity	Description
High	A water resource making up a vital component of a protected habitat or assemblage of species, which may have designated conservation status at an international and national scale. The water resource supports important (e.g. protected and/or large populations) of flora and fauna. The water resource is highly important and relied upon locally or is important at a regional or transboundary level for providing services.
Moderate	The water resource supports populations of flora and fauna. The water resource has a local importance in terms of providing services, but there is ample capacity and/or adequate opportunity for alternative sources.
Low	The water resource has limited or no role in supporting flora and fauna. The water resource has little or no role in terms of providing services for the local community.
Negligible	This category is considered non-applicable to surface water.

There are two surface water receptors within the Study Area:

- Shingar River; and
- An unnamed tributary of the Sukko River flowing through the Graphova Gap.

Each of these watercourses is within a 50 m wide sanitary protection zone (Ref. 8.20), which restricts the activities that take place in order to prevent contamination and silting of the water bodies. These protection zones help conserve the habitat for aquatic biological resources and other flora and fauna.

The watercourses are generally compliant (Ref. 8.1) according to the standards for amenity and general use of waters (Refs. 8.17, 8.18 and 8.19), although oil, nitrate and ammonia levels were exceeded (Section 8.5.1). Downstream of the landfall section, the watercourses flow through sensitive ecological habitats as described in **Chapter 11 Terrestrial Ecology**. The Graphova Gap will be crossed by the Pipeline (Figure 8.4). The watercourses are typically ephemeral. Flows are expected to vary seasonally and the watercourses are likely to only have substantial flow during and immediately after rainfall events. The watercourses support flora and fauna of low sensitivity (**Chapter 11 Terrestrial Ecology**). Both watercourses have been conservatively assessed as receptors of moderate sensitivity.

The surface water abstraction in the Study Area is located upstream of the Pipeline crossing in Graphova Gap (Ref. 8.4). The abstraction is unlicensed. The abstraction is used to irrigate the Kavkaz winery. This receptor is considered to have moderate sensitivity.

Mesophilic forest is present in the river valleys. The habitat is located adjacent to ephemeral watercourses that experience natural fluctuations in flow rate. Fish and invertebrate species have been identified as being present in the watercourses when flowing. The sensitivity of the mesophilic forest habitat and the aquatic ecology within the watercourses and the potential impacts on these ecological receptors due to the Project are assessed in **Chapter 11 Terrestrial Ecology**.

Impact Magnitude Criteria

The magnitude criteria consider size, likelihood and duration of the impact, both in terms of duration of the cause and the subsequent effect.

Impact magnitude assessment criteria have been developed, using four categories of high, moderate, low and negligible.

The determination of the overall impact magnitude rating has been determined on the basis of professional judgement and GIIP, considering all characteristics collectively rather than any one characteristic alone.

The likely frequency of the impact occurrence is also taken into account in assigning the overall impact grade. Impacts that would definitely occur are given a higher magnitude rating than impacts that might occur (e.g. removal of soil during earthworks compared with minor leaks and spills.)

Soil Impact Magnitude

For soils, the magnitude of a potential impact is determined predominantly in terms of the extent of loss of soil or loss of soil function. Typical activities and pathways for soil include:

- A direct change in soil volumes (e.g. excavation and disposal elsewhere);
- A direct change in soil area (e.g. covering soils with hardstanding);
- A direct change in the physical properties of soil (e.g. compaction);
- Changes in soil and water interactions (e.g. erosion or leaching);
- Increased potential for geomorphological instability or activation of existing geomorphologically unstable features; or
- Introduction of contaminants into the soil.

In particular, changes to chemistry of soils may lead to the applicable soil quality standards being exceeded.

Table 8.16 presents a description of the magnitude of change for soils using the classifications high, moderate, low and negligible.

Table 8.16 Soil Event Magnitude

Magnitude	Description
High	The potential for soil quality and/or physical structure to be permanently impacted. The area affected by the activity is predicted to be large (>10 ha).
Moderate	The impact on soil quality and condition may recover through natural processes and the impact will be medium term (several years). The area affected by the activity is predicted to be a medium extent (>1 ha and < 10 ha)
Low	The impact on soil quality and condition is predicted to recover rapidly through natural processes and the duration of impact is short (limited to the Construction Phase). The area affected by the activity is predicted to be a minor extent (<1 ha)
Negligible	No changes distinguishable from natural variability.

Human Impact Magnitude

If there is a linkage between soil-bound contamination and/or soil gas and construction workers the impact magnitude is considered to be high, otherwise the impact magnitude is negligible.

Groundwater Impact Magnitude

For groundwater systems, the magnitude of a potential impact is determined predominantly in terms of the extent of groundwater loss to the groundwater body in question. Losses to a groundwater resource can occur in terms of either quantity or quality. Typical activities and pathways for groundwater losses include:

- A direct change in the groundwater level causing deterioration of a groundwater resource (e.g. direct water abstraction);
- A reduction in groundwater and surface water interaction (e.g. tunnel providing barrier to groundwater flow to a river);
- Salt water intrusion for coastal receptors; or
- Introduction of contaminants into the groundwater body.

In particular, changes to water quality of groundwater bodies may lead to the applicable water quality standards for groundwater being exceeded.

Table 8.17 shows the criteria used to classify magnitude of impact.

Table 8.17 Groundwater Event Magnitude

Magnitude	Description
High	There is a potential for water quality and/or quantity to be permanently impacted. There is a complete loss of integrity of a groundwater body or utilisation by receptors.
Moderate	Water quality and condition is likely to recover through natural processes and the impact is predicted to be medium-term (several years). There is a loss in integrity of a groundwater body or a loss of part of the groundwater body.
Low	Water quality and condition is predicted to recover rapidly through natural processes and the duration of impact is short (limited to the Construction Phase). There is a temporary impact on receptor.
Negligible	Results in an impact on receptor but of insufficient magnitude to affect its use and/or integrity

Surface Water Impact Magnitude

For surface waters, the magnitude of a potential impact is determined predominantly in terms of the extent of changes to the flow regime or to water quality. Typical activities and pathways for surface water impacts include:

- A direct change in the flow regime causing deterioration of a surface water resource (e.g. change in flow, channel characteristics);
- A change in groundwater or surface water interaction (e.g. change in baseflow);
- A change in water availability for ecosystems or water supply; and
- Introduction of contaminants into the watercourse.

In particular, changes to surface water or stream bed sediment quality may lead to the applicable quality standards for watercourses being exceeded. Table 8.18 presents a description of the criteria used to classify magnitude of impact for surface water.

Table 8.18 Surface Water Impact Magnitude

Magnitude	Description
High	The potential for natural recovery of water quality, quantity and/or physical disturbance through natural processes is limited and the impact is predicted to be long term (several years). Predicted to affect an entire watercourse downstream of the landfall section
Moderate	Water quality, quantity and the condition of the watercourse is likely to recover through natural processes and the impact is predicted to be medium term (a year). Predicted to affect multiple or elongated stretches of a watercourse.
Low	Water quality, quantity and condition is predicted to recover rapidly through natural processes and the duration of impact is short (limited to the Construction and Pre-Commissioning Phase). Predicted to affect a limited stretch of a watercourse.
Negligible	No changes distinguishable from natural variability. Predicted to affect a single pool of a watercourse.

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

8.6.2.1 Assessment of Potential Impacts (Pre-mitigation)

The impact magnitudes have been assessed against the impact magnitude criteria described above. This has been combined with the receptor sensitivity assessment using the matrix approach described in **Chapter 3 Impact Assessment Methodology**. The results are summarised in Table 8.19 to Table 8.21.

Soils

Soils in Study Area

The estimated area for temporary facilities and works during construction in the Study Area is 52.33 hectares (ha) as outlined in **Chapter 5 Project Description.** This includes construction areas and storage areas. All open-cut pipeline construction activities will be undertaken within a temporary construction corridor. The construction corridor will nominally be 120 m wide.

Storage and Use of Fuels, Chemicals and Wastes

During the Construction and Pre-Commissioning Phase, fuels and chemicals will be stored and used on site. The storage facilities proposed include embedded mitigation as described in **Chapter 5 Project Description**; for example the diesel and slurry storage tanks are double-walled with leakage protection. Waste materials will be temporarily stored on site prior to disposal. Additionally, process wastewaters will be generated from mobile plant equipment and facilities operation, cleaning and maintenance. The handling of waste products, including hazardous materials (e.g. oil) is discussed in **Chapter 18 Waste Management**.

Potential contaminants include fuels, lubricants, cement, concrete, grout and slurry additives and metals. Contamination of the soil may result through accidental leaks or spills during construction (e.g. during refuelling or waste handling). Depending on the size and nature of the spillage, and the physical properties of the soil (including soil porosity, soil potential for pollutant sorption, and soil saturation), this could lead to contaminant migration and impacts at some distance from the site. The likelihood of leaks and spills occurring is higher in the main storage, refuelling and construction areas than along the Pipeline construction corridor. Refuelling of the fuel bowsers or vehicles within the construction sites will only be undertaken within designated refuelling areas. All fuel tanks will be located within secondary containment, which will form an impermeable bund, sufficient to contain at least 110% of the stored volume. The impact of a fuel spill on soil quality and condition may recover through natural processes and the impact is likely to be medium term. The likelihood of leaks and spills of grouts and slurry is primarily restricted to the construction area around the microtunnel entry shaft sites.

Leaks and spills are a potential impact of moderate magnitude to the agricultural soils, phaeozem soils and fluvisols, resulting in **Moderate** significance impact for agricultural soils and **High** significance impact for the phaeozem and fluvisol soils. The potential impact on other soils in the Study Area is low magnitude given the limited areas of these soils within construction areas, giving a **Low** significance impact.

Accidental damage to existing utilities could occur during land clearance and earthworks. This may result in contamination of the soil. This is likely to be minor in extent and is a low magnitude, resulting in **Low** significance impact for agricultural soils, **Moderate** significance impact for the phaeozem and fluvisol soils and **Low** significance impact for cambisols and anthropogenic soils.

Agricultural Soils and Phaeozem Soils

Land Clearance and Earthworks

Temporary alterations to ground conditions during the construction period may occur as a result of the clearance of land for the access roads, temporary construction areas, trenching activities, landfall facilities and vehicle movements.

The removal of vegetation will expose bare soils to erosion and/or compaction by the movement of heavy machinery and vehicles. The release of soil particles into surface watercourses and general migration down slopes could occur as a result of erosional processes (particularly where soil stockpiles are present).

Earthworks and stockpiling of soils can lead to the mixing of different soil types, and also the changing of the soil structure. Such mixing can influence soil type and structure, which may influence ecosystems or agricultural usage. Similarly, mixing of excavated soil types can result in the contamination of previously clean soils by contaminated soils.

For the access roads (excluding the Graphova Gap crossing, which is discussed below) and landfall facilities, the impacts associated with land clearance and earthworks are medium extent and moderate magnitude impacts for agricultural soils and phaeozem soils as the areas are less than 10 ha and the impacts are reversible, resulting in **Moderate** significance for agricultural soils and **High** significance for phaeozem soils.

For the temporary construction areas and trenching corridor (excluding Graphova Gap crossing, which is discussed below), the impact magnitude for agricultural soils is high as the area is large and is more than 10 ha, giving a **High** significance, and the impact magnitude for phaeozem soils and fluvisols is moderate given the minor extent of impact involved, giving a **High** significance for phaeozem soils.

In the event that excavated spoil generated as part of pipeline trenching or excavations for the landfall facilities or microtunnel entry shafts is unable to be re-used as part of Project, removal of excess spoil may be required. It is estimated that up to 15,000 m^3 of surplus spoil will be left over from the installation of the four pipelines. Any surplus or unsuitable backfilling material (such as inert waste) will be removed from site and disposed of at an approved waste handling facility. The handling of waste materials is discussed in **Chapter 18 Waste Management**. The potential loss of soil from the Project Area as a result of this is of minor extent and an impact of low magnitude and **Low** significance.

Microtunnelling

In order to construct the Pipeline through the sea cliff, 1.4 km of the Pipeline will be housed in microtunnels. The tunnelling has the potential to introduce contaminating materials to soil, including grouts, slurries and lubricants, particularly near the entry shafts. Uncontrolled ingress of slurry or grout into the subsurface could occur during the microtunnelling works. This is most likely to affect the soil in the vicinity of the entry shafts as the majority of the tunnelling is within bedrock. However, slurry or grout may migrate locally from bedrock into the overlying soils via fractures and fissure zones. Given the minor extent, the potential impacts are of low magnitude and **Low** significance.

Hydro-testing

Hydro-testing will be undertaken as part of the pipeline integrity checks post-construction. Therefore, there is a possibility that pipeline sections with poor seals may be identified. Leakage may occur in these areas or the worst-case scenario would be uncontrolled discharge of the test waters into the subsurface may occur temporarily. During the hydro-testing, the test water may contain increasing concentrations of suspended sediment including metal particulates. Other contaminants such as hydrocarbons may also be present. Depending on the location of the leaks, this could permit test water to infiltrate through the soil, potentially contaminating soil. The effects are expected to be minor in extent and the Pipeline will be below the topsoil. The potential impact has low magnitude and **Moderate** significance.

Fluvisols

Land Clearance and Earthworks

Land clearance and earthworks construction, particularly for the access roads and the microtunnelling construction platform, may cause increased potential for erosion and compaction and may cause changes to soil properties. The impact magnitude is moderate given their minor extent and the significance for the fluvisols is **High**.

Open-cut Trench Crossing at Graphova Gap

The landfall section of the Pipeline to the east of the microtunnels will be constructed using open-cut techniques. The Pipeline will cross the Graphova Gap, through which a tributary of the Sukko River flows. The watercourse at this point is ephemeral, i.e. flow rates vary in relation to rainfall events. During the summer, the flows are typically low and the watercourses can be dry during low rainfall periods. Additional baseflow is provided by springs, but these are anticipated to also vary seasonally and in response to rainfall events.

For each of the four pipelines crossing the gap, a dedicated trench will be excavated perpendicular to the watercourse, such that the top of pipelines will be approximately 1.5 to 2 m below the bed of the watercourse. The Pipeline route has been locally deepened as a design control measure to reduce the risk of scour or erosion during flood events. The bottom of the trench will be approximately 2 to 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 pipelines in the trench, protective measures will be installed as a design control measure 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 with rock fill (e.g. cobbles and boulders) on top of the Pipeline to prevent erosion, prior to backfilling. Following backfilling, the crossing will be reinstated, with banks rebuilt and seeded, or where additional stability is required, covered with a temporary geo-textile material or soil filled sacks where practicable. The modified slope angles created to aid slope stability during construction will be retained permanently post-reinstatement. All temporary works will then be removed.

Impacts on soils could include increased susceptibility to erosion due to vegetation clearance, the displacement of soils from the trenching process and the excavation and grading of the construction corridor due to the locally steep terrain, temporary stockpiling and storing of soil. The impact magnitudes for fluvisols taking into account the design controls are moderate given the works are localised but the effects may be medium term, giving a **High** significance.

Other Terrestrial Soils in Landfall Section (Cambisols and Anthropogenic Soils)

Land Clearance and Earthworks

Land clearance and earthworks during access road construction may cause increased potential for erosion and compaction and may cause changes to soil properties. The impact magnitudes and significance for the other soils in the Study Area are **Low** given their minor extent.

Geomorphologically Unstable Features

Impacts relating to ground instability are most likely to arise in areas of steep topography and where ground instability is already present due to natural weathering processes.

Land Clearance and Earthworks

Earthworks (including vegetation clearance, grading, soil stripping, trenching, and road access construction), stockpiles of excess spoil, construction of the land facilities and microtunnel entry shaft site have the potential to cause ground instability on slopes (either natural or man-made). This could lead to slope instability, associated ground subsidence and the formation of slope erosion features. Depending on the nature of the soil instability and ground movement, this could cause soil stability impacts that may extend over several years. The region is naturally subject to mudflows following intense rainfall events and materials from unstable slopes may be transported downstream during storm events. Ground instability of geomorphologically unstable features after the design controls are taken into account are of negligible magnitude giving a **Low** significance impact.

Open-cut Trench Crossing at Graphova Gap

As far as possible, the pipeline river crossing design at Graphova Gap takes the local topography into account to help manage ground instability risks. Ground instability of geomorphologically unstable features after the design controls are taken into account are of negligible magnitude giving a **Low** significance impact.

Microtunnelling

Microtunnelling beneath the Shingar River has reduced the likelihood of ground instability being caused by this aspect of the Project in the Shingar River valley and where the Pipeline crosses the coastal cliffs. Ground instability of geomorphologically unstable features after the design controls are taken into account are of negligible magnitude giving a **Low** significance impact.

Hydro-Testing

Potential leaks of water during hydro-testing could influence slope stability in areas of steeper terrain, predominantly associated with the valley sides. The effects are expected to be minor in extent and therefore the impact magnitude is low. The potential impact is of **Moderate** significance.

Human Health

Construction Workers

Elevated concentrations of contaminants that exceed published standards are known to occur in the soil within the Study Area (refer to the baseline in Section 8.5.1), albeit at comparatively low levels. The contaminants locally present in the soil may be harmful to human health under certain exposure scenarios. Contaminant concentrations in the soils appear to be highest in agricultural areas, at the watercourse crossings and near existing roads. Deposits of waste materials have been identified locally, including a ditch infilled with demolition materials that may contain asbestos. In addition to the known areas of contamination, the possibility exists that the Project may encounter currently unidentified, localised pockets of soil contamination, which may be disturbed by the earthworks. These may relate to past land use or uncontrolled waste disposal. However, the likelihood of encountering extensive unidentified contamination is relatively low given the current land uses in the Study Area.

Accidental leaks and spills during the works may also cause soil contamination (as discussed above).

Contaminated soil may affect construction workers through being inadvertently ingested or inhaled or through dermal contact. On the basis of the available information, the potential impact on human health before mitigation is of **High** significance given humans are a high sensitivity receptor and the magnitude is high due to a potential pollutant linkage being present between soil contaminants and humans.

Groundwater

Groundwater in Study Area

Potential impacts to the groundwater are likely to arise primarily in the Construction and Pre-Commissioning Phase through potential contamination from spills and leaks and potential disturbance of the flow regime during trenching and microtunnelling.

Storage and Use of Fuels, Chemicals and Wastes

During the Construction and Pre-Commissioning Phase, fuels and chemicals will be stored and used on site. The storage facilities proposed include embedded mitigation as described in **Chapter 5 Project Description**; for example the diesel and slurry storage tanks will have appropriate secondary containment for leakage protection. Waste materials will be temporarily stored on site prior to disposal. Additionally, process wastewaters will be generated from mobile plant equipment and facilities operation, cleaning and maintenance. Potential pollutants include fuels, lubricants, cement, concrete, grout and slurry additives and metals.

Construction workforce sewage and domestic wastewater will be generated. This includes wastewaters associated with ablution facilities, medical centres, showers, kitchens and other sewerage water mixed with drained water. The quantity of sewage and domestic wastewater produced depends on the number of workers present on onshore construction sites at any one time. All domestic wastewater shall be collected and tankered off-site to an appropriate waste treatment facility. Anticipated wastewater volumes and planned storage and disposal are further discussed in **Chapter 18 Waste Management**.

Accidental release of pollutants to groundwater may occur due to leaks or spills. Leaks and spills may contaminate the groundwater, either directly through infiltration and migration of wastewaters or liquid wastes, or indirectly by leaching of soil contamination. The removal of topsoil is likely to increase groundwater vulnerability. If the trench or excavation has intercepted groundwater, then the vulnerability of the groundwater to leaks and spills will be increased. The likelihood of leaks and spills occurring is likely to be higher in the main storage, refuelling and construction areas than along the main pipeline permanent RoW.

The majority of leaks and spills are likely to be relatively small in volume. Groundwater quality may be locally affected but is expected to gradually recover through natural attenuation over the medium term. The potential impact on groundwater quality associated with accidental leaks and spills is of moderate magnitude and **Moderate** significance for the aquifers in the Study Area. The impacts to the abstractions at Russkaya and Sukko are of negligible magnitude given the distance from the site and are **Not Significant**.

Accidental damage to existing utilities may occur during land clearance and earthworks. This could result in contamination of the groundwater, either directly or via the soil or surface waters. This is likely to be minor in extent and is a low magnitude impact of **Low** significance for the Study Area.

Concentrations of benzo(a)pyrene, arsenic, total PCBs and copper slightly exceeding screening criteria have been identified is parts of the Study Area. Whilst these concentrations exceed the screening criteria they are unlikely to be impacting groundwater in the underlying aquifers. Given the agricultural land use in the Study Area the likelihood of significant areas of unidentified contamination is considered to be low.

Land clearance including the removal of vegetation, topsoil, hardstanding or existing structures may increase the potential for infiltration of precipitation through the soil, increasing leaching of soil contaminants to groundwater. However, for low concentrations of contaminants this will be off-set in part by natural attenuation processes.

Based on the available baseline data on soil contamination, this is of minor extent and low magnitude impact of **Low** significance for the Study Area.

Land Clearance and Earthworks (Temporary Construction Areas)

If the pipeline trenches (except at the Graphova Gap, which is discussed below), access roads or excavations at the landfall facilities intersect the water table, then groundwater control (maintaining groundwater levels to enable dry excavation) may be required. Given the trench and excavation depths of only 2.5 m, dewatering is unlikely to be required along the entire Pipeline corridor. Similarly, access road construction is only expected to extend below the water table in the cuttings. However, locally there may be a requirement for groundwater control during construction. This may involve dewatering abstractions. The impacts will be temporary and recovery is expected to be rapid. The impact upon groundwater flows within the superficial and bedrock aquifers is low magnitude and **Low** significance.

Open-cut Trench Crossing at Graphova Gap

The open-cut trench crossing the watercourse at Graphova Gap is likely to intersect the water table in the alluvial aquifer; given the bedrock is locally exposed in the valleys the trench crossing may also intersect groundwater within the carbonate aquifer. Groundwater control (maintaining groundwater levels to enable dry excavation) is likely to be required. This may involve dewatering abstractions. The impact upon groundwater flows within the alluvial aquifer is low magnitude and **Moderate** significance as the impacts will be temporary and recovery is expected to be rapid. The degree of hydraulic connection between the superficial and carbonate aquifers is likely to be greatest in the valley bottom. However, given the trench depths compared with the aquifer thickness, the potential impact to the carbonate aquifer is anticipated to be negligible magnitude and **Not Significant**.

Microtunnelling

The tunnel entry shafts may intersect the water table. Groundwater control (maintaining groundwater levels to enable dry excavation) may be required. The shaft walls will act as a local barrier. Dewatering may also be required to manage groundwater during the excavation of the shafts. Any change in water level that occurs in response to dewatering will be temporary and recovery is expected to be rapid. The impact upon groundwater flows within the superficial aquifer is of negligible magnitude and **Not Significant** given the presence of the shaft walls. The impact on the carbonate aquifer is conservatively assessed to be low magnitude and **Moderate** significance; if dewatering is not required then this would drop to negligible and low respectively.

The tunnel is within the carbonate aquifer. The tunnelling itself is not expected to require groundwater control when below the water table as groundwater ingress will be controlled by operating the TBM in closed mode, which maintains a pressure system to actively support the tunnel face. Injection of grout into the formation will control groundwater ingress further. The impact on the flow regime in the carbonate aquifer during tunnelling taking into account the planned design controls is consequently of negligible magnitude and **Not Significant** as no changes to the groundwater flow regime are expected.

Tunnelling has the potential to introduce contaminating materials directly into groundwater in the form of lubricants and bentonite slurry. The volumes of lubricants that might enter groundwater accidentally during operation of the TBMs are expected to be low. Bentonite slurry[9] will be used to help stabilise the tunnels during excavation. Slurry may contain various additives to aid the tunnelling operations and some additives may contain hazardous chemicals. Under normal operating conditions, the slurry will form a filter cake around the edge of the tunnel excavation. This will help reduce losses of slurry into the surrounding ground. Where the microtunnels intersect fracture or fissure zones, slurry may be lost along individual fractures. Fracture zones may form preferential pathways linking to the alluvial aquifer or surface water features. Given the absence of known karstic features (Ref. 8.1), the distance slurry may travel along fractures is likely to be of the order of a few metres. Groundwater quality immediately

[9] Slurry may sometimes be referred to as mud.

adjacent to the slurry may be temporarily influenced. The majority of the slurry will be removed during grouting and no permanent impact on groundwater quality associated with slurry is expected. The impacts on the superficial aquifer and carbonate aquifer are low magnitude and **Low** significance.

As the tunnelling machine exits the tunnel, seawater will enter the tunnel. The residual slurry on the tunnel walls will reduce the ingress of seawater into the aquifer. The hydraulic gradient and differences in water density are expected to reduce the inland migration of saline water migration within the aquifer via the tunnel. During grouting, seawater remaining within the tunnel annulus will be gradually displaced in a seaward direction (**Chapter 5 Project Description**) but any seawater that has entered the aquifer surrounding the annulus may remain. Through the prevailing hydraulic gradient and differences in water density the balance in fresh water and saline water within the aquifer is likely to return to its original condition over time and mitigate any long term impacts post-construction. The impacts on the alluvial aquifer are negligible magnitude, because the aquifer is above sea level, and are **Not Significant**. The impacts on the carbonate aquifer are low magnitude and **Low** significance.

Subsurface grouting around the tunnels will occur. The majority of the tunnels are within the carbonate aquifer. Where the microtunnels intersect fracture zones, grout may be lost along individual fractures. Fracture and fissure zones may form preferential pathways linking to the alluvial aquifer or surface water features. Given the absence of known karstic features (Ref. 8.1), the distance grout may travel, along fractures and fissures, is likely to be of the order of a few metres. As grout goes off, it can temporarily and locally influence the chemical quality of the adjacent groundwater, changing the pH and level of mineralisation. Metal concentrations may also rise. The presence of the grout may locally reduce aquifer permeability around the tunnels. The impacts of grouting are expected to be localised. The impacts of grouting on the superficial and carbonate aquifers are of low magnitude and **Low** significance.

Hydro-Testing

As described in **Chapter 5 Project Description**, the pipelines will be cleaned prior to hydro-testing. Seawater and debris (consisting of rust, coating and weld debris) will be captured in temporary onshore water storage (break) tanks. The collected seawater will be stored for a sufficient length of time to allow the debris to settle to the bottom. The debris will be removed from site and disposed of through an approved waste disposal company. The seawater will be temporarily stored and then pumped back into the pipelines during hydro-testing. If leakage or spills from the storage tank occurred, saline water could infiltrate into the subsurface and migrate down into the aquifer. However, the event will be short-lived and temporary, and dilution within the groundwater will occur. Particulate matter, for example metal particles, is unlikely to migrate far. The impacts to both the superficial and carbonate aquifers are low magnitude and **Low** significance.

The hydro-testing of the pipelines will be undertaken using seawater. As described in **Chapter 5 Project Description**, the test water will be filtered seawater injected with an oxygen scavenger (sodium bisulphite)[10] to prevent internal corrosion of the Pipeline prior to dewatering at an injection rate of 250 parts per million (ppm). In the event that the hydro-test 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. The hydro-testing will then be repeated. Leakage from the Pipeline during a hydro-test failure would infiltrate through the subsurface and enter groundwater. As the pipeline will be buried or within a microtunnel, there may be minimal or no unsaturated zone present to attenuate any pollutants present prior to reaching groundwater. However, the event will be of short duration and dilution within groundwater will occur. Particulate matter, for example metal particles, is unlikely to migrate far. Locally the salinity of the groundwater would temporarily increase but then would gradually attenuate through natural processes such as dilution and dispersion. The impacts to both the superficial and carbonate aquifers are moderate magnitude and **Moderate** significance.

Following completion of the hydro-testing, the remaining seawater within the Pipeline will be discharged to the sea and the Pipeline will be dewatered.

The hydro-testing of the landfall facilities will be undertaken using fresh water. Leakage during a hydro-test failure at the landfall facilities would enter the site drainage system or infiltrate through the subsurface and enter groundwater. However, the event will be of short duration and dilution within groundwater will occur. Particulate matter, for example metal particles, is unlikely to migrate far. The impacts to both the superficial and carbonate aquifers are low magnitude and **Low** significance.

As described in **Chapter 5 Project Description**, it is possible that the filtered hydro-test water from the first pipeline segments will be collected and temporarily stored on site in tanks for use in hydro-testing the remaining three pipelines within the landfall facilities. If this is not possible, the filtered water (containing no particulates or chemicals) will be discharged into a sump constructed in an appropriate location within one of the temporary construction sites to allow the water to infiltrate into the ground. As the water used in the hydro-testing of the landfall facilities will be fresh and will be filtered, the impacts to both the superficial and carbonate aquifers are of negligible magnitude and are **Not Significant**.

Water Abstraction

Groundwater will be abstracted from the existing Ministry of Defence water supply in Sukko for freshwater supply during construction. An estimated total volume of 37,000 m^3 of freshwater is required for the microtunnelling process and 500 m^3 is required for hydro-testing of the landfall facilities. In addition, it is estimated that up to 25 m^3 per day freshwater will be used for general construction activities (domestic usages, wheel washing etc.) during peak periods. The water will be trucked to the construction areas from Sukko. There is a May to September (inclusive) exclusion period when water cannot be abstracted from the existing source at Sukko.

[10] Sodium Bisulphite is listed in OSPAR's list of additives that Pose Little or No Risk to the environment (PLONOR). OSPAR refers to the Oslo and Paris *Conventions for the Protection of the marine Environment of the North-East Atlantic* (OSPAR Conventions), 1992.

Due to this restriction, a large quantity of water (up to 10,000 m^3) may need to be stored at the western end of the Pipeline stringing area temporary construction site (adjacent to the microtunnel construction site). A much smaller quantity of water (no more than 800 m^3) may need to be stored at the landfall facilities site.

It is assumed that the licensed abstraction rate, including the seasonal exclusion period, has been set at a rate that will not cause the derogation, in terms of quality and quantity, of the aquifer resources, or of any other groundwater users within Sukko that utilise the same aquifer. The rate of abstraction during construction will not exceed the licensed rate and the impact to the groundwater resource is of negligible magnitude and **Not Significant**.

Surface Waters

Surface Waters in Study Area

Potential impacts to the surface watercourses are likely to arise primarily in the Construction and Pre-Commissioning Phase through potential spills and leaks, discharges and disturbance of soil and sediment leading to impacted surface water run-off.

Storage and Use of Fuels, Chemicals and Wastes

During the Construction and Pre-Commissioning Phase, fuels and chemicals will be stored and used on site. The storage facilities proposed include embedded mitigation as described in **Chapter 5 Project Description**; for example the diesel and slurry storage tanks are double-walled with leakage protection. Waste materials will be temporarily stored on site prior to disposal (**Chapter 18 Waste Management**). Additionally, process wastewaters will be generated from mobile plant equipment and facilities operation, cleaning and maintenance. Potential pollutants include fuels, lubricants, cement, concrete, grout, slurry additives and metals and waste waters (**Chapter 18 Waste Management**). As discussed for groundwater (Section 8.6.1.1), all domestic wastewaters are captured and transported by tanker to appropriate disposal sites.

Accidental release of pollutants to surface water may occur due to leaks or spills, either by entering watercourses directly, or through leaching from impacted soil to groundwater and subsequent migration in groundwater.

As described in **Chapter 5 Project Description**, stormwater drainage systems will be constructed at the landfall facilities site, the microtunnel construction site and the landfall construction site. The drainage systems will collect and manage surface water run-off. The drainage systems will incorporate measures to reduce suspended sediment concentrations and an oil separator and collection system.

The majority of leaks and spills are likely to be relatively small in volume. Long term potential impacts on surface waters are likely to be attenuated through natural processes such as dilution and degradation. Short term impacts may be more significant. Depending on the size and nature of the spillage, this could cause water quality or sediment quality impacts which affect elongated stretches of the watercourse and at some distance downstream from the site and it is therefore a potential impact of moderate magnitude and **Moderate** significance for the watercourses and the surface water abstractor.

Accidental damage to existing utilities may occur during land clearance and earthworks. This may result in contamination of the surface waters, either directly or via the soil or groundwater. This is likely to be temporary and limited in extent and is a low magnitude impact of **Low** significance for the watercourses and a moderate impact of **Moderate** significance for the assumed surface water abstractor.

Land Clearance and Earthworks

Temporary alterations to the surface water flow volumes and rates may occur as a result of trenching, land clearance, access road construction, development of the temporary construction areas and vehicle movements. It is likely that surface water run-off will temporarily increase in the temporary construction areas and permanently at the landfall facilities, due to the removal of vegetation, compaction of bare soils, and hardstanding at the landfall facility.

Increased sediment entering the surface watercourses could result from land clearance, excavation works and erosional processes (particularly on soil stockpiles and on access roads close to gullies until road drainage is established). The region is naturally subject to mudflows following intense rainfall events and materials from unstable slopes may be transported downstream during storm events. Increased sediment load may alter the flood capacity, increase water turbidity, and smother aquatic and riparian flora and fauna. The eroded sediment may also have a high nutrient or contaminant content which can contribute to the enrichment and contamination of downstream waters. Impacts on surface water quality will typically be of short duration (i.e. during and immediately after a storm event). It is considered that the watercourses will be able to recover relatively rapidly through natural processes; timescales are likely to be weeks to months depending on weather and the flow regime.

The impacts associated with land clearance and earthworks in the catchments of the Shingar River and the unnamed tributary in the Graphova Gap (except at the Graphova Gap crossing, which is discussed below) are likely to be medium term and of moderate magnitude and **Moderate** significance prior to mitigation for the watercourses and the assumed surface water abstraction.

Open-Cut Trench Crossing at Graphova Gap

Open cut trenching is proposed for the Graphova Gap pipeline crossing. Open cut trenching across the river will temporarily alter the flow during the installation works at the crossing and potentially result in flows during a flood event being diverted onto the surrounding floodplain. Given the nature of the topography at the crossing site with relatively steep valley sides, the impacts on the flow regime are likely to be local to the crossing. The crossing may also affect the sediment load and quality of the water at the crossing and along the downstream stretch of the watercourse. It is proposed that the construction be undertaken in dry weather when there is little to no flow in the ephemeral watercourse, which will reduce the likelihood of impacts. However, based on the worst case assumption that there are flows in the watercourse due to rainfall at the time of crossing construction, the impacts on the tributary in the Graphova Gap are medium term and is of moderate magnitude and **Moderate** significance. The assumed surface water abstraction is upstream and so should not be impacted.

Microtunnelling beneath the Shingar River

Microtunnelling is proposed for the Shingar River crossing. No direct disturbance of the Shingar River is expected as the microtunnels will be about 14 m below the base of the river. Indirect impacts may occur due to changes in groundwater quality resulting from slurry ingress and grouting during microtunnelling; these impacts are expected to be temporary and short lived. The impacts are of low magnitude and **Low** significance.

If failure of the slurry storage tanks occurred, slurry could directly enter the Shingar River via the tributary gully. If this happened, the consequences to water quality in the river could extend for a considerable distance downstream given the volumes of slurry being stored. However, the likelihood of this occurring is considered to be very low given the design controls in place, including bunded storage tanks with leakage protection (**Chapter 5 Project Description**). However, in the unlikely event that a major spill did occur, the impacts are of high magnitude and **High** significance.

Hydro-testing

As described in **Chapter 5 Project Description**, the pipelines will be cleaned prior to hydro-testing. Seawater and debris (consisting of rust, coating and weld debris) will be captured in temporary onshore water storage (break) tanks; the stored volume will be 100 m^3. The collected seawater will be stored for a sufficient length of time to allow the debris to settle to the bottom. The debris will be removed from site and disposed of through an approved waste disposal company. The seawater will be temporarily stored and then pumped back into the pipelines during hydro-testing. If leakage or spills from the storage tank occurred, saline water could directly enter the Shingar River via run-off or indirectly via groundwater. However, the event will be short-lived and temporary, and dilution will occur. Particulate matter, for example metal particles, is unlikely to migrate far in the short-term but will enter stream bed sediments. The impacts to the Shingar River are of low magnitude and **Low** significance.

The hydro-testing will be undertaken using treated seawater; the volume of seawater used for hydro-testing will be 2,000 m^3 per pipeline. As described in **Chapter 5 Project Description**, the test water will be filtered seawater injected with an oxygen scavenger (sodium bisulphite)[11] to prevent internal corrosion of the Pipeline prior to dewatering at an injection rate of 250 parts per million (ppm).

In the event that the hydro-test 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. The hydro-testing will then be repeated. Leakage during hydro-testing would be expected to infiltrate through the subsurface and may enter surface waters, usually via groundwater. This may temporarily affect surface water quality. The potential impacts in the tributary at the Graphova Gap may be medium term and are moderate magnitude and **Moderate** significance as leakage may enter surface waters directly at

[11] Sodium Bisulphite is listed in OSPAR's list of additives that Pose Little or No Risk to the environment (PLONOR). OSPAR refers to the Oslo and Paris *Conventions for the Protection of the marine Environment of the North-East Atlantic* (OSPAR Conventions), 1992.

Graphova Gap as well as indirectly via groundwater. At the Shingar River, the Pipeline is in a tunnel 14 m beneath the river but the indirect pathway via groundwater from elsewhere in the catchment may remain. The potential impacts at the Shingar River are short lived and of low magnitude and **Low** significance.

Following completion of the hydro-testing, the remaining seawater within the pipeline will be discharged to the sea and the Pipeline will be dewatered.

The hydro-testing of the landfall facilities will be undertaken using fresh water. Leakage during a hydro-test failure at the landfall facilities would enter the site drainage system or infiltrate through the subsurface and enter groundwater. The water may then reach the tributary of Graphova Gap. However, the event will be of short duration and dilution will occur. Particulate matter, for example metal particles, is unlikely to migrate far in the short-term but in the unlikely event that particulate matter was to reach the watercourse it may enter stream bed sediments. The impacts to the tributary within the Graphova Gap are of low magnitude and **Low** significance.

8.6.2.2 Mitigation and Monitoring

Potential impacts from Project Activities to soil, groundwater, surface water and human health have been identified. The significance of these impacts has been assessed based on the sensitivity of each receptor and the expected magnitude of the potential impacts. The results of this assessment are presented in Table 8.19, Table 8.20 and Table 8.22.

Where impacts are identified as being significant, mitigation measures will be required to minimise the impacts or reduce the likelihood of an impact occurring. Appropriate mitigation measures, recommended to be implemented in addition to the design controls described in **Chapter 5 Project Description**, are presented in this section.

Note that many of the proposed mitigation measures aim to reduce the likelihood of impacts occurring, for example impacts associated with accidental leaks and spills. The pathways may still be present and the scale and duration of the effects may not necessarily be reduced. However, the likely frequency of the potential impacts will be reduced.

The mitigation measures will be controlled through the Russian Landfall Construction Management Plan (CMP), which will be developed as part of South Stream Transport's Environmental and Social Management Plan (ESMP), outlined in **Chapter 22 Environmental and Social Management**. Monitoring will record how effective mitigation is and, if appropriate, may result in changes to the mitigation measures.

The construction contractor will ensure that site personnel are trained to be familiar with the current legislation and to comply with the requirements of the CMP. In particular, project staff will be made aware of:

- The relevant water and waste management requirements set out in the CMP and the contractors' own Waste Management Plan to address handling, transportation and storage of waste and discharges of wastewater;
- The relevant contractor's Spill Prevention and Response Plan for all chemicals, fuels and oils used during the Project; and

- The Project Overarching Environmental and Social Monitoring Programme and Project Emergency Preparedness and Response Plan.

Soils Mitigation (including Human Health)

A number of the design controls described in **Chapter 5 Project Description** aim to reduce the risks to soils during construction (Section 8.6.1.1). Additional mitigation measures are presented below to address significant impacts.

To reduce the potential impact from spills and leaks compliance with the Russian Landfall CMP is required. The control measures to be adopted by the Project will be defined within a Spill Prevention and Response Plan which will be developed and maintained by each Project contractor.

Specific mitigation measures required to maintain soil quality during the Construction and Pre-Commissioning Phase include spillage prevention, bunding and restrictions near drains and watercourses, to avoid impacts. Materials will be stored, where practicable, with secondary containment and a full method statement to address construction risks and avoid impacts.

Activities near to drains and exposed sensitive soil areas will be controlled appropriately and in accordance with requirements in the Russian Landfall CMP to avoid adverse impacts.

Appropriate storage and handling protocols will be required for fuels and other chemicals used on site. Refuelling will only be undertaken in designated areas.

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. 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.

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. The requirements of the Russian Landfall 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 and 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 hardstanding. 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.

Spill kits shall be kept in accessible locations at all times during construction, and employees trained in their use and disposal. To reduce the potential impact from spills and leaks compliance with the Russian Landfall CMP is required. The control measures to be adopted by the Project will be defined within a Spill Prevention and Response Plan which will be developed and maintained by each Project contractor.

All bulk materials and wastes used in the construction activities with the potential to pollute will be stored within appropriate storage facilities (bunded, secondary containment) and procedures will be implemented for handling, storage, transport and transfer, in order to minimise the potential for leaks or spills.

The exact storage locations and dimensions of the water storage tanks will be finalised during the detailed design and will be agreed between the Contractor, South Stream Transport and the relevant local authorities.

To mitigate the potential risks to the health of construction workers, should soil contamination be identified, appropriate personal protection equipment will be used and hygiene facilities made available to all workers.

Mitigation measures that will increase the protection of existing soil quality and structure include:

- Spillage prevention, bunding and restrictions near artificial drains, sensitive soils (moderate/high sensitivity) and water bodies to minimise impact. Material will be stored away from sensitive soils and water bodies where possible, with secondary containment. Remediate as far as practicable any pollution of soil and water;
- Soil and ground disturbance will be restricted to the Pipeline construction corridor, the footprint of the temporary and permanent landfall facilities and construction of temporary and permanent access roads;
- Vehicle movements will be restricted to defined access roads and hardstanding areas as far as possible to minimise compaction of the soils and changes to surface water runoff rates and volumes;
- Area of ground excavation and exposed soils and spoil heaps will be limited as far as possible to reduce the potential for erosion and sediment run-off. Additionally, during heavy rainfall, potentially polluting activities will be limited, as appropriate;
- Limit quantity of excavated soil material as far as practical, prevention of contamination of stockpiled material through appropriate waste management (**Chapter 18 Waste Management**) and management of stored soils to prevent contamination and change of soil properties; increasing the potential for re-use of soils on site, and decreasing the need for removal of soils from the landfall section to landfill;
- Minimise loss of soil through the implementation of GIIP. Management of stored soils to prevent contamination and change of geotechnical properties. Increase the potential for re-use of soils on site, and decrease the need for removal of soils from the Project Area to landfill;
- Pre-construction surveys and GIIP will be used to reduce the risk of accidental damage to existing utilities that might cause contamination;

- Construction measures in accordance with GIIP will be used to reduce the potential for soils mixing due to earthworks or erosion of soils. This will also reduce the risk of soil-based contaminant migration during earthworks;
- Removal of anthropogenic materials from existing infilled ditch and disposal off-site to an appropriately licensed waste disposal facility. This material potentially contains asbestos. The risks to human health will be managed in accordance with GIIP during handling, storage and transport of the waste materials;
- In the event that previously unidentified contamination is encountered during construction, works in the affected area will cease and appropriate steps will be taken in accordance with the Contractor's Contingency Plan, developed as part of the Contractor's Emergency Response Plan;
- Areas disturbed during construction activities, will be rehabilitated in accordance with the Russian Landfall CMP. Construction site rehabilitation will be started as soon as practicable following construction to limit loss of soil through erosion;
- Sediment and erosion controls (e.g. cut-off drains, swales, detention and retention basins, mesh fencing, sandbags etc.) will be implemented at construction sites to limit the loss of soil from the site;
- Ensure silted water is appropriately managed prior to entering into any watercourses, attenuation measures to minimise soil erosion and impacts on water quality through potential disturbance of sediment;
- Soil excavated from Pipeline trenches will be stored on the uphill side of the trench, where possible, until re-use or disposal;
- No stockpiles will be located within 50 m of a watercourse. Stockpiles will generally be less than 2 m high. Stockpiles will not be located on unstable slopes. Stockpiles will be covered to prevent erosion as required. Run-off collection and management systems shall be used to remove pathways which enable the entrained sediment to enter watercourses;
- Geotechnical engineering methods will be used if necessary to help stabilise temporary and permanent slopes at the landfall facilities. The potential for slope failures to occur will be minimised through design, management and monitoring;
- Management of microtunnelling and grouting operations will reduce risk of uncontrolled movement of slurry or grout through subsurface;
- To avoid the damage of phaeozem soils and instability of slopes, the potential for such failures to occur will be minimised through design, management and monitoring (in particular of excavation works). This includes the management of drainage systems, prevention of soil loading by restricting the height of stockpiles to 2 m, risk-assessed allocation of phaeozem soil and spoil storage areas by contractor, and monitoring of soils, water bodies, watercourses and drainage paths;
- Appropriate construction management practices will reduce the probability of occurrence of slope instabilities, activation of landslides, collapsing and slope erosion. Use of geotechnical engineering measures to aid slope stability. Design, management and monitoring carried

out in line with the appropriate Construction Method Statements. Siting of stockpiles away from watercourses or unstable slopes;

- Appropriate tunnelling and grouting management practice to minimise loss of grout and slurry to the surrounding formation;
- Direct discharges from access road drains to watercourses will be avoided where sediment can collect within the drain and be discharged during high flows. In such cases discharge will be via a filter system (swale or silt trap). The receiving watercourses are to be identified and agreed with appropriate authorities. Discharge will generally be by gravity to avoid disturbance of settled silts in the cut-off trenches. All discharge points will be designed to minimise scour;
- Ditches and lateral drains alongside the construction works areas (including pipeline trench activities, foundations and access roads) will be sized to a 1 in 100 rainfall event;
- Mitigation measures will include the management of drainage systems, minimisation of soft soils loading, risk-assessed allocation of soil and spoil storage areas, monitoring of excavation and construction works and monitoring of watercourses and drainage paths;
- Surface water runoff control measures for earthworks will generally comprise infiltration and cut-off trenches, formed at suitable locations to intercept flows and reduce the velocity and sediment content. The gradient of the trenches will be as flat as possible to avoid high velocities during storm events;
- Throughout the lifespan of the Project periodic inspection and cleaning of blockages within the site drainage will be carried out;
- Areas disturbed during construction activities, will be rehabilitated. Construction site rehabilitation will be started as soon as practicable following construction to limit loss of soil through erosion;
- Reinstate soils and replant as soon as possible after construction and testing; and
- Safe working plans as set out in the Health, Safety, Security and Environment – Integrated Management System (HSSE-IMS).

Soils Investigation and Monitoring

Study Area:

- No additional pre-construction investigation or monitoring is required;
- During construction, a watching brief will be in place during earthworks. A remediation and contingency plan will be developed to deal with encountering soil contamination not identified during the pre-construction studies;
- Monitoring of soil quality will be undertaken during the Construction Phase. The monitoring shall include soil sampling at a small number of locations along the RoW. The sampling will be undertaken on an annual basis during construction and on completion of the land restoration along the RoW. The soil samples shall be analysed for basic soil properties such as pH and organic matter content, as well as measurement of nutrients and potential pollutants concentrations (including metals and petroleum hydrocarbons); and

- Monitoring of the active geomorphological features will be undertaken during the Construction Phase. The monitoring shall include route inspections of active geomorphological features on a quarterly basis and on completion of the land restoration along the RoW. Additional monitoring will be undertaken following natural events that might affect geomorphological stability such as seismic events or flooding.

Groundwater Mitigation

In addition to the design controls (Section 8.6.1.1) and mitigation measures for soil outlined above (Section 8.6.2.2), the following mitigation measures will be adopted to minimise the potential for adverse impacts to groundwater:

- Sanitary and process wastewaters generated during construction will be stored in temporary facilities (mobile installations for wastewater treatment or septic tanks) and then regularly transported and disposed of in a nearby licensed facility for disposal of wastewater;
- Where dewatering is required all necessary discharge consents will be put in place. The quality of the water being discharged will be in accordance with the agreed discharge standards. If necessary, the abstracted water will be treated prior to discharge;
- All necessary discharge consents will be put in place prior to the disposal of the fresh water from the hydro-testing of the landfall facilities. The quality of the water being discharged will be in accordance with the agreed discharge standards;
- Groundwater control measures appropriate to the ground conditions will be used. Low permeability walls will be constructed for the tunnel entry shafts prior to dewatering;
- During heavy rainfall, potentially polluting activities such as dewatering of excavations is to be limited;
- Abstraction rates during any required dewatering of excavations will align with permitted agreements for any existing boreholes in use and in particular derogation of other water users will be avoided;
- Excavations should be backfilled with material with a similar permeability to the natural formation to prevent creating barriers or preferential pathways for water movement through the subsurface;
- The Drilling Management Plan will include measures to control groundwater ingress and minimise drilling fluid or grout loss from the trenchless option into surrounding aquifers. Avoid use of additives containing hazardous chemicals in drilling fluid or grout. Non hazardous chemicals will not exceed drinking water standards. All used additives will comply with PLONOR and therefore will be with low toxicity;
- If the ground conditions encountered during the excavation works indicate that there is the potential for the Pipeline at the Graphova Gap to create a barrier to groundwater flow such that baseflow to watercourses will be significantly affected, then drainage will be designed to allow groundwater to by-pass the obstruction to groundwater flow;
- Choice of anode material. Materials that are non-hazardous are preferable. Position the anodes above the water table if possible;

- Excavations should be backfilled with material with a similar permeability to the natural formation to prevent creating barriers or preferential pathways for water movement through the subsurface;
- If leaks or pipeline failure occurs during hydro-testing, the test will be stopped immediately to minimise potential infiltration of test water into the groundwater; and
- The leaching of grouts and drilling fluids will not cause pollution of groundwater and Russian standard SanPiN 2.1.4.1175-02 and Russian standard GN 2.1.5.1315-03 will be complied with.

As outlined in **Chapter 5 Project Description**, any construction activities in the Graphova Gap will be undertaken during dry weather as far as is practicable, when the groundwater levels and surface water flows are expected to be lower.

Groundwater Investigation and Monitoring

Groundwater will be monitored during and following the construction works. The monitoring programme will be agreed with the Russian Federation and shall adhere with national requirements. The monitoring programme will be included in South Stream Transport's Environmental and Social Monitoring Programme discussed in **Chapter 22 Environmental and Social Management**.

Study Area:

- The groundwater monitoring network will include selected natural springs as well as monitoring boreholes adjacent to the microtunnels in the Shingar River valley. The monitoring will include measurement of groundwater levels (or flow rates from springs) plus the collection of groundwater samples. The samples shall be analysed for basic water chemistry, such as pH and electrical conductivity, as well as to assess potential pollutant concentrations (including metals and petroleum hydrocarbons);
- Pre-construction monitoring of groundwater in accordance with South Stream Transport's Environmental and Social Monitoring Programme. This will include a monitoring round immediately prior to the start of construction to confirm there has been no significant change in groundwater quality since the baseline studies;
- Construction monitoring of groundwater in accordance with the Environmental and Social Monitoring Programme. Monitoring of groundwater levels and quality shall be undertaken at regular intervals during construction, with the frequency increased during microtunnelling and construction activities within the Graphova Gap;
- During construction a watching brief will be held during excavations. A remediation and contingency plan will be developed in the Contractor's Emergency Response Plan to manage any groundwater contamination not identified during the pre-construction investigations; and
- Post-construction monitoring of groundwater in accordance with the Environmental and Social Monitoring Programme.

Surface Water Mitigation

In addition to the design controls (Section 8.6.1.1) and mitigation measures for soil and groundwater outlined above (Section 8.6.2.2), many of which are also relevant to potential surface water impacts, the following mitigation measures are also recommended to minimise the potential for adverse impacts to surface waters:

- Spillage prevention, bunding and restrictions near artificial drains, sensitive soils (moderate/high sensitivity) and water bodies to minimise impact. Material will be stored away from sensitive soils and water bodies where possible, with secondary containment. Remediate as far as practicable any pollution of soil and water;
- The timing of construction activities in the Project Area will be important in limiting the potential for adverse impacts to surface waters. Where possible, construction in the immediate vicinity of watercourses will be carried out during dry weather, when the nearby watercourses have low or no flow and surface water runoff will be minimal;
- Appropriate diversion channels, or alternatively over-pumping provision, will be incorporated during construction in the Project Area such that continuity of the stream flow will be maintained during the works in the event of low intensity rainfall events during construction;
- Silt fences and/or other suitable measures will be located along and adjacent to the Graphova Gap crossing, as required. Other mitigation measures such as entrapment matting will be used where necessary. In order to prevent direct unplanned discharge to watercourses, drainage pathways will be identified during construction works and silt fences, settlement ponds, sediment entrapment matting and straw bales installed as necessary;
- Natural drainage patterns, in particular in the vicinity of surface water crossings will, where necessary, be maintained. Natural flows will, where necessary, be maintained. Existing artificial drainage to be diverted maintaining gravity flows;
- At the Project Area direct discharge of surface run-off to watercourses will be avoided as far as possible. Surface water runoff control measures for earthworks will generally comprise infiltration and cut-off trenches, formed at suitable locations to intercept flows and reduce velocity and sediment content. Ditches and lateral drains alongside the construction works areas (including pipeline trench activities, foundations and access roads) will be appropriately sized through GIIP for design and construction. Drainage systems shall be generally designed to be gravity controlled to avoid disturbance of settled silts. Drainage systems will be aligned with natural drainage patterns;
- Surface run-off treatment systems will be implemented at the landfall facilities to control the quality of the surface run-off entering watercourses. The drainage systems for the landfall facilities and the microtunnel construction area will include stormwater treatment systems. The necessary consents will be in place prior to discharge commencing. The quality of the water being discharged will be in accordance with the discharge consent. The treatment standards will be aligned with national water quality standards (Table 8.3). Treatment of road and pipeline construction corridor stormwater will not be undertaken;
- All drainage discharge points will be designed to minimise scour;

- Throughout the lifespan of the Project, periodic inspection and cleaning of blockages within the site drainage will be carried out. Limiting the area of ground to be excavated and the areas of exposed soils or spoil heaps will reduce the potential for erosion and sedimentation. Additionally, during heavy rainfall, potentially polluting activities such as dewatering of excavations is to be limited;
- The gradient of the pipeline trenches will be as flat as possible to avoid high velocities during storm events;
- Sediment and erosion controls will be implemented at construction sites to limit sediment in runoff;
- Road edge drains will be led away by ditches into drainage swales via settlement lagoons and small ponds away from the road edges so that runoff is controlled to prevent sediment entering local surface waters;
- Direct discharges from the landfall facilities drainage systems to watercourses will be avoided;
- No stockpiles will be stored within 50 m of any watercourses;
- Any stockpiles that are to be left for some time will be covered to prevent erosion and silt fences used to remove pathways which enable the entrained sediment to enter watercourses;
- Inspection and cleaning of pipe sections before installation will reduce the quantity of sediments and contaminants present in the dewatering and cleaning effluent, as well as from dewatering of the sites; and
- Collection and recycling of the drilling fluid and grout used in microtunnelling, which reduces water consumption.

Surface Water Investigation and Monitoring

Surface water will be monitored during and following the construction works. The monitoring programme will be agreed with the Russian Federation and shall adhere with national requirements. The monitoring programme is further discussed in **Chapter 22 Environmental and Social Management**.

Study Area:

- The monitoring network will comprise upstream and downstream locations on the Shingar River and the watercourse in the Graphova Gap. The monitoring will include measurement of surface water flows plus the collection of water and stream bed sediments samples. The water samples shall be analysed for basic chemistry, such as pH, electrical conductivity, dissolved oxygen and suspended solids, as well as to assess potential pollutant concentrations (including metals and petroleum hydrocarbons). The sediment samples shall be analysed for basic properties, such as pH, particle size distribution and organic matter content, as well as to assess potential pollutant concentrations (including metals and petroleum hydrocarbons);
- Pre-construction monitoring of surface water will be undertaken in accordance with Environmental and Social Monitoring Programme. This will include a monitoring round

immediately prior to the start of construction to confirm there has been no significant change in surface water or sediment quality since the baseline studies;

- The Environmental and Social Monitoring Programme includes construction monitoring of surface water;
- Monitoring of surface water will be undertaken during the Construction Phase in accordance with Environmental and Social Monitoring Programme. Monitoring of surface water flows and water quality shall be undertaken at regular intervals during construction, with the frequency increased during construction activities within or immediately adjacent to the watercourses; and
- During construction a watching brief will be held. A contingency plan will be developed in the Contractor's Emergency Response Plan to manage surface water contamination not identified during the pre-construction investigations.

Post-construction monitoring of surface water in accordance with Environmental and Social Monitoring Programme.

8.6.2.3 Residual Impacts: Construction and Pre-Commissioning Phase

Table 8.19, Table 8.20 and Table 8.21 present a summary of the potential residual impact significance to soil and terrestrial sediment, groundwater and surface water arising from the Project following application of the identified mitigation measures (Section 8.6.2.2).

The assessment of the significance of residual impacts assumes full application and effectiveness of the mitigation measures.

Soils

The mitigation measures proposed reduce the significance of the residual impacts on soils and sediments to **Low**.

Groundwater

The mitigation measures proposed reduce the significance of the residual impacts on groundwater to being **Low** to **Not Significant**.

Surface Water

The mitigation measures proposed reduce the significance of the residual impacts on surface watercourses to being **Low** to **Not Significant**. The residual impact at the surface water abstractor is **Low**.

Human Health

The mitigation measures proposed reduce the significance of the residual impacts on humans to **Low**.

Table 8.19 Assessment of Soil and Human Health Potential Impacts: Construction and Pre-Commissioning Phase

Site/Activity	Potential Impacts	Receptor	Sensitivity of Receptor	Magnitude of Impact	Pre-Mitigation Impact Significance	Mitigation Measures	Residual Impact Significance
General construction activities	Leaks and spills during use and storage of hazardous materials causing contamination of soil	Agricultural soils	Moderate	Moderate	Moderate	Spillage prevention, bunding and restrictions near artificial drains, sensitive soils (i.e., of moderate to high sensitivity) and water bodies to minimise impact. Material will be stored away from sensitive soils and water bodies where possible, with secondary containment. Compliance with the ESMP, and Project Emergency Preparedness and Response Plan	Low
		Phaeozem soils	High	Moderate	High		Low
		Fluvisols	High	Moderate	High		Low
		Other soils	Low	Low	Low		Low
	Accidental damage to existing utilities causing soil contamination	Agricultural soils	Moderate	Low	Low	Pre-construction surveys and Good International Industry Practice will be used to reduce the risk of accidental damage to existing utilities that might cause contamination. Compliance with the ESMP, and Project Emergency Preparedness and Response Plan	Low
		Phaeozem soils	High	Low	Moderate		Low
		Fluvisols	High	Low	Moderate		Low
		Other soils	Low	Low	Low		Low

Continued...

Site/Activity	Potential Impacts	Receptor	Sensitivity of Receptor	Magnitude of Impact	Pre-Mitigation Impact Significance	Mitigation Measures	Residual Impact Significance
	Contact with contaminated soil posing a risk to human health	Construction workers	High	High	High	Use of appropriate personal protection equipment and provision of hygiene facilities. Removal of anthropogenic materials from existing in-filled ditch and disposal off-site to an appropriately licensed waste disposal facility. This material potentially contains asbestos. The risks to human health will be managed in accordance with Good International Industry Practice during handling, storage and transport of the waste materials. In the event that previously unidentified contamination is observed during construction, works in the affected area will cease until the contaminated material is tested and appropriate mitigation measures designed or an appropriate disposal processes identified.	Low

Continued…

Site/Activity	Potential Impacts	Receptor	Sensitivity of Receptor	Magnitude of Impact	Pre-Mitigation Impact Significance	Mitigation Measures	Residual Impact Significance
	Loss of soils (removal)	Agricultural soils	Moderate	Low	Low	Limiting quantity of excavated soil material as far as practical, prevention of contamination of stockpiled material through appropriate waste management (**Chapter 18 Waste Management**) and management of stored soils to prevent contamination and change of soil properties; increasing the potential for re-use of soils on site, and decreasing the need for removal of soils from the landfall section to landfill. Re-use excess soils elsewhere within the landfall section if possible.	Low
		Phaeozem soils	High	Low	Moderate		Low
		Fluvisols	High	Low	Moderate		Low

Continued…

Site/Activity	Potential Impacts	Receptor	Sensitivity of Receptor	Magnitude of Impact	Pre-Mitigation Impact Significance	Mitigation Measures	Residual Impact Significance
Preparation of access road / upgrades to junctions of existing roads	Vegetation clearance causing increased vulnerability of soils to erosion and compaction	Agricultural soils	Moderate	Moderate	Moderate	Strip topsoil from working area and store in stockpiles. Stockpiles kept to agreed height, and free from disturbance. Stockpiles to be covered as required. Siting of stockpiles away from watercourses or unstable slopes. Design and management of site drainage to reduce risk of soil erosion in exposed subsoil areas or in stockpiles. Reinstate soils and replant along road verges as soon as possible after construction and testing.	Low
		Phaeozem soils	High	Moderate	High		Low
		Fluvisols	High	Moderate	High		Low
		Other soils	Low	Low	Low		Low
		Unstable geomorphic features	High	Negligible	Low		Low

Continued...

Site/Activity	Potential Impacts	Receptor	Sensitivity of Receptor	Magnitude of Impact	Pre-Mitigation Impact Significance	Mitigation Measures	Residual Impact Significance
Preparation of access road / upgrades to junctions of existing roads	Changes to soil properties through earthworks	Agricultural soils	Moderate	Moderate	Moderate	Strip topsoil from working area and store in stockpiles. Spoil handling protocols to avoid mixing different soil types. Topsoil to be stored separately to subsoil. Management of stored soils to prevent contamination and change of soil properties.	Low
		Fluvisols	High	Moderate	High		Low
		Other soils	Low	Low	Low		Low
	Earthworks influencing ground stability	Unstable geomorphic features	High	Negligible	Low	Appropriate construction management practices will reduce the probability of occurrence. Grading of slopes. Use of geotechnical engineering measures to aid slope stability. Design, management and monitoring carried out in line with the appropriate Construction Method Statements. Siting of stockpiles away from watercourses or unstable slopes.	Low

Continued...

Site/Activity	Potential Impacts	Receptor	Sensitivity of Receptor	Magnitude of Impact	Pre-Mitigation Impact Significance	Mitigation Measures	Residual Impact Significance
Establishment of Temporary Construction Areas	Vegetation clearance causing increased vulnerability of soils to erosion and compaction	Agricultural soils	Moderate	High	High	Strip topsoil from working area and store in stockpiles. Stockpiles kept to agreed height, and free from disturbance. Stockpiles to be covered as required. Siting of stockpiles away from watercourses or unstable slopes. Design and management of site drainage to reduce risk of soil erosion in exposed subsoil areas or in stockpiles. Reinstate soils and replant as soon as possible after construction and testing.	Low
		Phaeozem soils	High	Moderate	High		Low
		Fluvisols	High	Moderate	High		Low
		Unstable geomorphic features	High	Negligible	Low		Low
	Changes to soil properties through earthworks including stockpiling	Agricultural soils	Moderate	Moderate	Moderate	Strip topsoil from working area and store in stockpiles. Spoil handling protocols to avoid mixing different soil types. Topsoil to be stored separately to subsoil. Management of stored soils to prevent contamination and change of soil properties.	Low
		Phaeozem soils	High	Moderate	High		Low

Continued…

Site/Activity	Potential Impacts	Receptor	Sensitivity of Receptor	Magnitude of Impact	Pre-Mitigation Impact Significance	Mitigation Measures	Residual Impact Significance
Establishment of Temporary Construction Areas	Earthworks influencing ground stability	Unstable geomorphic features	High	Negligible	Low	Appropriate construction management practices will reduce the probability of occurrence. Grading of slopes. Use of geotechnical engineering measures to aid slope stability. Design, management and monitoring carried out in line with the appropriate Construction Method Statements. Siting of stockpiles away from watercourses or unstable slopes.	Low
Microtunnel construction	Uncontrolled slurry ingress into subsurface	Agricultural soils	Moderate	Low	Low	Appropriate tunnelling and slurry management practice. Compliance with the Project Emergency Preparedness and Response Plan and Russian Landfall CMP is required.	Low
	Tunnelling influencing ground stability	Unstable geomorphic features	High	Negligible	Low	Appropriate tunnelling management practice	Low
Pipeline pull-in through microtunnels	Uncontrolled grout ingress into subsurface	Agricultural soils	Moderate	Low	Low	Appropriate grouting management practice Compliance with the Project Emergency Preparedness and Response Plan and Russian Landfall CMP is required.	Low

Continued…

Site/Activity	Potential Impacts	Receptor	Sensitivity of Receptor	Magnitude of Impact	Pre-Mitigation Impact Significance	Mitigation Measures	Residual Impact Significance
Open trench pipe-laying activities – from microtunnel entry shafts to landfall facilities	Vegetation clearance causing increased vulnerability of soils to erosion and compaction	Agricultural soils	Moderate	High	High	Strip topsoil from working area and store in stockpiles. Stockpiles kept to agreed height, and free from disturbance. Stockpiles to be covered as required. Siting of stockpiles away from watercourses or unstable slopes. Design and management of site drainage and grading of slopes to reduce risk of soil erosion in exposed subsoil areas or in stockpiles. Reinstate soils and replant as soon as possible after construction and testing.	Low
		Phaeozem soils	High	Moderate	High		Low
		Fluvisols	High	Moderate	High		Low
		Unstable geomorphic features	High	Negligible	Low		Low
	Changes to soil properties through earthworks including excavation of trench and stockpiling	Agricultural soils	Moderate	High	High	Strip topsoil from working area and store in stockpiles. Spoil handling protocols to avoid mixing different soil types. Topsoil to be stored separately to subsoil. Management of stored soils to prevent contamination and change of soil properties.	Low
		Phaeozem soils	High	Moderate	High		Low
		Fluvisols	High	Moderate	High		Low

Continued...

Site/Activity	Potential Impacts	Receptor	Sensitivity of Receptor	Magnitude of Impact	Pre-Mitigation Impact Significance	Mitigation Measures	Residual Impact Significance
	Earthworks influencing ground stability	Unstable geomorphic features	High	Negligible	Low	Appropriate construction management practices will reduce the probability of occurrence. Grading of slopes. Use of geotechnical engineering measures to aid slope stability. Design, management and monitoring carried out in line with the appropriate Construction Method Statements. Siting of stockpiles away from watercourses or unstable slopes.	Low
Construction of landfall facilities	Vegetation clearance causing increased vulnerability of soils to erosion and compaction	Agricultural soils	Moderate	Moderate	Moderate	Strip topsoil from working area and store in stockpiles. Stockpiles kept to agreed height, and free from disturbance. Stockpiles to be covered as required. Siting of stockpiles away from watercourses or unstable slopes. Design and management of site drainage to reduce risk of soil erosion in exposed subsoil areas or in stockpiles. Reinstate soils and replant around the permanent landfall facilities as soon as possible after construction and testing.	Low
		Unstable geomorphic features	High	Negligible	Low		Low

Continued…

Site/Activity	Potential Impacts	Receptor	Sensitivity of Receptor	Magnitude of Impact	Pre-Mitigation Impact Significance	Mitigation Measures	Residual Impact Significance
	Changes to soil properties through earthworks	Agricultural soils	Moderate	Moderate	Moderate	Strip topsoil from working area and store in stockpiles. Spoil handling protocols to avoid mixing different soil types. Topsoil to be stored separately to subsoil. Management of stored soils to prevent contamination and change of soil properties.	Low
	Earthworks influencing ground stability	Unstable geomorphic features	High	Negligible	Low	Appropriate construction management practices will reduce the probability of occurrence. Grading of slopes. Use of geotechnical engineering measures to aid slope stability. Design, management and monitoring carried out in line with the appropriate Construction Method Statements. Siting of stockpiles away from watercourses or unstable slopes.	Low
Pre-commissioning activities associated with pipeline testing	Leaks of test water during testing influencing soil quality	Agricultural soils	Moderate	Low	Moderate	Inspection of pipe sections before installation. Design, management and monitoring carried out in line with the appropriate method statements for hydro-testing. Halt hydro-testing immediately if leakage is detected and remediate as far as practicable any pollution of soil or water.	Low

Continued...

Site/Activity	Potential Impacts	Receptor	Sensitivity of Receptor	Magnitude of Impact	Pre-Mitigation Impact Significance	Mitigation Measures	Residual Impact Significance
	Leaks of test water during testing influencing soil quality	Phaeozem soils	High	Low	Moderate	Inspection of pipe sections before installation. Design, management and monitoring carried out in line with the appropriate method statements for hydro-testing. Halt hydro-testing immediately if leakage is detected and remediate as far as practicable any pollution of soil or water.	Low
		Fluvisols	High	Low	Moderate		Low
		Other Soils	Low	Low	Moderate		Low
	Leaks of water during testing influencing slope stability	Unstable geomorphic features	High	Low	Moderate	Design, management and monitoring carried out in line with the appropriate method statements for hydro-testing. Halt hydro-testing immediately if leakage is detected, monitor for ground instability and remediate as far as practicable, if necessary.	Low

Complete.

Table 8.20 Assessment of Groundwater Potential Impacts: Construction and Pre-Commissioning Phase

Site/Activity	Potential Impacts	Receptor	Sensitivity of Receptor	Magnitude of Impact	Pre-Mitigation Impact Significance	Mitigation Measures	Residual Impact Significance
General construction activities	Leaks and spills during use and storage or pollutants causing contamination of groundwater (directly or indirectly via soil or surface water)	Superficial aquifer	Moderate	Moderate	Moderate	Spillage prevention, bunding and restrictions near artificial drains, sensitive soils (moderate/high sensitivity) and water bodies to minimise impact. Material will be stored away from sensitive soils and water bodies where possible, with secondary containment. Collection and off-site disposal of sanitary wastewaters. Drainage and treatment systems for managing surface run-off designed to avoid adverse effects on groundwater quality. Compliance with the ESMP, and Project Emergency Preparedness and Response Plan	Low
		Carbonate aquifer	Moderate	Moderate	Moderate		Low
		Russkaya abstraction	Negligible	Negligible	Not Significant		Not Significant
		Sukko groundwater resource	High	Negligible	Not Significant		Not Significant

Continued…

Site/Activity	Potential Impacts	Receptor	Sensitivity of Receptor	Magnitude of Impact	Pre-Mitigation Impact Significance	Mitigation Measures	Residual Impact Significance
	Accidental damage to existing utilities causing groundwater contamination	Superficial aquifer	Moderate	Low	Low	Pre-construction surveys and Good International Industry Practice will be used to reduce the risk of accidental damage to existing utilities that might cause contamination. Compliance with the ESMP, and Project Emergency Preparedness and Response Plan	Low
		Carbonate aquifer	Moderate	Low	Low		Low
	Water abstraction from Sukko well	Sukko groundwater resource	High	Negligible	Not Significant	Restrict abstraction to agreed volumes. No abstraction May to September.	Not Significant
Preparation of access road / upgrades to junctions of existing roads	Vegetation clearance and earthworks causing or increasing mobilisation of contamination in the soil causing deterioration in groundwater quality	Superficial aquifer	Moderate	Low	Low	In the event that previously unidentified contamination is observed during construction, works in the affected area will cease until the contaminated material is tested and appropriate mitigation measures designed or an appropriate disposal process identified. Reinstate soils and replant as soon as possible after construction and testing.	Not Significant
		Carbonate aquifer	Moderate	Low	Low		Not Significant
		Russkaya abstraction	Negligible	Negligible	Not Significant		Not Significant
		Kavkaz abstraction	Moderate	Low	Not Significant		Not Significant

Continued...

Site/Activity	Potential Impacts	Receptor	Sensitivity of Receptor	Magnitude of Impact	Pre-Mitigation Impact Significance	Mitigation Measures	Residual Impact Significance
Establishment of Temporary Construction Areas	Vegetation clearance and earthworks causing or increasing mobilisation of contamination in the soil causing deterioration in groundwater quality	Superficial aquifer	Moderate	Low	Low	In the event that previously unidentified contamination is observed during construction, works in the affected area will cease until the contaminated material is tested and appropriate mitigation measures designed or an appropriate disposal process identified. Reinstate soils and replant as soon as possible after construction and testing.	Not Significant
		Carbonate aquifer	Moderate	Low	Low		Not Significant
Microtunnel construction	Change in water levels due to dewatering of shafts	Superficial aquifer	Moderate	Negligible	Not Significant	Adopt groundwater control measures appropriate to ground conditions. Abstraction and discharge permits will be obtained, as required.	Low
		Carbonate aquifer	Moderate	Low	Moderate		Low
	Changes in water levels due to tunnelling	Carbonate aquifer	Moderate	Negligible	Not Significant	Appropriate tunnelling and slurry management practice to control groundwater ingress and minimise slurry loss from the tunnel into surrounding aquifers.	Low

Continued...

Site/Activity	Potential Impacts	Receptor	Sensitivity of Receptor	Magnitude of Impact	Pre-Mitigation Impact Significance	Mitigation Measures	Residual Impact Significance
	Change in water quality due to slurry	Superficial aquifer	Moderate	Low	Low	Appropriate tunnelling and slurry management practice to control groundwater ingress and minimise slurry loss from the tunnel into surrounding aquifers. Avoid use of additives containing hazardous chemicals in slurry as far as is practicable. Compliance with the Project Emergency Preparedness and Response Plan and Russian Landfall CMP is required.	Low
		Carbonate aquifer	Moderate	Low	Low		Low
Pipeline pull-in through microtunnels	Change in groundwater quality due to ingress of seawater prior to grouting	Superficial aquifer	Moderate	Negligible	Not Significant	-	Not Significant
		Carbonate aquifer	Moderate	Low	Low		Low
	Change in groundwater quality due to grout	Superficial aquifer	Moderate	Low	Low	Appropriate grouting management practice to minimise grouting loss into aquifer beyond tunnel annulus. Limit the use of additives containing hazardous chemicals in grout.	Low
		Carbonate aquifer	Moderate	Low	Low		Low

Continued...

Site/Activity	Potential Impacts	Receptor	Sensitivity of Receptor	Magnitude of Impact	Pre-Mitigation Impact Significance	Mitigation Measures	Residual Impact Significance
	Change in aquifer properties due to uncontrolled grout ingress	Superficial aquifer	Moderate	Low	Low	Appropriate grouting management practice to minimise grouting loss into aquifer beyond tunnel annulus.	Low
		Carbonate aquifer	Moderate	Low	Low		Low
Open trench pipe-laying activities – from microtunnel entry shafts to landfall facilities	Vegetation clearance and earthworks causing or increasing mobilisation of contamination in the soil causing deterioration in groundwater quality	Superficial aquifer	Moderate	Low	Low	In the event that previously unidentified contamination is observed during construction, works in the affected area will cease until the contaminated material is tested and appropriate mitigation measures designed or an appropriate disposal process identified. Reinstate soils and replant as soon as possible after construction and testing.	Low
		Carbonate aquifer	Moderate	Low	Low		Low

Continued…

Site/Activity	Potential Impacts	Receptor	Sensitivity of Receptor	Magnitude of Impact	Pre-Mitigation Impact Significance	Mitigation Measures	Residual Impact Significance
	Change in groundwater levels if groundwater control required at Graphova Gap crossing	Superficial aquifer	Moderate	Low	Moderate	Adopt groundwater control measures appropriate to ground conditions. Backfill excavation with material of similar or greater permeability than original materials. Undertake works during dry weather if possible.	Low
		Carbonate aquifer	Moderate	Negligible	Not Significant		Low
	Change in groundwater levels if groundwater control required in trench (except Graphova Gap)	Superficial aquifer	Moderate	Low	Low	Adopt groundwater control measures appropriate to ground conditions. Backfill excavation with material of similar or greater permeability than original materials.	Low
		Carbonate aquifer	Moderate	Low	Low		Low
Construction of landfall facilities	Vegetation clearance and earthworks causing or increasing mobilisation of contamination in the soil causing deterioration in groundwater quality	Superficial aquifer	Moderate	Low	Low	In the event that previously unidentified contamination is observed during construction, works in the affected area will cease until the contaminated material is tested and appropriate mitigation measures designed or an appropriate disposal process identified. Reinstate soils and replant as soon as possible after construction and testing.	Not Significant
		Carbonate aquifer	Moderate	Low	Low		Not Significant

Continued…

Site/Activity	Potential Impacts	Receptor	Sensitivity of Receptor	Magnitude of Impact	Pre-Mitigation Impact Significance	Mitigation Measures	Residual Impact Significance
	Change in groundwater levels if groundwater control required for foundation or other excavations	Superficial aquifer	Moderate	Low	Low	Adopt groundwater control measures appropriate to ground conditions.	Low
		Carbonate aquifer	Moderate	Negligible	Not Significant		Low
Pre-commissioning activities associated with pipeline testing	Leaks of stored seawater following pipeline cleaning	Superficial aquifer	Moderate	Low	Low	Compliance with the ESMP, and Project Emergency Preparedness and Response Plan	Low
		Carbonate aquifer	Moderate	Low	Low		Low
	Leaks of seawater during hydro-testing of pipeline influencing groundwater quality	Superficial aquifer	Moderate	Moderate	Moderate	Design, management and monitoring carried out in line with the appropriate method statements for hydro-testing. Halt hydro-testing immediately if leakage is detected and remediate as far as practicable any pollution of soil or water.	Low
		Carbonate aquifer	Moderate	Moderate	Moderate		Low

Continued…

Site/Activity	Potential Impacts	Receptor	Sensitivity of Receptor	Magnitude of Impact	Pre-Mitigation Impact Significance	Mitigation Measures	Residual Impact Significance
	Leaks of fresh test water during hydro-testing of landfall facilities influencing groundwater quality	Superficial aquifer	Moderate	Low	Low	Design, management and monitoring carried out in line with the appropriate method statements for hydro-testing. Halt hydro-testing immediately if leakage is detected and remediate as far as practicable any pollution of soil and water.	Low
		Carbonate aquifer	Moderate	Low	Low		Low
	Disposal of fresh hydro-testing water from landfall facilities	Superficial aquifer	Moderate	Negligible	Not Significant	Design, management and monitoring carried out in line with the appropriate method statements for hydro-testing. Halt hydro-testing immediately if leakage is detected and remediate as far as practicable any pollution of soil and water. The necessary consents will be in place prior to discharge commencing. The quality of the water being discharged will be in accordance with the discharge consent.	Not Significant
		Carbonate aquifer	Moderate	Negligible	Not Significant		Not Significant

Complete.

Table 8.21 Assessment of Surface Water Potential Impacts: Construction and Pre-Commissioning Phase

Site/Activity	Potential Impacts	Receptor	Sensitivity of Receptor	Magnitude of Impact	Pre-Mitigation Impact Significance	Mitigation Measures	Residual Impact Significance
General construction activities	Leaks and spills during use and storage or pollutants causing contamination of surface water (directly or indirectly via soil or groundwater)	Shingar River	Moderate	Moderate	Moderate	Spillage prevention, bunding and restrictions near artificial drains, and water bodies to minimise impact. Material will be stored away from sensitive soils and water bodies where possible, with secondary containment. Surface run-off treatment systems will be implemented at the landfall facilities to control the quality of the surface run-off entering watercourses. The drainage systems for the landfall facilities and the microtunnel construction area will include stormwater treatment systems. The necessary consents will be in place prior to discharge commencing. The quality of the water being discharged will be in accordance with the discharge consent. The treatment standards will be aligned with national water quality standards (Table 8.3). Collection and off-site disposal of sanitary wastewaters. Compliance with the ESMP, and Project Emergency Preparedness and Response Plan.	Low
		Tributary in Graphova Gap	Moderate	Moderate	Moderate		Low
		Existing surface water abstraction	Moderate	Moderate	Moderate		Low

Continued…

Site/Activity	Potential Impacts	Receptor	Sensitivity of Receptor	Magnitude of Impact	Pre-Mitigation Impact Significance	Mitigation Measures	Residual Impact Significance
	Accidental damage to existing utilities causing surface water contamination	Shingar River	Moderate	Low	Low	Appropriate construction management practices will reduce the probability of this occurring. Compliance with the ESMP, and Project Emergency Preparedness and Response Plan.	Low
		Tributary in Graphova Gap	Moderate	Low	Low		Low
		Existing surface water abstraction	Moderate	Moderate	Moderate		Low
Preparation of access road / upgrades to junctions of existing roads	Vegetation clearance and earthworks causing increased vulnerability of soils to erosion affecting surface water quality via run-off	Shingar River	Moderate	Moderate	Moderate	Avoid unnecessary changes to natural drainage systems. Existing artificial drainage to be diverted maintaining gravity flows. Stockpiles to be covered as required. Siting of stockpiles away from watercourses or unstable slopes. Design and management of site drainage to reduce risk of soil erosion in exposed subsoil areas or in stockpiles. Drainage systems for surface run-off designed to avoid poor quality water directly entering watercourses.	Low
		Tributary in Graphova Gap	Moderate	Moderate	Moderate		Low
		Existing surface water abstraction	Moderate	Moderate	Moderate		Low

Continued...

Site/Activity	Potential Impacts	Receptor	Sensitivity of Receptor	Magnitude of Impact	Pre-Mitigation Impact Significance	Mitigation Measures	Residual Impact Significance
	Vegetation clearance and earthworks causing increased run-off affecting flow regime	Shingar River	Moderate	Moderate	Moderate	In the event that previously unidentified contamination is observed during construction, works in the affected area will cease until the contaminated material is tested and appropriate mitigation measures designed or an appropriate disposal processes identified. Reinstate soils and replant as soon as possible after construction and testing.	Low
		Tributary in Graphova Gap	Moderate	Moderate	Moderate		Low
		Existing surface water abstraction	Moderate	Moderate	Moderate		Low
Establishment of Temporary Construction Areas	Vegetation clearance and earthworks causing increased vulnerability of soils to erosion affecting surface water quality via run-off	Shingar River	Moderate	Moderate	Moderate	Avoid unnecessary changes to natural drainage systems. Existing artificial drainage to be diverted maintaining gravity flows. Strip topsoil from working area and store in stockpiles. Stockpiles kept to agreed height, and free from disturbance. Stockpiles to be covered as required. Siting of stockpiles away from watercourses or unstable slopes. Design and management of site drainage to reduce risk of soil erosion in exposed subsoil areas or in stockpiles.	Low
		Tributary in Graphova Gap	Moderate	Moderate	Moderate		Low
		Shingar River	Moderate	Moderate	Moderate		Low

Continued…

Site/Activity	Potential Impacts	Receptor	Sensitivity of Receptor	Magnitude of Impact	Pre-Mitigation Impact Significance	Mitigation Measures	Residual Impact Significance
	Vegetation clearance and earthworks causing increased run-off affecting flow regime	Tributary in Graphova Gap	Moderate	Moderate	Moderate	Drainage systems for surface run-off designed to avoid poor quality water directly entering watercourses. Surface run-off treatment systems will be implemented at the landfall facilities to control the quality of the surface run-off entering watercourses. The drainage systems for the landfall facilities and the microtunnel construction area will include stormwater treatment systems. The necessary consents will be in place prior to discharge commencing. The quality of the water being discharged will be in accordance with the discharge consent. The treatment standards will be aligned with national water quality standards (Table 8.3). In the event that previously unidentified contamination is observed during construction, works in the affected area will cease until the contaminated material is tested and appropriate mitigation measures designed or an appropriate disposal process identified. Reinstate soils and replant as soon as possible after construction and testing.	Low

Continued…

Site/Activity	Potential Impacts	Receptor	Sensitivity of Receptor	Magnitude of Impact	Pre-Mitigation Impact Significance	Mitigation Measures	Residual Impact Significance
Microtunnel construction	Changes in water quality due to slurry ingress during tunnelling	Shingar River	Moderate	Low	Low	Appropriate tunnelling and slurry management practice. Avoid use of additives containing hazardous chemicals in slurry as far as is practicable.	Low
	Leaks and spills of slurry			High*	High	Appropriate tunnelling and slurry management practice. Compliance with the Project Emergency Preparedness and Response Plan and Russian Landfall CMP is required.	Low
Pipeline pull-in through microtunnels	Changes in water quality due to grouting	Shingar River	Moderate	Low	Low	Appropriate grouting management practice to reduce risk of breakouts. Limit the use of additives containing hazardous chemicals in grout.	Low

Continued...

Site/Activity	Potential Impacts	Receptor	Sensitivity of Receptor	Magnitude of Impact	Pre-Mitigation Impact Significance	Mitigation Measures	Residual Impact Significance
Open trench pipe-laying activities – from microtunnel entry shafts to landfall facilities	Vegetation clearance and earthworks causing increased vulnerability of soils to erosion affecting surface water quality via run-off	Shingar River	Moderate	Moderate	Moderate	Avoid unnecessary changes to natural drainage systems. Existing artificial drainage to be diverted maintaining gravity flows.	Low
		Tributary in Graphova Gap	Moderate	Moderate	Moderate	Strip topsoil from working area and store in stockpiles. Stockpiles kept to agreed height, and free from disturbance. Stockpiles to be covered as required. Siting of stockpiles away from watercourses or unstable slopes. Design and management of site drainage to reduce risk of soil erosion in exposed subsoil areas or in stockpiles. Drainage systems for surface run-off designed to avoid poor quality water directly entering watercourses. In the event that previously unidentified contamination is observed during construction, works in the affected area will cease until the contaminated material is tested and appropriate mitigation measures designed or an appropriate disposal process identified. Reinstate soils and replant as soon as possible after construction and testing.	Low
	Vegetation clearance and earthworks causing increased run-off affecting flow regime	Shingar River	Moderate	Moderate	Moderate		Low
		Tributary in Graphova Gap	Moderate	Moderate	Moderate		Low

Continued...

Site/Activity	Potential Impacts	Receptor	Sensitivity of Receptor	Magnitude of Impact	Pre-Mitigation Impact Significance	Mitigation Measures	Residual Impact Significance
	Change in flow regime during crossing works	Tributary in Graphova Gap	Moderate	Moderate	Moderate	Undertake crossing works during dry weather if possible. Divert any remaining flows around working area. Reinstate stream as close to original condition as possible. Use sediment control measures (e.g. silt curtains or straw bales) as required. Backfill excavation with material of similar or greater permeability than original materials to avoid changes to baseflow.	Low
	Disturbance of stream bed sediments during crossing works	Tributary in Graphova Gap	Moderate	Moderate	Moderate		Low
	Changes in water quality (turbidity, suspended solids) during crossing works	Tributary in Graphova Gap	Moderate	Moderate	Moderate		Low
Construction of landfall facilities	Vegetation clearance and earthworks causing increased vulnerability of soils to erosion affecting surface water quality via run-off	Tributary in Graphova Gap	Moderate	Moderate	Moderate	Avoid unnecessary changes to natural drainage systems. Existing artificial drainage to be diverted maintaining gravity flows. Strip topsoil from working area and store in stockpiles. Stockpiles kept to agreed height, and free from disturbance. Stockpiles to be covered as required. Siting of stockpiles away from watercourses or unstable slopes.	Low

Continued...

Site/Activity	Potential Impacts	Receptor	Sensitivity of Receptor	Magnitude of Impact	Pre-Mitigation Impact Significance	Mitigation Measures	Residual Impact Significance
	Vegetation clearance and earthworks causing increased run-off affecting flow regime	Tributary in Graphova Gap	Moderate	Moderate	Moderate	Design and management of site drainage to reduce risk of soil erosion in exposed subsoil areas or in stockpiles. Drainage systems for surface run-off designed to avoid poor quality water directly entering watercourses. Surface run-off treatment systems will be implemented at the landfall facilities to control the quality of the surface run-off entering watercourses. The drainage systems for the landfall facilities will include stormwater treatment systems. The necessary consents will be in place prior to discharge commencing. The quality of the water being discharged will be in accordance with the discharge consent. The treatment standards will be aligned with national water quality standards (Table 8.3). In the event that previously unidentified contamination is observed during construction, works in the affected area will cease until the contaminated material is tested and appropriate mitigation measures designed or an appropriate disposal process identified.	Low

Continued…

Site/Activity	Potential Impacts	Receptor	Sensitivity of Receptor	Magnitude of Impact	Pre-Mitigation Impact Significance	Mitigation Measures	Residual Impact Significance
Pre-commissioning activities associated with pipeline testing	Leaks of stored seawater following pipeline cleaning	Shingar River	Moderate	Low	Low	Reinstate soils and replant as soon as possible after construction and testing. Compliance with the ESMP and Project Emergency Preparedness and Response Plan.	Low
	Leaks of seawater during hydro-testing of pipeline influencing surface water quality	Shingar River	Moderate	Low	Low	Design, management and monitoring carried out in line with the appropriate method statements for hydro-testing. Halt hydro-testing immediately if leakage is detected.	Low
		Tributary in Graphova Gap	Moderate	Moderate	Moderate		Low
	Leaks of fresh water during hydro-testing of landfall facilities influencing surface water quality	Tributary in Graphova Gap	Moderate	Low	Low	Design, management and monitoring carried out in line with the appropriate method statements for hydro-testing. Halt hydro-testing immediately if leakage is detected and remediate as far as practicable any pollution of soil/water.	Low

* Potential impact magnitude is high but likelihood of occurrence is very low.

Complete.

8.6.3 Assessment of Potential Impacts: Operational Phase

8.6.3.1 Assessment of Potential Impacts (Pre-mitigation)

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. The permanent RoW will include an access track.

Operational activities associated with the Project are limited. Operation of the Project for the terrestrial part of the landfall section will involve routine inspections, maintenance activities and monitoring.

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.

Maintenance activities will include the periodic clearing of certain vegetation from the permanent RoW. It is assumed that the vegetation clearance will be primarily through mechanical clearing. It is assumed that regular and widespread herbicide application will not be required for the required partial vegetation clearance as shallow vegetation will be allowed to grow. However, it is recognised that herbicide usage may be locally required on occasion.

The operation of vehicles and equipment to undertake these maintenance and inspection activities are seen as the key activities of relevance to soil, groundwater and surface water baseline conditions.

The impacts due to the presence of the Pipeline, tunnel, the Graphova Gap pipeline crossing and access roads, are presented under the Operational Phase assessment because these are considered to be impacts that arises as a result of operation and not as a result of construction activity.

Soils

There is the potential for soils around the landfall facilities, RoW and access roads to be contaminated through vehicle movements, spills and leaks. Typical contaminants include those associated with vehicle operations including hydrocarbons and heavy metals. There will be no discharges to soil of sanitary or process wastewater. The potential for contamination of soil at the landfall facility, RoW and access road is low magnitude and **Moderate** significance.

Soils within the permanent right of way (RoW) along the Pipeline route may be disturbed through the periodic clearance of vegetation and vehicle movements. Vegetation provides protection and stability to soils from erosive forces. Maintenance and permanent RoW clearance activities are not anticipated to require removal of all ground vegetation, and therefore soil disturbance will be limited. This impact is of low magnitude and **Moderate** significance.

The pipeline crossings at the Graphova Gap and the anode groundbed at the Landfall facilities are in areas with naturally unstable geomorphic features (**Chapter 7 Physical and Geophysical Environment**). Erosion during flood events can be a key natural mechanism triggering ground movements associated with these features. The presence of the Project infrastructure could influence stability but the effects are expected to be localised and can be managed through design controls implemented during the Construction Phase. The impact during the Operational Phase due to the on-going presence of the structures is of low **magnitude** and **Moderate** significance.

Groundwater

Groundwater quality may be affected by any accidental leaks or spills at the landfall facilities or during maintenance activities. The limited activity on site during the Operational Phase reduces the likelihood of spills occurring. Therefore, it is an impact of low magnitude and **Moderate** significance for the superficial and carbonate aquifer. Negligible impact is expected at the groundwater abstractions; this is **Not Significant.**

The buried pipes will pass under the Graphova Gap. The buried pipes may act as a barrier to groundwater flow in the superficial aquifer. Any impact on flows that did occur would be long term but spatially localised. However, given the design it is unlikely that the pipelines will create a complete barrier to groundwater flow. Therefore, it is an impact of low magnitude and **Low** significance for the superficial aquifer. The impact on the carbonate aquifer is to be negligible magnitude and **is Not Significant**. No impact is expected at any of the abstractions.

The microtunnels may act as a barrier to groundwater flow. Any impact on flows that did occur would be long term but spatially localised. However, given the size of the tunnels relative to the aquifer geometry it is unlikely that the pipelines will create a complete barrier to groundwater flow. Therefore it is an impact of low magnitude and **Low** significance for the carbonate aquifer. The impact on the superficial aquifer is of negligible magnitude and **Low** significance. No impact is expected at any of the abstractions.

The anodes in the subsurface as part of the cathodic protection systems will gradually degrade, releasing metal ions into the subsurface, which will be leached and infiltrate into groundwater. The anodes are proposed to be titanium with mixed metal oxides. The rate of anode degradation is anticipated to be very slow (decades). Natural attenuation including dilution within the groundwater will reduce concentrations in groundwater within a relatively short distance from the anode bed. The calcined petroleum coke backfill around the anodes is considered effectively inert; no significant leaching of contaminants from the backfill into groundwater is expected. Some sorption of metal ions onto the coke may occur. Considering that the anodes are below the water table the impacts on both aquifers are of negligible magnitude and are **Not Significant**. No impact is expected at any of the abstractions.

Surface Water

Surface water quality may be affected by any accidental leaks or spills. The limited activity on site during the Operational Phase reduces the likelihood of spills occurring. The impact on water quality in both watercourses within the Study Area and at the assumed surface water abstraction is likely to be limited and of low magnitude and **Moderate** significance.

Periodic clearance of vegetation may lead to an increase in soil erosion and run-off rates. This may influence water quality and the flow regime. However, maintenance and permanent RoW clearance activities will not require removal of all ground vegetation, and soil disturbance will be limited. This impact is limited and of low magnitude and **Moderate** significance.

It is unlikely that the presence of the tunnels would affect natural groundwater baseflow such that the flow regime in the Shingar River is influenced. Thus the impact magnitude is assessed as negligible magnitude and **is Not Significant**.

Where the pipelines cross the Graphova Gap, they may behave as an obstruction and cause groundwater levels to change, which may lead to a change in baseflow to surface waters, especially during the winter months. However, given the design, including permeable rock fill, it is unlikely that the pipeline trenches will create a complete barrier to groundwater flow. The impact for the watercourse is therefore low magnitude and **Low** significance. The impact on the surface water abstraction is negligible magnitude and is **Not Significant**.

As described in **Chapter 5 Project Description**, rock fill and a buried concrete slab will be used to help protect the Pipeline from scour and erosion during flood events. This will be designed not to erode significantly during typical flow events. However, during major flood events the backfill may be eroded. This would not naturally recover without maintenance works. The overall impact on the watercourse is therefore moderate magnitude and **Moderate** significance.

The presence of the rock fill will alter the nature of the local bed sediments over this stretch of the stream. Gradually, fine-grained sediment will infill the gaps between the rock fill and the stream bed will return to a more natural condition. The impact will be limited in spatial extent and will gradually recover through natural processes. The impact on the watercourse is therefore low magnitude and **Low** significance.

The access roads and landfall facilities will be static sites. Run-off from areas of hardstanding will be higher than from vegetated areas. Storm water run-off during wet weather events may capture minor volumes of contaminants (e.g. traces of oil and grease) and entrain sediments. However, the impacts of run-off on water quality will only occur during times of high flow (i.e. when water quality in the watercourses is naturally likely to be highly turbid and dilution factors will be high). The impact on the Shingar River is of negligible magnitude and **Not Significant**. The impact on surface waters in Graphova Gap and the surface water abstraction from surface run-off from the access road and landfall facilities is limited and of low magnitude and **Low** significance for the flow regime and of **Moderate** significance for water quality.

The anode groundbed in the landfall facilities is located in a natural run-off channel with evidence of natural erosion during rainfall events. Further downhill is a gully which is a tributary of the watercourse in Graphova Gap. During flood events, the backfill from the anode groundbed may be eroded by run-off. The calcined petroleum coke is inert and the groundbed is uphill from the main stream channel. However, the coke backfill may migrate further than rock-based sediment during flood events as it will be lighter. The impact on downstream water quality is limited and of low magnitude and **Low** significance.

8.6.3.2 Mitigation and Monitoring

Some of the effects of activities associated with the Operational Phase of the Project may impact on soil, groundwater and surface waters. The significance of these impacts has been assessed based on the sensitivity of each receptor and the expected magnitude of the potential impacts. The results of this assessment are presented in Table 8.22, Table 8.23 and Table 8.24.

Where significant impacts are identified, mitigation measures will be required to minimise the impacts or reduce the likelihood of an impact occurring. Appropriate mitigation measures are presented in this section.

The mitigation measures will be controlled through the ESMP for the Operational Phase. Monitoring will record how effective mitigation is and may result in changes to the mitigation measures.

Soils Mitigation

A number of the design controls described in **Chapter 5 Project Description** aim to reduce the risks to soils during the Operational Phase (Section 8.6.1.1).

Mitigation measures are recommended to further reduce the risk of leaks and spills occurring. Compliance with the Emergency Response and Crisis Management Plan and requirements in the Russian Landfall CMP is required. In the event of a leak or spill occurring, the speed of response to the incident is a key factor in determining the magnitude of the resultant impacts.

Appropriate storage and handling protocols will be required for fuels and other chemicals used on site. Refuelling will only be undertaken in designated areas. Activities near to watercourses and drains and exposed soil areas will be controlled. All bulk materials or wastes stored on site will be within appropriate storage facilities and procedures will be implemented for handling, storage, transport and transfer to minimise the potential for leaks or spills.

Further specific mitigation measures that will be implemented to protect the existing soil quality and structure include:

- Restriction of construction activities to the Pipeline RoW, the footprint of the permanent landfall facilities, and permanent access roads;
- Vehicle movements will be restricted to defined access tracks and hardstanding areas;
- Sediment and erosion controls (e.g. cut-off drains, swales, detention and retention basins, mesh fencing and sandbags etc.) will be implemented at all maintenance sites to limit the loss of soil from the site;
- Sediment and erosion controls, including appropriate drainage systems, will be routinely inspected and maintained to manage run-off and to limit the loss of soil from the site, in particular following vegetation clearance;
- Spillage prevention, bunding and restrictions near drains, sensitive soils and water bodies to avoid impacts. Material will be stored away from sensitive soils and water bodies where possible, with secondary containment and a full method statement to address construction risks and avoid impacts; and

- Ensure potential silted water is appropriately managed prior to entering into any watercourses, attenuation measures to minimise soil erosion and impacts on water quality through potential disturbance of sediments.

Soils Monitoring

- Monitoring of the active geomorphological features will be undertaken in accordance with Russian guidance in relation to 'Safety in emergency situations - Monitoring and predicting hazardous geological phenomena and processes - General requirements' (GOST R 22.1.06-99 and GOST R 22.1.08-99). The monitoring shall include route inspections of active geomorphological features; the frequency of monitoring shall be gradually reduced as stabilisation progresses but is expected to be at least every three years. Additional monitoring will be undertaken following natural events that might affect geomorphological stability such as seismic events or mudflows; and
- No ongoing monitoring of soil quality is required during the Operational Phase.

Groundwater Mitigation

In addition to the design controls (Section 8.6.1.1) and mitigation measures for soil outlined above (Section 8.6.2.2), the following mitigation measures are also recommended to be adopted to minimise the potential for adverse impacts:

- Sanitary wastewaters generated during Operational Phase will be safely stored in temporary facilities (mobile installations for wastewater treatment or septic tanks) and then regularly transported and disposed of in a nearby licensed facility for the disposal of wastewater;
- Choice of anode material. Materials that are non-hazardous are preferable. Position the anodes above the water table if possible;
- If there is the potential for the Pipeline to create a barrier to groundwater flow such that baseflows to Graphova Gap are significantly affected, then drainage will be designed and installed during construction to allow groundwater to by-pass the obstruction to groundwater flow; and
- Consultation with neighbouring abstractors as and when required.

Groundwater Monitoring

No ongoing groundwater monitoring is required during the Operational Phase.

Surface Water Mitigation

In addition to the design controls (Section 8.6.1.1) and mitigation measures for soil and groundwater outlined above (Section 8.6.2.2), many of which are relevant to potential surface water impacts, the following mitigation measures are also recommended to be adopted to minimise the potential for adverse impacts:

- The detailed design of the Graphova Gap pipeline and access road crossings will allow for maintaining natural flows. The access road crossing will be designed to avoid significant increase in flood risk downstream;

- Stormwater discharges from the landfall facilities will pass through a sand trap and filter, and an oil interceptor prior to discharge. The treatment standards will be aligned with required water quality standards prior to discharge of the stormwater into the environment;
- The anode groundbed will be microsited in relation to local terrain and the backfill and surfacing will be designed to reduce the potential for erosion by run-off;
- Throughout the lifespan of the Project, periodic inspection and cleaning of blockages within the site drainage will be carried out and detailed within a monitoring programme;
- Direct discharges from the landfall facilities drainage systems to watercourses will be avoided;
- Where possible, drainage of working areas will include routing of surface water to detention basins to settle out suspended solids before discharge to watercourses;
- Throughout the lifespan of the Project periodic inspection and cleaning of blockages within the site drainage will be carried out and detailed within a monitoring programme; and
- Inspection and reinstatement following major flood event.

Surface Water Monitoring

Surface water quality monitoring is required during the Operational Phase. Monitoring shall be undertaken periodically within the watercourse in the Graphova Gap to confirm the stormwater drainage systems at the landfall facility are operating as designed. This will include collection of upstream and downstream water samples. The monitoring scope and frequency will be in accordance with the agreed discharge consent for the stormwater drainage system. The water samples shall be analysed for basic chemistry, such as pH, electrical conductivity, dissolved oxygen and suspended solids, as well as to assess potential pollutant concentrations (including petroleum hydrocarbons).

8.6.3.3 Residual Impacts: Operational Phase

Table 8.22, Table 8.23 and Table 8.24 present a summary of the potential residual impacts to soil, groundwater and surface water respectively arising from the Project following application of the mitigation measures described in Section 8.6.2.2.

The assessment of the significance of residual impacts assumes full application and effectiveness of the mitigation measures.

Soils

The significance of the residual impacts on soils is **Low**.

Groundwater

The significance of the residual impacts on groundwater is **Not Significant** to **Low**.

Surface Water

The significance of the residual impacts on surface waters is **Not Significant** to **Low**.

Table 8.22 Assessment of Soil Potential Impacts: Operational Phase

Site/Activity	Potential Impacts	Receptor	Sensitivity of Receptor	Magnitude of Impact	Pre-Mitigation Impact Significance	Mitigation Measures	Residual Impact Significance
General maintenance activities	Leaks and spills during use and storage or pollutants causing contamination of soil	Agricultural soils	Moderate	Low	Moderate	Spillage prevention, bunding and restrictions near watercourses, artificial drains, sensitive soils (moderate and high sensitivity) and water bodies to minimise impact. Material will be stored away from sensitive soils and water bodies where possible, with secondary containment. Compliance with the ESMP and Project Emergency Preparedness and Response Plan.	Low
		Phaeozem soils	High	Low	Moderate		Low
		Fluvisols	High	Low	Moderate		Low
	Vegetation clearance along RoW causing increased vulnerability of soils to erosion and compaction	Agricultural soils	Moderate	Low	Moderate	Restrict vegetation clearance to removal of trees and shrubs. Geotechnical slope stabilisation will be undertaken where required during Construction Phase which will also reduce future impacts during Operational Phase. Restrict vehicle movements to agreed access routes.	Low
		Phaeozem soils	High	Low	Moderate		Low
		Fluvisols	High	Low	Moderate		Low
		Unstable geomorphic features	High	Low	Moderate		Low

Continued...

Site/Activity	Potential Impacts	Receptor	Sensitivity of Receptor	Magnitude of Impact	Pre-Mitigation Impact Significance	Mitigation Measures	Residual Impact Significance
Presence of pipeline crossing in Graphova Gap	Slope instability	Unstable geomorphic features	High	Low	Moderate	Grade slopes during pipeline crossing construction to avoid creation of unstable slopes on stream banks and valley sides. Geotechnical slope stabilisation will be undertaken where required during Construction Phase which will also reduce future impacts during Operational Phase.	Low
Presence of landfall facilities including anode groundbed	Slope instability	Unstable geomorphic features	High	Low	Moderate	Micrositing of anode groundbed and array within existing topography during detailed design. Grade slopes during construction to avoid creation of unstable slopes. Geotechnical slope stabilisation will be undertaken where required during Construction Phase which will also reduce future impacts during Operational Phase.	Low

Complete.

Table 8.23 Assessment of Groundwater Potential Impacts: Operational Phase

Site/Activity	Potential Impacts	Receptor	Sensitivity of Receptor	Magnitude of Impact	Pre-Mitigation Impact Significance	Mitigation Measures	Residual Impact Significance
General maintenance activities	Leaks and spills during use and storage or pollutants causing contamination of groundwater (directly or indirectly via soil or surface water)	Superficial Aquifer	Moderate	Low	Moderate	Spillage prevention, bunding and restrictions near watercourses, artificial drains, sensitive soils (moderate and high sensitivity) and water bodies to minimise impact. Material will be stored away from sensitive soils and water bodies where possible, with secondary containment Collection and off-site disposal of sanitary wastewaters. Drainage and treatment systems for managing surface run-off designed to avoid adverse effects on groundwater quality. Compliance with the ESMP and Project Emergency Preparedness and Response Plan. Consultation with neighbouring abstractors.	Low
		Carbonate Aquifer	Moderate	Low	Moderate		Low
		Russkaya abstraction	Negligible	Negligible	Not Significant		Not Significant
		Kavgaz abstraction	Moderate	Negligible	Not Significant		Not Significant
		Sukko groundwater resource	High	Negligible	Not Significant		Not Significant

Continued…

Site/Activity	Potential Impacts	Receptor	Sensitivity of Receptor	Magnitude of Impact	Pre-Mitigation Impact Significance	Mitigation Measures	Residual Impact Significance
Presence of microtunnels beneath Shingar River	Tunnels act as hydraulic barrier to groundwater flow causing potential change in water levels	Superficial Aquifer	Moderate	Negligible	Low	Appropriate grouting management practice during Construction Phase to minimise grouting loss into aquifer from tunnel annulus.	Low
		Carbonate Aquifer	Moderate	Low	Low		Low
Presence of pipeline crossing in Graphova Gap	Pipelines act as hydraulic barrier to groundwater flow causing potential change in water levels	Superficial Aquifer	Moderate	Low	Low	Backfill excavation during Construction Phase with material of similar or greater permeability than original materials to avoid changes to baseflow.	Low
		Carbonate Aquifer	Moderate	Negligible	Not Significant		Not Significant
Presence of landfall facilities including anode groundbed	Consumption of anode materials for cathodic protection influencing groundwater quality	Superficial Aquifer	Moderate	Negligible	Not Significant	Choice of anode materials. Locate anodes above the water table if possible.	Not Significant
		Carbonate Aquifer	Moderate	Negligible	Not Significant		Not Significant

Complete.

Table 8.24 Assessment of Surface Water Potential Impacts: Operational Phase

Site/Activity	Potential Impacts	Receptor	Sensitivity of Receptor	Magnitude of Impact	Pre-Mitigation Impact Significance	Mitigation Measures	Residual Impact Significance
General maintenance activities	Leaks and spills during use and storage or pollutants causing contamination of surface water (directly or indirectly via soil or groundwater)	Shingar River	Moderate	Low	Moderate	Spillage prevention, bunding and restrictions near artificial drains, sensitive soils (moderate and high sensitivity) and water bodies to minimise impact. Material will be stored away from sensitive soils and water bodies where possible, with secondary containment. Collection and off-site disposal of sanitary wastewaters. Drainage management systems designed to manage surface run-off and avoid poor quality water entering watercourses directly. Drainage management systems at landfall facilities to include sand trap and filter, and oil interceptor prior to discharge. Water discharge standards at landfall facility to be aligned with national water quality criteria (Table 8.4).	Low

Continued…

Site/Activity	Potential Impacts	Receptor	Sensitivity of Receptor	Magnitude of Impact	Pre-Mitigation Impact Significance	Mitigation Measures	Residual Impact Significance
General maintenance activities	Leaks and spills during use and storage or pollutants causing contamination of surface water (directly or indirectly via soil or groundwater)	Tributary in Graphova Gap	Moderate	Low	Moderate	Compliance with the ESMP and Project Emergency Preparedness and Response Plan. Consultation with neighbouring abstractors.	Low
		Surface water abstraction	Moderate	Low	Moderate		Low
	Vegetation clearance along RoW causing increased vulnerability of soils to erosion affecting water quality via run-off	Shingar River	Moderate	Low	Moderate	Restrict vegetation clearance to removal of trees and shrubs. Grade slopes during reinstatement works following construction to avoid unstable slopes. The natural terrain should be re-established where possible. Restrict vehicle movements to agreed access routes.	Low

Continued…

Site/Activity	Potential Impacts	Receptor	Sensitivity of Receptor	Magnitude of Impact	Pre-Mitigation Impact Significance	Mitigation Measures	Residual Impact Significance
General maintenance activities	Vegetation clearance along RoW causing increased vulnerability of soils to erosion affecting water quality via run-off	Tributary in Graphova Gap	Moderate	Low	Moderate	Restrict vegetation clearance to removal of trees and shrubs. Grade slopes during reinstatement works following construction to avoid unstable slopes. The natural terrain should be re-established where possible. Restrict vehicle movements to agreed access routes.	Low
		Surface water abstraction	Moderate	Low	Moderate		Not Significant
	Vegetation clearance along RoW causing increased run-off affecting flow regime	Shingar River	Moderate	Low	Moderate		Low
		Tributary in Graphova Gap	Moderate	Low	Moderate		Low
		Surface water abstraction	Moderate	Low	Moderate		Not Significant

Continued…

Site/Activity	Potential Impacts	Receptor	Sensitivity of Receptor	Magnitude of Impact	Pre-Mitigation Impact Significance	Mitigation Measures	Residual Impact Significance
Presence of microtunnels beneath Shingar River	Tunnels act as hydraulic barrier to groundwater flow causing potential change in baseflow changing stream flow regime during low flow conditions	Shingar River	Moderate	Negligible	Not Significant	Appropriate grouting management practice during Construction Phase to minimise grouting loss into aquifer from tunnel annulus.	Not Significant

Continued…

Site/Activity	Potential Impacts	Receptor	Sensitivity of Receptor	Magnitude of Impact	Pre-Mitigation Impact Significance	Mitigation Measures	Residual Impact Significance
Presence of pipeline crossing in Graphova Gap	Pipelines act as hydraulic barrier to groundwater flow causing potential change in baseflow changing stream flow regime during low flow conditions	Tributary in Graphova Gap	Moderate	Low	Low	Design and construction of rock backfill above Pipeline. Backfill excavation with material of similar or greater permeability than original materials to avoid changes to baseflow. Grade slopes within floodplain during pipeline crossing construction to minimise obstructions during flood events. The natural terrain should be re-established where possible. Inspection and reinstatement following major flood event.	Low
		Surface water abstraction	Moderate	Negligible	Not Significant		Not Significant
	Erosion of pipeline trench during flood events	Tributary in Graphova Gap	Moderate	Moderate	Moderate		Low
		Surface water abstraction	Moderate	Negligible	Not Significant		Not Significant

Continued…

Site/Activity	Potential Impacts	Receptor	Sensitivity of Receptor	Magnitude of Impact	Pre-Mitigation Impact Significance	Mitigation Measures	Residual Impact Significance
Presence of pipeline crossing in Graphova Gap	Change to stream bed sediments	Tributary in Graphova Gap	Moderate	Low	Low	Design and construction of rock backfill above Pipeline. Backfill excavation with material of similar or greater permeability than original materials to avoid changes to baseflow. Grade slopes within floodplain during pipeline crossing construction to minimise obstructions during flood events. The natural terrain should be re-established where possible. Inspection and reinstatement following major flood event.	Low
		Surface water abstraction	Moderate	Negligible	Not Significant		Not Significant

Continued…

Site/Activity	Potential Impacts	Receptor	Sensitivity of Receptor	Magnitude of Impact	Pre-Mitigation Impact Significance	Mitigation Measures	Residual Impact Significance
Presence of landfall facilities and access road in catchment	Increased run-off from hardstanding areas affecting flow regime	Shingar River	Moderate	Negligible	Not Significant	and filter, and oil interceptor, prior to discharge. Water discharge standards at landfall facility to be aligned with national water quality criteria (Table 8.3).	Low
		Tributary in Graphova Gap	Moderate	Low	Low		Low
		Surface water abstraction	Moderate	Low	Low		Low
	Run-off changing water quality	Shingar River	Moderate	Negligible	Not Significant		Low
		Tributary in Graphova Gap	Moderate	Low	Moderate		Low
		Surface water abstraction	Moderate	Low	Moderate		Low
	Erosion of anode groundbed backfill influencing run-off quality	Tributary in Graphova Gap	Moderate	Low	Low	Design groundbed backfill and surfacing to reduce risk of erosion. Micrositing of anode groundbed and array within existing topography.	Low

Complete.

8.6.4 Assessment of Potential Impacts: Decommissioning Phase

8.6.4.1 Introduction

The planned Project lifetime is 50 years, within which there may be changes to statutory decommissioning requirements, as well as advances in technology and knowledge. The eventual decommissioning requirements will be taken into account in the design stage by ensuring that a range of possible options will be available.

Decommissioning of the South Stream Offshore Pipeline will be carried out according to prevailing international and national legislation, regulations and good practice regarding environmental and other potential impacts.

At this stage in the Project the full extent of the decommissioning requirements is not known. If the trenched pipeline is removed, the impacts during decommissioning are expected to be broadly similar to those during construction. If the trenched pipeline is left in place, the potential impacts are likely to be reduced. It is assumed that it is probable that the pipelines within the microtunnels shall be decommissioned but will remain in situ.

Potential impacts to abstractions have not been assessed as it is unknown what, if any, abstractions may be present in the Study Area at the time of decommissioning.

8.6.4.2 Assessment of Potential Impacts (Pre-mitigation)

Soils

Potential impacts to soil during decommissioning will relate to the storage and use of fuels, chemical and waste, land clearance and earthworks, and the interactions between decommissioning workers and the soil.

Leaks and spills are a potential impact of medium extent and moderate magnitude to the agricultural soils, phaeozem soils and fluvisols, resulting in **Moderate** significance impact for agricultural soils and **High** significance impact for the phaeozem and fluvisol soils. The potential impact on other soils in the Study Area is low magnitude given the minor extent of these soils within the landfall section, giving a **Low** significance impact.

For the landfall facilities, the impacts associated with land clearance and earthworks are of moderate magnitude impacts for agricultural soils and phaeozem soils as the areas are medium in extent and less than 10 ha and the impacts are potentially reversible, resulting in **Moderate** significance for agricultural soils and **High** significance for phaeozem soils.

If the trenched pipeline has to be removed during decommissioning, then there will be impacts associated with land clearance and earthworks along the trenching corridor. The impact magnitude for agricultural soils is high as the area is large and more than 10 ha, giving a **High** significance, and the impact magnitude for phaeozem soils is moderate given the medium extent, giving a **High** significance for phaeozem soils. The impact magnitudes for fluvisols during the removal of the pipeline crossing at Graphova Gap are moderate given the works are medium in extent and the soils are expected to gradually recover after reinstatement due to natural processes, giving a **High** significance.

Ground instability of geomorphologically unstable features are of moderate magnitude given the effects are likely to be minor in extent but of medium term, giving a **High** significance impact.

Construction Workers

The potential for contamination to be present in the soils will be reviewed prior to decommissioning. Contamination may be present locally due to current or future land use or illegal dumping.

Accidental leaks and spills during the decommissioning works may also cause soil contamination.

Contaminated soil may affect construction workers through being inadvertently ingested or inhaled or through dermal contact. For conservatism the potential impact on human health before mitigation is of high magnitude and **High** significance given humans are a high sensitivity receptor.

Groundwater

Potential impacts to the groundwater are likely to arise primarily in the Decommissioning Phase through potential contamination and disturbance of the flow regime during any excavations.

The majority of leaks and spills are likely to be relatively small in volume. Groundwater quality may be locally affected but is expected to gradually recover through natural attenuation and the impact will be medium term. The potential impact on groundwater quality associated with accidental leaks and spills is moderate magnitude and **Moderate** significance.

If the trenched pipeline is removed or any excavations are required during decommissioning of the landfall facilities, there is the potential for the excavations to intersect the water table, particularly at the Graphova Gap. The impact upon groundwater flows within the superficial aquifer is low magnitude and **Low** significance as the impacts will be temporary and recovery is expected to be rapid. Given the expected excavation depths, the potential impact to the carbonate aquifer is anticipated to be negligible magnitude and **Not Significant**.

The soil strip and removal of vegetation during land clearance and earthworks will have a low magnitude impact of **Low** significance.

Surface Water

Potential impacts to the surface watercourses are likely to arise primarily in the Decommissioning Phase through potential contamination and disturbance associated with construction site discharges, run-off and changes to local landforms.

The majority of leaks and spills are likely to be relatively small in volume. Depending on the size and nature of the spillage, this could cause water quality or sediment quality impacts along multiple reaches and it is therefore a potential impact of moderate magnitude and **Moderate** significance.

The impacts associated with land clearance and earthworks are of moderate magnitude and **Moderate** significance prior to mitigation.

If the trenched pipeline is removed, then the impact on the watercourse will be of moderate magnitude and **Moderate** significance.

8.6.4.3 Mitigation and Monitoring

Potential impacts to soil, groundwater and surface water have been identified. The significance of these impacts has been assessed based on the sensitivity of each receptor and the expected magnitude of the potential impacts. The results of this assessment are presented in Table 8.25, Table 8.26 and Table 8.27.

As the potential impacts on soil and water during the Decommissioning Phase will be similar to those during the Construction Phase, the mitigation measures outlined in Section 8.6.2.2will be relevant.

A detailed scope for appropriate monitoring will be developed at the time of decommissioning, taking into account prevailing environmental conditions, good international practice and available technology.

8.6.4.4 Residual Impacts: Decommissioning Phase

Table 8.25, Table 8.26 and Table 8.27 present a summary of the potential residual impacts to terrestrial soil, groundwater and surface water arising during the Decommissioning Phase following application of the identified mitigation measures.

Soils

The impacts assessed and the mitigation measures put in place reduce the residual impacts on soils to **Low** significance.

Groundwater

The impacts assessed and the mitigation measures put in place reduce the residual impacts on groundwater to **Not Significant** to **Low** significance.

Surface Water

The impacts assessed and the mitigation measures put in place reduce the residual impacts on surface water to **Low** significance.

Table 8.25 Assessment of Soil Potential Impacts: Decommissioning Phase

Site/Activity	Potential Impacts	Receptor	Sensitivity of Receptor	Magnitude of Impact	Pre-Mitigation Impact Significance	Mitigation Measures	Residual Impact Significance
General decommissioning activities	Leaks and spills during use and storage or pollutants causing contamination of soil	Agricultural soils	Moderate	Moderate	Moderate	Spillage prevention, bunding and restrictions near watercourses, artificial drains, sensitive soils (moderate and high sensitivity) and water bodies to minimise impact. Material will be stored away from sensitive soils and water bodies where possible, with secondary containment. Compliance with the ESMP and Project Emergency Preparedness and Response Plan.	Low
		Phaeozem soils	High	Moderate	High		Low
		Fluvisols	High	Moderate	High		Low
		Other soils	Low	Low	Low		Low
	Contact with contaminated soil posing a risk to human health	Construction workers	High	High	High	In the event that previously unidentified contamination is observed during decommissioning, works in the affected area will cease until the contaminated material is tested and appropriate disposal processes identified. Use of appropriate personal protection equipment.	Low

Continued…

Site/Activity	Potential Impacts	Receptor	Sensitivity of Receptor	Magnitude of Impact	Pre-Mitigation Impact Significance	Mitigation Measures	Residual Impact Significance
Establishment of Temporary Construction Areas	Vegetation clearance causing increased vulnerability of soils to erosion and compaction	Agricultural soils	Moderate	Moderate	Moderate	Strip topsoil from working area and store in stockpiles. Stockpiles kept to agreed height, and free from disturbance. Stockpiles to be covered as required. Siting of stockpiles away from watercourses or unstable slopes. Design and management of site drainage to reduce risk of soil erosion in exposed subsoil areas or in stockpiles. Reinstate soils and replant as soon as possible after decommissioning.	Low
		Phaeozem soils	High	Moderate	High		Low
		Unstable geomorphic features	High	Moderate	High		Low
	Changes to soil properties through earthworks including stockpiling	Agricultural soils	Moderate	Moderate	Moderate	Strip topsoil from working area and store in stockpiles. Spoil handling protocols to avoid mixing different soil types. Topsoil to be stored separately to subsoil. Management of stored soils to prevent contamination and change of soil properties.	Low
		Phaeozem soils	High	Moderate	High		Low

Continued…

Site/Activity	Potential Impacts	Receptor	Sensitivity of Receptor	Magnitude of Impact	Pre-Mitigation Impact Significance	Mitigation Measures	Residual Impact Significance
Establishment of Temporary Construction Areas	Earthworks influencing ground stability	Unstable geomorphic features	High	Moderate	High	Appropriate construction management practices will reduce the probability of occurrence. Grading of slopes. Use of geotechnical engineering measures to aid slope stability. Design, management and monitoring carried out in line with the appropriate Construction Method Statements. Siting of stockpiles away from watercourses or unstable slopes.	Low
Open trench pipe removal activities – from microtunnel entry shafts to landfall facilities	Vegetation clearance causing increased vulnerability of soils to erosion and compaction	Agricultural soils	Moderate	High	High	Strip topsoil from working area and store in stockpiles. Stockpiles kept to agreed height, and free from disturbance. Stockpiles to be covered as required. Siting of stockpiles away from watercourses or unstable slopes. Design and management of site drainage to reduce risk of soil erosion in exposed subsoil areas or in stockpiles Reinstate soils and replant as soon as possible after trench is backfilled.	Low
		Phaeozem soils	High	Moderate	High		Low
		Fluvisols	High	Moderate	High		Low
		Unstable geomorphic features	High	Moderate	High		Low

Continued…

Site/Activity	Potential Impacts	Receptor	Sensitivity of Receptor	Magnitude of Impact	Pre-Mitigation Impact Significance	Mitigation Measures	Residual Impact Significance
Open trench pipe removal activities – from microtunnel entry shafts to landfall facilities	Changes to soil properties through earthworks including excavation of trench and stockpiling	Agricultural soils	Moderate	Moderate	Moderate	Strip topsoil from working area and store in stockpiles. Spoil handling protocols to avoid mixing different soil types. Topsoil to be stored separately to subsoil. Management of stored soils to prevent contamination and change of soil properties.	Low
		Phaeozem soils	High	Moderate	High		Low
		Fluvisols	High	Moderate	High		Low
	Earthworks influencing ground stability	Unstable geomorphic features	High	Moderate	High	Appropriate construction management practices will reduce the probability of occurrence. Grading of slopes. Use of geotechnical engineering measures to aid slope stability. Design, management and monitoring carried out in line with the appropriate Construction Method Statements. Siting of stockpiles away from watercourses or unstable slopes.	Low

Continued…

Site/Activity	Potential Impacts	Receptor	Sensitivity of Receptor	Magnitude of Impact	Pre-Mitigation Impact Significance	Mitigation Measures	Residual Impact Significance
Decommissioning of landfall facilities	Vegetation clearance causing increased vulnerability of soils to erosion and compaction	Agricultural soils	Moderate	Moderate	Moderate	Strip topsoil from working area and store in stockpiles. Stockpiles kept to agreed height, and free from disturbance. Stockpiles to be covered as required. Siting of stockpiles away from watercourses or unstable slopes. Design and management of site drainage to reduce risk of soil erosion in exposed subsoil areas or in stockpiles. Reinstate soils and replant as soon as possible after decommissioning.	Low
		Unstable geomorphic features	High	Moderate	High		Low
	Changes to soil properties through earthworks	Agricultural soils	Moderate	Moderate	Moderate	Strip topsoil from working area and store in stockpiles. Spoil handling protocols to avoid mixing different soil types. Topsoil to be stored separately to subsoil. Management of stored soils to prevent contamination and change of soil properties.	Low

Continued...

Site/Activity	Potential Impacts	Receptor	Sensitivity of Receptor	Magnitude of Impact	Pre-Mitigation Impact Significance	Mitigation Measures	Residual Impact Significance
Decommissioning of landfall facilities	Earthworks influencing ground stability	Unstable geomorphic features	High	Moderate	Moderate	Appropriate construction management practices will reduce the probability of occurrence. Grading of slopes. Use of geotechnical engineering measures to aid slope stability. Design, management and monitoring carried out in line with the appropriate Construction Method Statements. Siting of stockpiles away from watercourses or unstable slopes.	Low

Complete.

Table 8.26 Assessment of Groundwater Potential Impacts: Decommissioning Phase

Site/Activity	Potential Impacts	Receptor	Sensitivity of Receptor	Magnitude of Impact	Pre-Mitigation Impact Significance	Mitigation Measures	Residual Impact Significance
General decommissioning activities	Leaks and spills during use and storage or pollutants causing contamination of groundwater (directly or indirectly via soil or surface water)	Superficial aquifer	Moderate	Moderate	Moderate	Spillage prevention, bunding and restrictions near watercourses, artificial drains, sensitive soils (moderate and high) and water bodies to minimise impact. Material will be stored away from sensitive soils and water bodies where possible, with secondary containment. Collection and off-site disposal of domestic wastewaters. Drainage and treatment systems for managing surface run-off designed to avoid adverse effects on groundwater quality. Compliance with the ESMP and Project Emergency Preparedness and Response Plan.	Low
		Carbonate aquifer	Moderate	Moderate	Moderate		Low

Continued…

Site/Activity	Potential Impacts	Receptor	Sensitivity of Receptor	Magnitude of Impact	Pre-Mitigation Impact Significance	Mitigation Measures	Residual Impact Significance
Establishment of Temporary Construction Areas	Vegetation clearance and earthworks causing or increasing mobilisation of contamination in the soil causing deterioration in groundwater quality	Superficial aquifer	Moderate	Low	Low	In the event that previously unidentified contamination is observed during decommissioning, works in the affected area will cease until the contaminated material is tested and appropriate disposal processes identified.	Low
		Carbonate aquifer	Moderate	Low	Low		Low
Open trench pipe removal activities – from microtunnel entry shafts to landfall	Vegetation clearance and earthworks causing or increasing mobilisation of contamination in the soil causing deterioration in groundwater quality	Superficial aquifer	Moderate	Low	Low	In the event that previously unidentified contamination is observed during decommissioning, works in the affected area will cease until the contaminated material is tested and appropriate disposal processes identified.	Low
		Carbonate aquifer	Moderate	Low	Low		Low

Continued...

Site/Activity	Potential Impacts	Receptor	Sensitivity of Receptor	Magnitude of Impact	Pre-Mitigation Impact Significance	Mitigation Measures	Residual Impact Significance
Open trench pipe removal activities – from microtunnel entry shafts to landfall	Change in groundwater levels if groundwater control required at Graphova Gap crossing	Superficial aquifer	Moderate	Low	Low	Adopt groundwater control measures appropriate to ground conditions. Backfill excavation with material of similar or greater permeability than original materials. Undertake works during dry weather if possible.	Low
		Carbonate aquifer	Moderate	Low	Low		Low
	Change in groundwater levels if groundwater control required in trench (except Graphova Gap)	Superficial aquifer	Moderate	Low	Low	Adopt groundwater control measures appropriate to ground conditions. Backfill excavation with material of similar or greater permeability than original materials.	Low
		Carbonate aquifer	Moderate	Negligible	Not Significant		Not Significant
Decommissioning of landfall facilities	Change in groundwater levels if groundwater control required for excavations	Superficial aquifer	Moderate	Low	Low	Adopt groundwater control measures appropriate to ground conditions. Backfill excavations with material of similar permeability to original materials.	Low
		Carbonate aquifer	Moderate	Negligible	Not Significant		Not Significant

Complete.

Table 8.27 Assessment of Surface Water Potential Impacts: Decommissioning Phase

Site/Activity	Potential Impacts	Receptor	Sensitivity of Receptor	Magnitude of Impact	Pre-Mitigation Impact Significance	Mitigation Measures	Residual Impact Significance
General decommissioning activities	Leaks and spills during use and storage or pollutants causing contamination of surface water (directly or indirectly via soil or groundwater)	Shingar River	Moderate	Moderate	Moderate	Spillage prevention, bunding and restrictions near watercourses, artificial drains, sensitive soils (moderate and high) and water bodies to minimise impact. Material will be stored away from sensitive soils and water bodies where possible, with secondary containment. Collection and off-site disposal of domestic wastewaters. Stormwater discharges from the landfall facilities will pass through a sand trap and filter, and an oil interceptor prior to discharge. The treatment standards will be aligned with required water quality standards prior to discharge of the stormwater into the environment. Compliance with the ESMP and Project Emergency Preparedness and Response Plan.	Low
		Tributary in Graphova Gap	Moderate	Moderate	Moderate		Low

Continued...

Site/Activity	Potential Impacts	Receptor	Sensitivity of Receptor	Magnitude of Impact	Pre-Mitigation Impact Significance	Mitigation Measures	Residual Impact Significance
Establishment of Temporary Construction Areas	Vegetation clearance and earthworks causing increased vulnerability of soils to erosion affecting surface water quality via run-off	Shingar River	Moderate	Moderate	Moderate	Avoid unnecessary changes to natural drainage systems. Existing artificial drainage to be diverted maintaining gravity flows. Strip topsoil from working area and store in stockpiles. Stockpiles kept to agreed height, and free from disturbance. Stockpiles to be covered as required. Siting of stockpiles away from watercourses or unstable slopes. Design and management of site drainage to reduce risk of soil erosion in exposed subsoil areas or in stockpiles. Drainage systems for surface run-off designed to avoid poor quality water entering watercourses.	Low
		Tributary in Graphova Gap	Moderate	Moderate	Moderate		Low
	Vegetation clearance and earthworks causing increased run-off affecting flow regime	Shingar River	Moderate	Moderate	Moderate		Low
		Tributary in Graphova Gap	Moderate	Moderate	Moderate		Low

Continued…

Site/Activity	Potential Impacts	Receptor	Sensitivity of Receptor	Magnitude of Impact	Pre-Mitigation Impact Significance	Mitigation Measures	Residual Impact Significance
Establishment of Temporary Construction Areas	Vegetation clearance and earthworks causing increased run-off affecting flow regime	Tributary in Graphova Gap	Moderate	Moderate	Moderate	Stormwater discharges from the landfall facilities will pass through a sand trap and filter, and an oil interceptor prior to discharge. The treatment standards will be aligned with required water quality standards prior to discharge of the stormwater into the environment. In the event that previously unidentified contamination is observed during decommissioning, works in the affected area will cease until the contaminated material is tested and appropriate disposal processes identified. Reinstate soils and replant as soon as possible after decommissioning.	Low

Continued…

Site/Activity	Potential Impacts	Receptor	Sensitivity of Receptor	Magnitude of Impact	Pre-Mitigation Impact Significance	Mitigation Measures	Residual Impact Significance
Open trench pipe removal activities – from microtunnel entry shafts to landfall facilities	Vegetation clearance and earthworks causing increased vulnerability of soils to erosion affecting surface water quality via run-off	Shingar River	Moderate	Moderate	Moderate	Avoid unnecessary changes to natural drainage systems. Existing artificial drainage to be diverted maintaining gravity flows. Strip topsoil from working area and store in stockpiles. Stockpiles kept to agreed height, and free from disturbance. Stockpiles to be covered as required. Siting of stockpiles away from watercourses or unstable slopes. Design and management of site drainage to reduce risk of soil erosion in exposed subsoil areas or in stockpiles. Drainage/ treatment systems for surface run-off designed to avoid poor quality water directly entering watercourses.	Low
		Tributary in Graphova Gap	Moderate	Moderate	Moderate		Low
	Vegetation clearance and earthworks causing increased run-off affecting flow regime	Shingar River	Moderate	Moderate	Moderate		Low
		Tributary in Graphova Gap	Moderate	Moderate	Moderate		Low

Continued…

Site/Activity	Potential Impacts	Receptor	Sensitivity of Receptor	Magnitude of Impact	Pre-Mitigation Impact Significance	Mitigation Measures	Residual Impact Significance
Open trench pipe removal activities – from microtunnel entry shafts to landfall facilities	Vegetation clearance and earthworks causing increased run-off affecting flow regime	Tributary in Graphova Gap	Moderate	Moderate	Moderate	In the event that previously unidentified contamination is observed during decommissioning, works in the affected area will cease until the contaminated material is tested and appropriate disposal processes identified. Reinstate soils and replant as soon as possible after decommissioning.	Low
	Change in flow regime during crossing works	Tributary in Graphova Gap	Moderate	Moderate	Moderate	Undertake crossing works during dry weather if possible.	Low
	Disturbance of stream bed sediments during crossing works	Tributary in Graphova Gap	Moderate	Moderate	Moderate	Divert any remaining flows around working area. Reinstate stream as close to original condition as possible. Use sediment control measures (e.g. silt curtains or straw bales) as required.	Low
	Changes in water quality (turbidity, suspended solids) during crossing works	Tributary in Graphova Gap	Moderate	Moderate	Moderate	Backfill excavation with material of similar or greater permeability than original materials to avoid changes to baseflow.	Low

Continued...

Site/Activity	Potential Impacts	Receptor	Sensitivity of Receptor	Magnitude of Impact	Pre-Mitigation Impact Significance	Mitigation Measures	Residual Impact Significance
Decommissioning of landfall facilities	Earthworks causing increased vulnerability of soils to erosion affecting surface water quality via run-off	Tributary in Graphova Gap	Moderate	Moderate	Moderate	Avoid unnecessary changes to natural drainage systems. Existing artificial drainage to be diverted maintaining gravity flows. Strip topsoil from working area and store in stockpiles. Stockpiles kept to agreed height, and free from disturbance. Stockpiles to be covered as required. Siting of stockpiles away from watercourses or unstable slopes.	Low

Continued…

Site/Activity	Potential Impacts	Receptor	Sensitivity of Receptor	Magnitude of Impact	Pre-Mitigation Impact Significance	Mitigation Measures	Residual Impact Significance
Decommissioning of landfall facilities	Earthworks causing increased run-off affecting flow regime	Tributary in Graphova Gap	Moderate	Moderate	Moderate	Design and management of site drainage to reduce risk of soil erosion in exposed subsoil areas or in stockpiles. Drainage management systems designed to manage surface run-off and avoid poor quality water entering watercourses directly. Drainage management systems at landfall facilities to include appropriately certified water treatment systems to treat stormwater prior to discharge. Water treatment standards to be aligned with national water quality criteria (Table 8.3). In the event that previously unidentified contamination is observed during decommissioning, works in the affected area will cease until the contaminated material is tested and appropriate disposal processes identified. Reinstate soils and replant as soon as possible after decommissioning.	Low

Complete.

8.6.5 Unplanned Events

The potential impacts associated with unplanned events are discussed in **Chapter 19 Unplanned Events**.

Procedures to minimise the risk and impact of accidental spills will be developed within the Spill Prevention and Response Plan **(Chapter 22 Environmental and Social Management**). Spill kits shall be kept in accessible locations at all times during the Construction and Pre-Commissioning, Operation and Decommissioning Phases, and employees will be trained in their use and disposal. Considering the small size of any potential spillages and mitigation employed the impacts on soils, groundwater and surface water are expected to be **Low**.

8.6.6 Cumulative Impacts Assessment

All cumulative impacts identified are summarised in **Chapter 20 Cumulative Impact Assessment**.

8.7 Conclusions

8.7.1 Soils – Construction and Pre-Commissioning Phase

The soil receptors in the Study Area include agricultural soils, fluvisols, phaeozem soils and unstable geomorphic features. Construction workers are also a high sensitivity receptor for soils. The impacts pre-mitigation are **Low** to **High** significance. The Project Area impacts are primarily associated with potential contamination of the soils through use and storage of materials, increased susceptibility to erosion, changes in soil properties and unstable ground. Through mitigation the residual significance of the impacts are reduced to **Low**.

8.7.2 Soils – Operational Phase

The Project Area impacts pre-mitigation are **Moderate** significance. The impacts are primarily associated with potential for leaks and spills, vegetation management along the permanent RoW, and interaction of Project infrastructure with natural geomorphological processes. Through mitigation the residual significance of the impacts are reduced to **Not Significant** to **Low**.

8.7.3 Groundwater – Construction and Pre-Commissioning Phase

The groundwater receptors in the Study Area include superficial and carbonate aquifers and existing abstractions. The impacts pre-mitigation are **Not Significant** to **Moderate** significance. The impacts in the Study Area are primarily associated with potential contamination of the groundwater through use and storage of materials, groundwater control, the mobilisation of existing contamination and hydro-testing. Through mitigation the residual significance of the impacts are reduced to **Not Significant** to **Low**.

8.7.4 Groundwater –Operational Phase

The Study Area impacts pre-mitigation are **Moderate** to **Low** significance. The impacts are primarily associated with potential contamination and the potential influence of the pipeline structure on the groundwater flow regime. Through mitigation the residual significance of the impacts are reduced to **Not Significant** to **Low**.

8.7.5 Surface Water – Construction and Pre-Commissioning Phase

The Study Area surface water receptors include the Shingar River and the tributary of the Sukko River in the Graphova Gap and existing surface water abstractions. The Study Area impacts pre-mitigation are of **Moderate** significance. The impacts are primarily associated with the contamination of the surface water through use and storage of materials, construction of access roads, surface water run-off across disturbed soils and river crossing by the Pipeline. Through mitigation the residual significance of the impacts are reduced to **Not Significant** to **Low.**

8.7.6 Surface Water –Operational Phase

The Study Area impacts significance pre-mitigation are **Low** to **Moderate**. The impacts are primarily associated with impact on the surface watercourses through potential contamination, surface water run-off at landfall facilities and access road, and river crossings by the Pipeline and access road. Through mitigation the residual significance of the impacts are reduced to **Not Significant** to **Low**.

8.7.7 Decommissioning Phases

If the activities involve the removal of the trenched pipeline and access road then the impacts and pre-mitigation impact significances are likely to be similar to those reported during the Construction Phase. The exception being the impacts associated with microtunnelling and hydro-testing.

Through mitigation the residual significance of impacts on soil, groundwater and surface water can be reduced to **Not Significant** to **Low**. If the Pipeline is left in place then the impacts will be greatly reduced compared with the impacts if the Pipeline is removed. If the landfall facilities are removed then the impacts during the decommissioning works will be greater than if the facilities are left in place, but the long-term impacts on the water environment will be reduced if the facilities are removed.

References

Numbers	Explanations
Ref. 8.1	Giprospetzgas (2011) Complex engineering surveys at the phase "design documentation" within the framework of the "South Stream" gas pipeline marine sector project implementation. Technical documentation Volume 5: Environmental survey and archaeological studies. Part 1 Environmental survey, The Russian sector. Book 3: Technical report.
Ref. 8.2	Letter of the Ministry of Environment and Natural Resources, No. 04-25 dated 27 December 1993.
Ref. 8.3	Giprospetsgaz, 2012. South Stream Stage 1 (West Corridor). Technical Documentation, Volume 20, Part 5 Report on the survey and assessment work on water supply Book 6 Planned Sanitary Protection Zones (6976.211.001.21.14.20.05.06-1)
Ref. 8.4	Peter Gaz (2013). Personal communication regarding groundwater abstractions within Russian terrestrial part of the landfall section, made to South Stream (London, UK, 27 June 2013).
Ref. 8.5	South Stream (2013). Personal communication regarding surface water abstractions within Russian terrestrial part of the landfall section, made to URS (London, UK, 27 June 2013).
Ref. 8.6	OJSC Slavyanka (2013). Letter from Repair and Operational Region No. 7 of the Krasnodar Branch to LLC Peter Gaz regarding Sukko boreholes.
Ref. 8.7	South Stream, 2013. Personal communication on abstractions with Anapa Administration. Communicated to URS 29 August 2013.
Ref. 8.8	Giprospetzgas (2013) "South Stream" (Russian Sector). Vol. 5 Engineering and environmental studies and archaeological investigations. Part 1 – Engineering and Environmental Studies. Book 5 – Landfall Section near Anapa. Technical Report 6976.101.004.21.14.05.01.05.
Ref. 8.9	Giprospetzgas (2011) Complex engineering surveys at the phase "design documentation" within the framework of the "South Stream" gas pipeline marine section. Technical documentation Volume 7: Valuations surveys, Parts 1, 2, 4 and 5.
Ref. 8.10	Giprospetzgas (2011) Complex engineering surveys at the phase "design documentation" within the framework of the "South Stream" gas pipeline marine section. Technical documentation Volume 8: Engineering Survey, first phase.
Ref. 8.11	Giprospetzgas (2011) Complex engineering surveys at the phase "design documentation" within the framework of the "South Stream" gas pipeline marine section. Technical documentation Volume 9: Engineering-geological survey (geotechnical works).

Numbers	Explanations
Ref. 8.12	Peter Giprospetzgaz (2013). Complex engineering surveys at design documentation phase as part of South Stream gas pipeline marine section, Technical documentation, Volume 18 integrated report on first phase, Part 2 integrated report, Book 13 Appendix 13 shore transition charts, landfall charts, Russian Sector, 6976.101.004.21.14.18.02.13
Ref. 8.13	GN 2.1.7.2041-06. Maximum permissible concentrations (MPCs) of chemical substances in the soil.
Ref. 8.14	GN 2.1.7.2511-09. Approximate permissible concentrations (APCs) of chemical substances in soil.
Ref. 8.15	GN 1.2.2701-10. Hygienic regulations of pesticides in the environment (list).
Ref. 8.16	SanPiN 2.1.4.1175-02. Hygiene requirements for quality of water from non-centralised water supply systems. Sanitary protection of water sources.
Ref. 8.17	GN 2.1.5.1315-03. Maximum permissible concentrations (MPCs) of chemicals substances contained in water of Water Bodies for Economic-Potable and Social-Domestic Water Use, including the Supplements and Amendments No 1 to GN2.1.5.1315-03.
Ref. 8.18	SanPiN 2.1.5.980-00 for Water Drainage of Populated Areas, Sanitary Protection of Water Bodies. Hygienic requirements to surface waters protection. Sanitary Rules and Standards.
Ref. 8.19	Order of the Federal Fisheries Agency No. 20 dated 18 January 2010, on approving the standards for Water Quality in Fishing Water Bodies, including Standards for maximum permissible concentrations of Harmful Substances in the Water of Fishing Water Bodies.
Ref. 8.20	SanPiN 2.1.4.1110-022.1.4. Drinking water and water supply of populated areas. Zones of sanitary protection of water sources and potable water supply, Russian Ministry of Health. Moscow 2002.
Ref. 8.21	Article 65 of the Water Code of the Russian Federation
Ref. 8.22	SanPiN 2.1.7.1287 -03. Soil quality sanitary epidemiological requirements for industrial sites
Ref. 8.23	World Health Organisation (2011). Guidelines for drinking water quality, Fourth Edition.
Ref. 8.24	International Finance Corporation (2007). Environmental, Health and Safety General Guidelines. World Bank Group.

Numbers	Explanations
Ref. 8.25	Order of State Committee of Russian Federation (13 April 1999). Order No. 165 Concerning recommendations for inventory of producing operations, equipment, materials, or use of PCB and PCB-containing waste in the Russian Federation.
Ref. 8.26	The Netherlands Government Ministry of Housing, Spatial Planning and the Environment (2000). Circular on target values and intervention values for soil remediation, Government Gazette 2000-39.
Ref. 8.27	The Netherlands Ministry of Housing, Spatial Planning and the Environment (2009). Soil Remediation Circular, Government Gazette 2009.
Ref. 8.28	Canadian Environmental Quality Guidelines, http://ceqg-rcqe.ccme.ca/
Ref. 8.29	Food and Agriculture Organisation (FAO) (2006). World Reference Base for Soil Resources (WRB). A framework for international classification, correlation and communication. Food and agriculture organization of the United Nations, Rome.
Ref. 8.30	Environ, 2013. Personal communication on presence of potentially contaminated material made to URS on 16/09/2013.
Ref. 8.31	Peter Gaz (2013). Note to URS. Additional information on Shingar Stream.
Ref. 8.32	Guidelines for Soil Quality Assessment in Conservation Planning, United States Department of Agriculture, Natural Resources Conservation Service, Soil Quality Institute, January 2001.