SAKARYA GAS FIELD DEVELOPMENT PROJECT – ENHANCEMENT OF SUBSEA PRODUCTION CAPACITY AND FLOATING PRODUCTION UNIT

Chapter 7.3 Offshore Physical and Biological Components Impact Assessment

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7.3.1 Physical environment

7.3.1.1 Seafloor morphology

Based on the information collected for the definition of the baseline (see 6.3.1.1), it was assigned a **Medium-high** value of sensitivity the component *seafloor morphology* for the following reasons:

- Absence of rocky outcrops and gently sloping bathymetry upon the continental slope;
- Presence sedimentary waves in the canyon area;
- Presence of a possible ship wrack within the AoI;
- Presence of Mud Volcano 3 at about 6 km from the AoI; and
- Medium Seismicity.

Impacts potentially affecting this component are assessed here below for the construction and operation phase.

7.3.1.1.1 Construction phase

Impact factors

The impact factors from the Project activities potentially affecting seafloor morphology during construction phase are listed in the following table.

Table 7-1: Project actions and related impact factors potentially affecting seafloor morphology during construction phase

Project actions	Brief descriptions	Impact factors
Offshore excavation (trenching) and sediment storage	Excavation of a trench in shallow water in correspondence of the land approach (approx. 1.66 km). The sediments removed (approx. 82,200 m^3) will be temporarily stored west of Filyos Port, east of the pipeline, and will be moved back to cover the pipeline	▪ Handling and resuspension of sediments ▪ Presence of the cofferdam ▪ Introduction of new offshore infrastructures
Offshore pipeline laying	Offshore laying of pipelines, umbilical line and lines within the SPS and their connection, various submarine structures (e.g., XT and MEG)	

All the impact factors identified above are described below and assessed in the matrix that follows.

- **Handling of and resuspension of sediments**

The offshore excavation of the trench for the first 1.66 km of the pipeline corridor is expected to actively mobilize sediments to be stored at the temporary storage area before the backfill. This may cause an alteration of the seafloor morphology of the AoI, which, as shown in 6.3.1.1, consists mostly of soft bottoms.

In fact, during the implementation of the excavation and sediment storage, 82.200 m^3 of sediments are expected to be moved and temporary deposited in the storage area. This will cause an alteration of the seascape, since the seafloor, which is currently rather homogeneous, will present a trench in the pipeline corridor and the temporary storage area will be covered by layers of new sediments coming from the trench. The storage area presents a surface of 260.000 m^2; the dredge sediment will be deposited between a minimum water depth of 5 meters and a maximum water depth of 11 meters.

Considering the volume of sediments mobilized (82.200 m^3) and the surface where the dredged material will be deposited (i.e., 260.000 m^2), a temporary increase of about 0.32 m is expected in the storage area. In both cases the bathymetry of the affected areas will be altered. However, it must be considered that this is only a temporary effect and that the increase in the sediment thickness of the storage area will not exceed 32 cm.

Sediment mobilization is also expected during the activities of pipeline cover whereby the dredge material previously deposited in the storage area will be transferred on bulk vessels to backfill the pipeline.

The excavation of the coastal trench is expected to be completed in approximately 75 days. After the trench is excavated, the pipeline will be laid within 14 days and then covered with the dredged material in approximately 167 days. The total schedule for the dredging activities is approximately 303 days (including weather delays).

However, it must be considered that the filling works will be carried out in two stages. For the first stage of backfilling, approximately 50 cm of backfill material will be placed over the pipelines along the trench using the excavator/material holder placed on the barge. In the second stage, the dredged material will be placed on the dump vessels and the material will be discharged into the trench. After the dredged material is loaded, the bulk vessels will pass through the trench. This allows to mobilize less sediment simultaneously.

Moreover, after the pipeline is laid and the trench backfilled, the seafloor morphology will be restored at both the affected areas.

- **Presence of the cofferdams**

A cofferdam will be placed for the excavation of the first 332 m of the 1.66 km trench in order to reduce the risk of sediment flowing from the Filyos River into the trench. Two rows of cofferdams will form the side walls of the ditch. This is expected to possibly alter the seascape and the morphology of the seafloor of the affected area, even if temporary.

After the pipeline is laid, in fact, the cofferdam ditches (as well as the trench) will be backfilled with the stored sediments excavated during the dredging and the cofferdams themselves will be removed, completely restoring the morphology of the AoI.

The presence of the two rows of cofferdams will be limited to the dredging period (around 303 days) and to the first 332 m of the pipeline corridor. Moreover, potential alterations of the seafloor morphology related to the presence of the cofferdams are expected to be completely reversible. In fact, it is expected the original seafloor morphology will be restored after and cofferdams removal the backfilling.

- **Introduction of new offshore infrastructures**

The production system is a subsea network that connects the production wells throughout the entire SGFD. A number of different structures and pipelines will be installed onto the seafloor.

The structures include:

- Xmas trees (XT, valve assemblies placed on top of the wellheads) a key safety barrier and flow control device for gas from formation to the pipeline;
- Mono-ethylene Glycol (MEG) distribution manifolds which transports MEG from the Onshore Processing Facility (OPF) to the Subsea Production System (SPS), where it is injected into the gas stream to inhibit hydrate formation;
- Umbilical interconnection which will allow communication between the FPU and OPF;
- A 170 km long gas export offshore pipeline connected to the existing tie-in point with the BOTAŞ onshore natural gas grid.

Due to the low load-bearing capability of the seabed in the region where the gas production and will be installed, a foundation for the above-described units will be installed by erecting suction piles at defined locations within the gas production field. Subsequently, the distribution manifolds will be installed on the pre-installed suction piles. The suction pile foundation for MEG manifold will be approximately 87 tons in weight, 12 m in length and 6 m in diameter.

Other components of the SPS will be installed on seabed directly. After all components of the subsea distribution system are installed, they will be connected to the XTs.

The new structure located onto the seabed will introduce a new type of artificial hard substrate upon the seafloor. As illustrated in 6.3.1.1, the seafloor of the AoI consists mostly of soft bottoms and, besides the canyon systems, the seascape is highly homogeneous.

The introduction of the pipelines and cables (i.e., umbilical and cables at the SPS), XT and MEG is therefore expected to alter the seafloor morphology, by altering the natural homogeneity of the sandy-muddy-clayey bottoms of the AoI. However, this alteration is expected to be very limited in the case of pipelines, considering the linear typology of the infrastructures and their size (16'' maximum for the pipeline diameter).

A more significant effect is instead expected for the introduction of the XT and MEG. However, it should be considered that the restoration of baseline environmental conditions is expected to happen in a relatively short time following the removal of artificial structures.

Mitigation measures

The following mitigation measures shall be implemented to mitigate the effects of the impact factors.

<u>Handling of and resuspension of sediments</u>

- Avoid uncontrolled release of the sediments potentially creating abnormal 3D structures at the temporary storage area and during the backfilling;

- Pipeline backfill takes place in two steps to avoid the mobilization of the entire sediment volume (82,200 m^3) simultaneously;
- Restore the homogeneity of the seafloor to pre-work conditions during the backfill of the trench.

Residual impacts

The table below summarizes the impacts caused by the identified impact factors on the component assessed.

Based on the component information reported in Chapter 6.3.1.1, the project characteristics and activities, as well as the proper implementation of the mitigation measures proposed above, a potential **low negative residual impact** is expected on the seafloor morphology during the construction phase.

Table 7-2: Residual impact assessment matrix for the seafloor morphology during construction phase

Impact Factor	Impact Factor Features		Component Sensitivity	Impact Reversibility	Impact Value	Mitigation Effectiveness	Residual Impact Value
Handling and resuspension of sediments	Duration:	Medium	Medium-high	Short-term	**Low**	Medium-high	**Negligible**
	Frequency:	Continuous					
	Geo. Extent:	Local					
	Intensity:	Medium					
Presence of the cofferdams	Duration:	Medium	Medium-high	Short-term	**Low**	None	**Low**
	Frequency:	Continuous					
	Geo. Extent:	Local					
	Intensity:	High					
Introduction of new offshore infrastructures	Duration:	Medium	Medium-high	Short-term	**Low**	None	**Low**
	Frequency:	Continuous					
	Geo. Extent:	Local					
	Intensity:	Medium					
Overall assessment		**Low**	Rationale: Using a strong precautionary approach, the highest residual impact value may be considered as a theoretical overall residual impact value.				

Monitoring measures

The following monitoring measure shall be implemented to assess the true effects of the project on the seafloor morphology during the construction and verify the effectiveness of the mitigation measures.

- Bathymetric surveys (i.e., by MBES), or alternatively ROV inspections along transects (500 m minimum), conducted in the scope of the project monitoring, whether planned, to be analyzed to assess the effectiveness of the restoration of the seafloor morphology after the backfill of the trench.

7.3.1.1.2 Operation phase

Impact factors

The impact factors from the Project activities potentially affecting the seafloor morphology during operation phase are listed in the following table.

Table 7-3: Project actions and related impact factors potentially affecting seafloor morphology during operation phase

Project actions	Brief descriptions	Impact factors
FPU/infrastructure operation offshore	Technical and administrative activities, including operation of the FPU/infrastructure, surveillance, monitoring, maintenance, performed according to standard operating procedures to maintain the Project offshore parts in operation.	▪ Presence of new offshore infrastructures

All the impact factors identified above are described below and assessed in the matrix that follows.

- <u>**Introduction of new offshore infrastructures**</u>

As already described for the construction phase, during operation, the new structure located onto the seabed will introduce a new type of artificial hard substrate upon the seafloor. The only exception is represented by the area close to the land approach, where the pipeline will be buried for approximatively 1.66 km.

As illustrated in 6.3.1.1, the seafloor of the AoI consists mostly of soft bottoms and, besides the canyon systems, the seascape is highly homogeneous. Therefore, the presence of the pipelines and cables (i.e., umbilical and cables at the SPS), XT and MEG is therefore expected to alter the seafloor morphology, by altering the natural homogeneity of the sandy-clayey bottoms of the AoI.

However, the alteration is expected to be very limited in the case of pipelines, considering the linear typology of the infrastructures and their size (16'' maximum for the pipeline diameter). Instead, a more significant effect is expected for the introduction of the XT and MEG.

This impact should also be considered to affect the seafloor morphology over an extensive period of time because the new infrastructures will remain on place for the whole operation phase.

Mitigation measures

No mitigation measures are expected for this impact during operation phase.

Residual impacts

The table below summarizes the impacts caused by the identified impact factors on the component assessed.

Based on the component information reported in Chapter 6.3.1.1, the project characteristics and activities, as well as the proper implementation of the mitigation measures proposed above, a potential **low negative residual impact** is expected on the seafloor morphology during the operation phase.

Table 7-4: Residual impact assessment matrix for the seafloor morphology during operation phase

Impact Factor	Impact Factor Features		Component Sensitivity	Impact Reversibility	Impact Value	Mitigation Effectiveness	Residual Impact Value
Presence of new offshore infrastructures	Duration:	Long	Medium-high	Short-term	**Low**	None	**Low**
	Frequency:	Continuous					
	Geo. Extent:	Local					
	Intensity:	Medium					
Overall assessment		**Low**	Rationale: Only one impact factor is expected to influence this component, therefore its residual impact value corresponds to the overall assessment for the component itself.				

Monitoring measures

The following monitoring measure shall be implemented to assess the true effects of the project on the seafloor morphology during the operation and verify the effectiveness of the mitigation measures.

- Bathymetric surveys (i.e., by MBES) and/or ROV inspections conducted in the scope of the project monitoring, whether planned, to be analyzed to inform on the presence of unplanned erosion or accumulation processes.

7.3.1.2 Sediments

Based on the information collected for the definition of the baseline (see 6.3.1.2), it was assigned a **low** value of sensitivity to the component *sediments* for the following reasons:

- Limited presence of fine sediment in the excavation area (trench); and
- Absence of significant contamination.

Impacts potentially affecting this component are assessed here below for the construction phase and operation phase.

7.3.1.2.1 Construction phase

Impact factors

The impact factors from the Project activities potentially affecting sediments during construction phase are listed in the following table.

Table 7-5: Project actions and related impact factors potentially affecting the sediment during construction phase

Project actions	Brief descriptions	Impact factors
▪ Offshore excavation (trenching) and sediment storage ▪ Offshore pipeline lying	Offshore construction works (i.e., i.e., dredging, pipeline laying and backfilling) may lead to sediment removal and resuspension with consequent release of contaminants, if accumulated within the seafloor	▪ Handling of and resuspension of sediments ▪ Minor leakage of contaminants into water ▪ Discharge of wastewater ▪ Emission of contaminants into marine water

All the impact factors identified above are described below and assessed in the matrix that follows.

- **Handling of and resuspension of sediments**

The offshore excavation of the trench for the first 1.66 km of the pipeline corridor is to actively mobilize the sediment with consequent resuspension of sediment particles into the water column. The main consequence of sediment mobilization is linked to the possible resuspension and availability of pollutants (if accumulated in the sediment) which may be released into the marine environment with decreased sediment quality.

Regarding the concentration of the pollutants (i.e., Aluminium, Arsenic, Cadmium, Chromium, Copper, Nickel, Lead, Zinc, Mercury, Total PCBs) analyzed within the AoI sediments (Chapter 6.3.1.2), It should be considered that all the contaminants in the AoI not exceed the Limit Value set by the Turkish regulations with the only exception of Cadmium and Mercury at some stations. In particular, Cadmium concentrations exceed the limits set by the Turkish regulation at 6 stations, namely EN- 24 (3.55 mg/kg), EN- 25 (3.16 mg/kg), EN-26 (3.16 mg/kg), EN-27 (2.47 mg/kg), EN-28 (4.06 mg/kg) and EN-29 (3.80 mg/kg), while Mercury concentrations exceed the maximum concentration set by the Turkish regulation at 2 stations, namely EN-32 (2.43 mg/kg) and EN-10 (1.30 mg/kg).

Similarly, the chemical analyses show that none of the contaminants exceed the Probable Effect Levels (PEL) of the National Oceanic and Atmospheric Administration (NOAA), where the concentration levels of the contaminant frequently pose adverse effects (Port of London Authority, 2022).

Nevertheless, it must be stated that Cadmium and Mercury concentrations detected in some of the analyzed samples are comprised between the Threshold Effect Levels (TELs) and PELs of the NOAA. In particular, Cadmium concentrations are comprised between NOAA's TEL and PEL at 3 stations, namely EN-24 (3.55 mg/kg), EN-28 4.06 (mg/kg) and EN-29 3.80 (mg/kg), while Mercury concentrations are comprised between NOAA's TEL and PEL at 2 stations, namely EN-10 (1.30 mg/kg) and EN-32 (2.43 mg/kg).

Heavy metals can bioaccumulate in aquatic organisms and can lead to physiological and biochemical disorders (Bears, Richards, & Schulte, 2006; Ribeiro, Vollaire, Sanchez-Chardi, & Roche, 2005) (the effects of heavy metals on the biological components will be assessed in the Biological Environment section). However, metals in sediments are generally present as sulphides, a form generally not bioavailable and therefore non-toxic (Rainbow, 2007). When sediment is resuspended in the water column, the oxidation of the sediment can lead to heavy metals remobilization and release. Coarse sediments (e.g., sand, which represents the AoI sediment type) remain in suspension shorter and can therefore release less metals than fine sediment.

Dredging operations can induce sediment resuspension, followed by their relocation to areas more or less adjacent to the intervention point. It is known that larger sediment particles tend to resettle quickly on the seabed, while finer particles, such as silts and clays, can remain in suspension for prolonged periods, from hours to days. These particles are therefore susceptible to being transported even hundreds of meters from the source (but generally in the order of 100-200 meters, Blaas et al., 2007).

As previously mentioned, a total of approximately 82.200 m^3 of sediments is expected to be mobilized in the near-shore section of the AoI. However, primary data collected in 2024 (chapter 6.3.1.2) showed that sand represents the dominant sediment component in all the analyzed samples, from 0 m to 2.000 m depth (with the only exception of 4 stations, namely EN-5, EN-9, EN-13 and EN-20 where clay dominates over sand), thus resuspended sediment in the Aoi tends to settle down quickly.

As previously discussed, most of the potential sediment resuspension is expected to occur in the near-shore area, where the trench will be excavated. Apart from sampling n. E-10, no other near-shore sample has shown contamination levels exceeding the limits. Therefore, any potential mobilization of contaminants is expected to be of extremely limited magnitude.

- **Minor leakage of contaminants into water**

Vessels will be used for all the activities concerning the offshore section of the project: 7 vessels for the land approach (i.e., first 1.6 km from the shoreline) and 19 for the pipelay operations in deeper waters.

When dealing with a vessel, the leakage of small amounts (i.e., negligible, but still present) of contaminants (mostly oily and greasy) from the engines is considered "physiological" and inevitable. Contaminants of such typology are mostly insoluble in water and undergo various physical, chemical, and biological processes that influence their fate and transport[1]. As matter of facts, oil can be transported vertically through processes such as dispersion and sinking, thus reaching the sediment. In particular, over time, oil particles can bind with suspended sediments and organic matter, causing them to sink and accumulate on the ocean floor.

As described above, a total of 26 vessels will be continuously operating in the AoI, although not simultaneously. On top of the working vessels, two waste ships will be operating withing the AoI to collect and transport the wastewater onshore.

However, it must be noted that:

- These are negligible quantities of released pollutants in the order of 2-3 l/day (Shankar et al., 2020; Jalkanen et al., 2021);
- The two groups of vessels mentioned above will be rarely operational in the same timeframe, having sequential functions, thus minimizing the impact;

[1] nap.nationalacademies.org2nap.nationalacademies.org

- The extent to which oil reaches marine sediments depends on factors like water currents and wave action. The AoI is mainly localized at open sea, with a depth greater than 1000 m and characterized by current speeds of 40 – 50 cm/s;
- All the vessels must be compliant with MARPOL, to which Türkiye is signatory.
- **Discharge of wastewater**

During the construction phase, sewage and domestic wastewater generated by personnel at the onshore camp site will be collected by sewage infrastructures and treated in package wastewater treatment plants that will be established by contractors and subcontractors.

The impacts generated by the wastewater released into the Filyos River are assessed in section 7.2.1.4 of the present Impact Assessment.

Wastewater produced at the camp site will be collected and properly treated at the OPF treatment plants before disposal into Filyos River to be compliant with both national and international standards. However, domestic wastewater and sewage, even if treated and compliant with the national and international regulations, may still affect the quality of receiving environment especially if the discharge point is located close to the shoreline. As matter of facts, domestic wastewaters contain nutrients (such as nitrogen and phosphorus derivates) and other chemicals that may affect the water quality and cause eutrophication, especially if not properly managed (i.e., discharge point located at adequate depth to ensure dilution).

In this case, the discharge point is located within Filyos River estuary where flow can guarantee adequate dilution and because the seaward AoI is characterized by currents of 20 – 30 cm/sec speed in proximity of the coastline, it can be assumed that the water discharged will be also promptly diluted by the currents present in the area.

On the contrary, sewage produced on board of the vessels used during the construction phase will be collected by waste ships and transferred to Zonguldak TTK Waste Reception Facility; therefore, it will not be discharged into the sea.

In regard to bilge water (leachate and oily wastewater from machinery spaces in vessels), it will be collected on board and shipped to Zonguldak TTK Waste Reception Facility for disposal, thus it will not be discharged into the sea.

Ballast waters will be produced on board of the vessels during construction activities due to water pumped into and out of storage during loading and off-loading operations. However, ships will be compliant with Ballast Water Management Convention and Guidelines developed by International Maritime Organization (IMO). The ballast water exchange will take place at least 50 nautical miles (NM) from the nearest land and in water at least 200 m in depth. Since the seafloor depth is about 2.100 m at a distance of 50 NM from the coastline, the discharged ballast waters are expected to be diluted into the water column before reaching the sediment.

- **Emission of contaminants into marine water**

After the completion of the construction phase and before the pipelines are put into operations, all the pipes will be hydrotested by pumping liquids at 550 PPM into them to detect possible faults in the junctions and prevent leakage. Wastewater resulting from offshore pre-commissioning activities (typically filtered seawater, or filtered seawater with chemical additives including corrosion inhibitor, oxygen scavenger, biocide, and dye to prevent internal corrosion or to identify leaks, MEG or umbilical transportation liquid) will be discharged into the sea at high depth (about 2.200 m depth), in correspondence to the SPS site.

In fact, after the completion of the construction phase and before the pipelines and SPS components are put into operations, all the pipes will be pre-commissioned to detect possible faults in the junctions and prevent leakage. Such test, as described in Section 3.2.1 and 3.2.2 of the Project Description (Chapter 3) for SPS and SURF, respectively. The amount of wastewater and chemicals resulting from pre-commissioning activities are given below.

Table 7-6: Discharges related with Pre-commissioning Activities of SPS, SURF, and Offshore Pipeline

Discharge Type	Amount (m³)
Chemically Treated Sea Water	23,699.0
Non-Chemically Treated Sea Water	18,824.0
Offshore Discharged MEG (@ 2200m WD)	191.0
Additive (RX 5255 @2200m WD)	11.3
Additive (RX 5102D @2200m WD)	1.9
Total	42,523.0

Since this type of wastewater is released in the proximity of the seafloor, pollutants potentially present in the water can be accumulated into the sediment. However, considering that that the discharge will be a one-time event, even if a small amount of chemicals will be distributed over the sediment in proximity of the SPS, it is unlikely this will have an impact on the overall sediment quality.

Mitigation measures

The following mitigation measures shall be implemented to mitigate the effects of the impact factors.

<u>Handling and resuspension of sediments</u>

- Sediments to be gently placed at the temporary storage area in order to reduce the resuspension.
- Dredged sediments to be stored in mapped sections at the temporary storage area so the backfill operation shall bring back the sediments at the proper location not to disrupt the sediment type distribution.
- Pipeline backfill takes place in two steps to avoid the mobilization of the entire sediment volume (82,200 m^3) simultaneously.
- Presence of fine sediment (i.e., clay) to be tolerated but its dominance in the upper layer (i.e., the first 20 cm) to be avoided.

<u>Minor leakage of contaminants into water</u>

- All vessels shall be compliant with MARPOL.

<u>Discharge of wastewater</u>

- Wastewater discharged, even if located within Filyos River, shall be compliant with the international standards and regulations (as reported in section 7.2.1.4).

- For what concern the ballast waters, the **International Convention for the Control and Management of Ships' Ballast Water and Sediments** (BWM Convention) sets out specific standards to control and manage ships' ballast water and sediments to prevent the spread of harmful aquatic organisms from one region to another through ballast water discharge. These standards are primarily defined in two regulations:

  1. **Regulation D-1: Ballast Water Exchange Standard**
     - Ships performing ballast water exchange must do so at least 200 nautical miles from the nearest land and in water at least 200 meters deep. If this is not possible, exchange should be done as far from the nearest land as possible, and in all cases at least 50 nautical miles from the nearest land and in water at least 200 meters deep[2].
  2. **Regulation D-2: Ballast Water Performance Standard**
     - This standard sets limits on the concentration of viable organisms in ballast water. Specifically, ships must ensure that ballast water discharged contains fewer than 10 viable organisms per cubic meter that are greater than or equal to 50 micrometers in minimum dimension, and fewer than 10 viable organisms per milliliter that are between 10 and 50 micrometers in minimum dimension. Additionally, the discharge must meet specific limits for microbe indicators, including *E. coli, intestinal enterococci, and Vibrio cholerae*[3].

Moreover, the BWM Convention requires ships to manage their ballast water to certain standards, including:

- **Ballast Water Management Plan**: Each ship must have a specific plan detailing how it will manage ballast water to meet the convention's standards.
- **Ballast Water Record Book**: Ships must maintain a record book documenting all ballast water operations.
- **Ballast Water Management Certificate**: Ships must carry this certificate to demonstrate compliance with the convention[4].

<u>Emission of contaminants into marine water</u>

- Hydrotest fluids discharged at deep sea to be compliant with the relevant standards for deep sea discharges as reported in Appendix B.
- Minimize, when possible, the volume of hydrotest water offshore by testing equipment at an onshore site prior to loading the equipment onto the offshore facilities.
- Use the same water for multiple tests, when feasible.
- Reduce the need for chemicals by minimizing as much as possible the time that test water remains in the equipment or pipeline.

[2] alfalaval.com

[3] marineinsight.com

[4] mdpi.com and imo.org

- Carefully select chemical additives in terms of dose concentration, toxicity, biodegradability, bioavailability, and bioaccumulation potential.

Residual impacts

The table below summarizes the impacts caused by the identified impact factors on the component assessed.

Based on the component information reported in Chapter 6.3.1.12, the project characteristics and actions, as well as the proper implementation of the mitigation measures proposed above, a potential **negligible negative impact** is expected on the sediments during the construction phase.

Table 7-7: Residual impact assessment matrix for the sediment during construction phase

Impact Factor	Impact Factor Features		Component Sensitivity	Impact Reversibility	Impact Value	Mitigation Effectiveness	Residual Impact Value
Handling of and resuspension of sediments	Duration:	Medium	Low	Short-term	**Negligible**	Medium-high	**Negligible**
	Frequency:	Continuous					
	Geo. Extent:	Local					
	Intensity:	Medium					
Minor leakage of contaminants into water	Duration:	Medium	Low	Short-term	**Negligible**	Medium-high	**Negligible**
	Frequency:	Continuous					
	Geo. Extent:	Local					
	Intensity:	Negligible					
Discharge of wastewater	Duration:	Medium	Low	Short-term	**Negligible**	Medium-high	**Negligible**
	Frequency:	Frequent					
	Geo. Extent:	Local					
	Intensity:	Low					
Emission of contaminants into marine water	Duration:	Short	Low	Short-term	**Negligible**	Medium-high	**Negligible**
	Frequency:	Concentrated					
	Geo. Extent:	Local					
	Intensity:	Low					

Overall assessment	**Negligible**	Rationale: Using a strong precautionary approach, the highest residual impact value may be considered as a theoretical overall residual impact value.

Monitoring measures

The following monitoring measure shall be implemented to assess the true effects of the project on the sediments during the construction and verify the effectiveness of the mitigation measures.

- Sediment samplings (i.e., by grab) and analyses to be performed at both the trench and temporary storage area during the construction activities and once completed the construction. Results to be compared with the baseline conditions.
- In case of contaminant levels exceed the concentration detected before the beginning of the work activities monitoring must be performed once per month until the end of the working activities.

7.3.1.2.2 Operation phase

Impact factors

The impact factors from the Project activities potentially affecting sediments during operation phase are listed in the following table.

Table 7-8: Project actions and related impact factors potentially affecting sediment during operation phase

Project actions	Brief descriptions	Impact factors
FPU/infrastructure operation offshore	Technical and administrative activities, including operation of the FPU/infrastructure, surveillance, monitoring, maintenance, performed according to standard operating procedures to maintain the Project offshore parts in operation.	Minor leakage of contaminants into water Discharge of wastewater Discharge of produced water

All the impact factors identified above are described below and assessed in the matrix that follows.

- **Minor leakage of contaminants into water**

During the operation phase, monitoring activities will be performed in order to inspect the pipelines localized on the seafloor. Since the pipelines are strategically important for the Project, conducting the maintenance-repair operations during the operation phase regularly is essential.

Monitoring vessels will be performing monitoring at frequencies to be provided prior operation. On top of the ordinary monitoring, a waste receiving ship will be used to collect the wastewater from the FPU three times per week during the entire operation period (25-40 year).

As described in the construction phase, a minimal leaking of contaminants is expected from the vessel's engines in the order of 2-3 L/day. These contaminants, in particular oil, can be transported vertically through processes such as dispersion and sinking, thus reaching the sediment and accumulating on the ocean floor over time.

However, due to the level of contaminants released and the AoI location, whereby most of the Project footprint is located at depths greater than 1000 m and with currents in the order of 40 - 50 m/sec, it represents an impact of small magnitude. In fact, it is expected that the small amount of contaminants will be promptly diluted by the currents present in the AoI. Nevertheless, it represents an impact already present within the AoI since the area is characterized by a high intensity of commercial routes in proximity of the port. Finally, all the operating vessels will be compliant with MARPOL which addresses the prevention of pollution.

- **Discharge of wastewater**

As already described in section 7.3.1.2 wastewaters (including slop, bilge and sewage) will be produced on board of the FPU in the order of 50 m^3/day over a period of 20-45 years.

The bilge and slop water on FPU will be transferred to Zonguldak TTK Waste Reception Facility for disposal, thus bilge and slop water will not be discharged into the sea.

The bilge and slop water on PSV's will be collected in slop tank and transferred to Zonguldak TTK Waste Reception Facility for disposal.

The sewage generated by the personnel on board of the FPU (approximately 29.4 m^3/day) will be treated in the Sewage Treatment Plant onboard and then discharged into the sea, if international and local standards are met.

Ballast waters will be produced on board of the vessels during operation activities due to water pumped into and out of storage during loading and off-loading operations. However, ships will be compliant with Ballast Water Management Convention and Guidelines developed by International Maritime Organization (IMO). The ballast water exchange will take place at least 50 nautical miles (NM) from the nearest land and in water at least 200 m in depth.

- **Discharge of produced water**

Produced water, a byproduct of gas extraction, may pose a significant environmental challenge when discharged from FPU. This water often contains various contaminants, including hydrocarbons and chemicals. The total amount of discharged produced water is expected to be on average 500 m^3/day (see chapter 3.10.2 of project description).

The discharged produced water may decrease sediment quality due to the introduction of chemicals.

The produced water to be generated from topsides facilities on FPU is planned to be discharged to Black Sea and it will need to satisfy the "Project Specific Discharge Standards", issued by the MoEUCC (refer to Table 3-18 in Chapter 3.10.2) and MARPOL.

Mitigation measures

The following mitigation measures shall be implemented to mitigate the effects of the impact factors.

Minor leakage of contaminants into water

- All vessels shall be compliant with MARPOL.

Discharge of wastewater

In regard to the wastewater discharged shall be compliant with a number of international standards and national regulations, including:

- Oil Pollution: MARPOL Annex I which addresses the prevention of pollution by oil from operational measures as well as from accidental discharges. FPU must comply with these regulations, which include requirements for the treatment and discharge of oily water.
- Safety and Pollution Prevention: The International Maritime Organization (IMO) provides guidelines for the safety, pollution prevention, and security of FPU.
- Local Standards: In addition to international regulations, FPU must comply with local environmental standards set by the coastal states where they operate, e.g. National Ballast Water Management Strategy for Türkiye.
- Industry Standards: The industry also follows best practices for the management of produced water and other wastewaters. This includes the use of advanced treatment technologies to remove contaminants and ensure that discharges meet environmental standards.
- Turkish Ministry of Environment, Urbanization, and Climate Change (MoEUCC)
  - Project Specific Discharge Standards (refer to Table 3-18 given in Chapter 3.10.2).

For what concern the ballast waters, the BWM Convention sets out specific standards to control and manage ships' ballast water and sediments. These standards are primarily defined in two regulations:

- Regulation D-1: Ballast Water Exchange Standard: Ships performing ballast water exchange must do so at least 200 nautical miles from the nearest land and in water at least 200 meters deep. If this is not possible, exchange should be done as far from the nearest land as possible, and in all cases at least 50 nautical miles from the nearest land and in water at least 200 meters deep.
- Regulation D-2: Ballast Water Performance Standard: this standard sets limits on the concentration of viable organisms in ballast water. Specifically, ships must ensure that ballast water discharged contains fewer than 10 viable organisms per cubic meter that are greater than or equal to 50 micrometers in minimum dimension, and fewer than 10 viable organisms per milliliter that are between 10 and 50 micrometers in minimum dimension. Additionally, the discharge must meet specific limits for indicator microbes, including *E*. *coli*, intestinal enterococci, and *Vibrio cholerae*.

Discharge of produced water

- Produced water shall be compliant with a number of international and national standards and regulations, including:
  - Bucharest Convention
    - **Protocol on Protection of the Black Sea Marine Environment Against Pollution from Land-Based Sources:** This protocol mandates that all necessary measures be taken to prevent, reduce, and control pollution from land-based sources, including offshore installations like FPU.
    - **Annex I Substances:** The protocol lists specific substances that must be controlled or eliminated in discharges, such as heavy metals, persistent organic pollutants, and nutrients that can cause eutrophication.

- **Monitoring and Reporting:** Continuous monitoring of water quality and regular reporting are required to ensure compliance with environmental standards.

- MARPOL Convention
  - **Annex I**: This annex addresses the prevention of pollution by oil and other harmful substances. FPU must comply with these regulations, which include requirements for the treatment and discharge of oily water.
  - **Guidelines for FPU**: The International Maritime Organization (IMO) provides specific guidelines for the application of MARPOL Annex I to FPU, ensuring uniform standards for the treatment and discharge of processed water.
- Turkish Ministry of Environment, Urbanization, and Climate Change (MoEUCC)
  - Project Specific Discharge Standards (refer to Table 3-18 given in Chapter 3.10.2).

Residual impacts

The table below summarizes the impacts caused by the identified impact factors on the component assessed.

Based on the component information reported in Chapter 6.3.1.12, the project characteristics and actions, as well as the proper implementation of the mitigation measures proposed above, a potential **negligible negative impact** is expected on the sediments during the operation phase.

Table 7-9: Residual impact assessment matrix for the sediment during operation phase

Impact Factor	Impact Factor Features		Component Sensitivity	Impact Reversibility	Impact Value	Mitigation Effectiveness	Residual Impact Value
Minor leakage of contaminants into water	Duration:	Long	Low	Short-term	**Negligible**	Medium-high	**Negligible**
	Frequency:	Highly frequent					
	Geo. Extent:	Local					
	Intensity:	Negligible					
Discharge of wastewater	Duration:	Long	Low	Short-term	**Negligible**	Medium-high	**Negligible**
	Frequency:	Frequent					
	Geo. Extent:	Local					
	Intensity:	Low					
Discharge of produced water	Duration:	Long	Medium-high	Short-mid-term	**Low**	Medium-high	**Negligible**
	Frequency:	Continuous					

Impact Factor	Impact Factor Features		Component Sensitivity	Impact Reversibility	Impact Value	Mitigation Effectiveness	Residual Impact Value
	Geo. Extent:	Regional					
	Intensity:	High					
Overall assessment		**Negligible**	Rationale: Using a strong precautionary approach, the highest residual impact value may be considered as a theoretical overall residual impact value.				

Monitoring measures

No monitoring measures are required for the physical oceanography during operation.

7.3.1.3 Seawater

Based on the information collected for the definition of the baseline (see 6.3.1.2), it was assigned a **High** value of sensitivity to the component *seawater* for the following reasons:

- CTD measurements and main parameters in line with the regional context;
- Most of the contaminant’s concentrations are under the instrument detection limit, therefore it is not possible to make a comparison with international standards;
- AoI located mainly in open sea area with good water circulation.

Impacts potentially affecting this component are assessed here below for the construction phase and operation phase.

7.3.1.3.1 Construction phase

Impact factors

The impact factors from the Project activities potentially affecting seawater during construction phase are listed in the following table.

Table 7-10: Project actions and related impact factors potentially affecting seawater during construction phase.

Project actions	Brief descriptions	Impact factors
▪ Offshore excavation (trenching) and sediment storage ▪ Offshore pipeline lying	Offshore construction works (i.e., dredging, pipeline laying and backfilling) may lead to sediment resuspension with consequent release of contaminants (if accumulated within the seafloor), increased turbidity and decease of water quality	▪ Minor leakage of contaminants into water ▪ Handling of and resuspension of sediments ▪ Emission of contaminants into marine water ▪ Discharge of wastewater

All the impact factors identified above are described below and assessed in the matrix that follows.

- **Minor leakage of contaminants into water**

As described for the sediment, vessels will be used for all the activities concerning the offshore section of the project: 7 vessels for the land approach (i.e., first 1.66 km from the shoreline) and 19 for the pipelay operations in deeper waters.

The leakage of small amounts (i.e., negligible, but still present) of contaminants (mostly oily and greasy) from the engines is considered “physiological” and inevitable. As already reported, given the amount of contaminants released (2-3 l/day) and the AoI location, whereby most of the Project footprint is located at depths greater than 1.000 m and with currents in the order of 40 - 50 cm/sec, this represents an impact of small magnitude. In fact, it is expected that the small amount of contaminants will be promptly diluted by the currents present in the AoI. Nevertheless, it represents an impact already present within the AoI since the area is characterized by a high intensity of commercial routes in proximity of the port. Finally, all the operating vessels will be compliant with MARPOL which addresses the prevention of pollution.

- **Handling of and resuspension of sediments**

The construction activities, in particular dredging of the trench for the pipeline land approach and the backfilling, will mobilize approximatively 82,000 m^3 of sediments potentially causing a reintroduction into the water column of contaminants accumulated within the sediments (if present). In addition, such mobilization is expected to cause a temporary increase of seawater turbidity and possible reduction of dissolved oxygen into the water column.

As already stated (i.e., impact assessment for sediments in chapter 7.3.1.2.1), all contaminants identified in the AoI sediments did not exceed neither the PELs of NOAA nor the TLV of the Turkish regulation. Moreover, the AoI is localized close to the Filyos river mouth, which produce natural turbidity in the area due to sediment discharge.

However, as described in chapter 6.3.1.3, it was not possible to infer if the concentrations of many seawater contaminants were above or below the PELs of NOAA or the TLV of the Turkish regulation due to the low sensibility of the instrument used for the analysis. When the data allowed for a comparison, almost all the contaminants were above the PELs or TLV standards.

Specifically, Nickel concentrations were always above the limits set by the Turkish regulation and NOAA acute and chronic standards.

Chromium and Ammonia concentrations, for which no NOAA standards are available, were above the Turkish limit in all samples except for one station (EN–20 station, ammonia below 0.02 mg/L).

Copper exceeds both the Turkish regulation and NOAA limits at 2 stations, namely EN-2 (2.11 mg/kg) and EN-5 (1.47 mg/kg) while for the remaining 35 stations was not possible to make a comparison as the thresholds are below the detection limit of the instrumentation used. Similarly, Mercury concentrations exceeded both the Turkish regulation and NOAA limits at 3 stations EN- 20 (0.17 mg/L), EN-29 (0.12 mg/L) and EN-37 (0.12 mg/L) while for the remaining 34 stations was not possible to make a comparison.

Finally, it was not possible to make a comparison between the Lead, Zinc and Arsenic detected concentration and standards as the thresholds are below the detection limit of the instrumentation used.

Only Cadmium concentrations were below the standards set by the NOAA.

In the event that more contaminants are released into the marine environment following sediment mobilization, a significant decrease in water quality is expected due to the increase in Nickel, Chromium, and Ammonia, whose concentrations are already above the PELs and/or TLV. Based on primary data, it is not possible to make any assumption for Copper, Mercury, Lead, Zinc and Arsenic.

Moreover, increased sedimentation and suspended sediment could also reduce the amount of dissolved oxygen (DO) in the water due to both the lack of photosynthetic activity (linked to increased turbidity) and increased microbial mineralization. In fact, the resuspension of sediment particles could boost microbial mineralization rates with consequent consumption of oxygen, while the photosynthetic phytoplanktonic activity could be reduced by the limited light. Within the AoI, particularly referring to the area interested by the dredging and backfill activities, while the concentration of DO across the water column is homogeneous in winter due intensive vertical mixing processes (which take place from 0 to up about 180 m depth), it decreases near the seafloor in summer due to water stratification. A further DO decrease at the sediment/water interface, as consequence of increased mineralization rates and reduced phytoplanktonic activity, could lead to hypoxic phenomena in the water column, especially at low depth.

For the reasons above described, and using a precautional approach, this impact factor could severely affect the seawater of the AoI.

- **<u>Emission of contaminants into marine water</u>**

After the completion of the construction phase and before the pipelines are put into operations, all the pipes will be hydrotested to detect possible faults in the junctions and prevent leakage. Such test, as described in chapter 3.0 (Project Description), is typically made by filtered seawater, or filtered seawater with chemical additive (e.g., corrosion inhibitor, oxygen scavenger, biocide, and dye) to prevent internal corrosion or to identify leaks.

Ideally, the liquids used to hydrotest the pipelines are not supposed to leak into the marine environment and, therefore, affect the seawater, especially in the oxygenated layers (i.e., from 0 to -100/-150 m). However, it is common for newly laid pipelines to have small faults, primarily at the junctions, that need to be repaired before the operation phase. In such cases, a limited volume of hydrotest liquid may leak, introducing chemicals that could alter the seawater quality.

However, since this activity is planned to be implemented punctually and over a short period of time it can be assumed that this impact may be considered of limited magnitude. Moreover, even if the seawater might be temporally affected by the discharged test water, most of the pipeline length is localized in an environment characterized by oxygen depletion, where no life exists, and the anoxic layer does not mix with the above oxygenated seawater layer.

- **Discharge of wastewater**

During construction phase, sewage will be produced on board of the vessels used during the construction phase. However, the generated sewage will be taken by waste ships and transferred to Zonguldak TTK Waste Reception Facility; therefore, it will not be discharged into the sea.

For what concern bilge water (leachate and oily wastewater from machinery spaces in vessels), will be collected and shipped to Zonguldak TTK Waste Reception Facility for disposal and will not be discharged into the sea.

Ballast waters will be produced on board of the vessels during construction activities due to water pumped into and out of storage during loading and off-loading operations. However, ships will be compliant with Ballast Water Management Convention and Guidelines developed by International Maritime Organization (IMO). The ballast water exchange will take place at least 50 nautical miles (NM) from the nearest land and in water at least 200 m in depth.

The only possible alteration of seawater quality may be related to the wastewater resulting from offshore pre-commissioning activities (typically filtered seawater, or filtered seawater with chemical additives including corrosion inhibitor, oxygen scavenger, biocide, and dye to prevent internal corrosion or to identify leaks, MEG or umbilical transportation liquid) will be discharged into the sea at high depth (about 2.200 m depth), in correspondence to the SPS site.

The amount of wastewater resulting from pre-commissioning activities and additives immitted into the Black Sea are reported in Table 7-6.

However, as already reported for the sediment in section 7.3.1.2.1, it is expected that the release of hydrotesting fluid will not pose a significant environmental impact.

Mitigation measures

The following mitigation measures shall be implemented to mitigate the effects of the impact factors.

Minor leakage of contaminants into water

- All vessels shall be compliant with MARPOL.

Handling and resuspension of sediments

The relative mitigation measures have been reported in the sediment section 7.3.1.2.1.

Emission of contaminants into marine water

- The relative mitigation measures have been reported in the sediment section 7.3.1.2.1.

Discharge of wastewater

The relative mitigation measures have been reported in the sediment section 7.3.1.2.

Residual impacts

The table below summarizes the impacts caused by the identified impact factors on the component assessed.

Based on the baseline conditions of the assessed component, the project characteristics and actions, as well as the proper implementation of the mitigation measures proposed above, a potential **low negative impact** is expected on the seawater during the construction phase.

Table 7-11: Residual impact assessment matrix for the seawater during construction phase

Impact Factor	Impact Factor Features		Component Sensitivity	Impact Reversibility	Impact Value	Mitigation Effectiveness	Residual Impact Value
Minor leakage of contaminants into water	Duration:	Medium	Medium-high	Short-term	**Low**	Medium-high	**Negligible**
	Frequency:	Frequent					
	Geo. Extent:	Local					
	Intensity:	Negligible					
Handling of and resuspension of sediments	Duration:	Medium	Medium-high	Short-term	**Low**	Medium	**Low**
	Frequency:	Highly frequent					
	Geo. Extent:	Regional					
	Intensity:	High					
Emission of contaminants into marine water	Duration:	Short	Medium-high	Short-term	**Negligible**	Medium-high	**Negligible**
	Frequency:	Infrequent					
	Geo. Extent:	Local					

Impact Factor	Impact Factor Features		Component Sensitivity	Impact Reversibility	Impact Value	Mitigation Effectiveness	Residual Impact Value
	Intensity:	Negligible					
Discharge of wastewater	Duration:	Medium	Medium-high	Short-mid-term	**Medium**	Medium-high	**Low**
	Frequency:	Highly frequent					
	Geo. Extent:	Local					
	Intensity:	Low					
Overall assessment		**Low**	Rationale: Using a strong precautionary approach, the highest residual impact value may be considered as a theoretical overall residual impact value.				

Monitoring measures

The following monitoring measure shall be implemented to assess the true effects of the project on the seawater during the construction and verify the effectiveness of the mitigation measures.

- Water samplings (i.e., by Niskin bottle close to the surface and close to the bottom) and analyses to be performed at both the trench and temporary storage area during the construction activities and immediately after the dredging and backfill activities; results to be compared with the baseline conditions.
- Water samplings (i.e., by Niskin bottle close to the surface and close to the bottom) and analyses to be performed at the hydrotest discharge point immediately after the hydrotesting activities and by one month after them (i.e., a time interval from a week after to a month after is accepted). Chemicals used for the hydrotest (see chapter 3.0 of the project description) to be searched and quantified in laboratory.
- In case of leakages during the hydrotest, water samplings (i.e., by Niskin bottle close to the surface and close to the bottom) and analyses to be conducted in correspondence of the leakage point(s) immediately after the leak(s) and by one month after (i.e., a time interval from a week after to a month after is accepted).

7.3.1.3.2 Operation phase

Impact factors

The impact factors from the Project activities potentially affecting the seawater during operation phase are listed in the following table.

Table 7-12: Project actions and related impact factors potentially affecting seawater during operation phase

Project actions	Brief descriptions	Impact factors
FPU/infrastructure operation offshore	Technical and administrative activities, including operation of the FPU/infrastructure, surveillance, monitoring, maintenance, performed according to	▪ Discharge of wastewater

	standard operating procedures to maintain the Project offshore parts in operation.	▪ Minor leakage of contaminants into water ▪ Discharge of produced water ▪ Use of seawater

The impact factors identified above are described below and assessed in the matrix that follows.

- **Discharge of wastewater**

As already described in section 7.3.1.2 wastewaters (including slop, bilge and sewage) will be produced on board of the FPU in the order of 50 m^3/day over a period of 20-45 years.

The bilge and slop water on FPU will be collected in slop tank and transferred to Zonguldak TTK Waste Reception Facility for disposal, thus it will not be discharged into the sea.

The bilge and slop water on PSV's will be collected in slop tank and transferred to Zonguldak TTK Waste Reception Facility for disposal.

The sewage generated by the personnel on board of the FPU (approximately 29.4 m^3/day) will be treated in the Sewage Treatment Plant onboard and then discharged to sea, if international and local standards are met.

Ballast waters will be produced on board of the vessels during operation activities due to water pumped into and out of storage during loading and off-loading operations. However, ships will be compliant with Ballast Water Management Convention and Guidelines developed by International Maritime Organization (IMO). The ballast water exchange will take place at least 50 nautical miles (NM) from the nearest land and in water at least 200 m in depth.

- **Minor leakage of contaminants into water**

The SPS, umbilical and pipelines are essential for the project, therefore conducting maintenance/repair operations is mandatory. Such operations are always conducted using vessels that, such as previously stated, may lose small amounts of contaminants (mostly oily and greasy) from the engines, altering the seawater quality.

However, it must be noted that these maintenance/repair operations are not performed continuously and do not require a large number of vessels. In addition, all vessels must be compliant with MARPOL, to which Türkiye is signatory; therefore, it is unlikely that this impact factor could severely affect the AoI seawater quality.

- **Discharge of produced water**

Produced water, a byproduct of gas extraction, may pose a significant environmental challenge when discharged from FPU. This water often contains various contaminants, including hydrocarbons and chemicals. The total amount of discharged produced water with monovalent salt is expected to be on average 500 m^3/day (see chapter 3.10.2 of project description). Moreover, the water used during the cooling process will be discharged into the marine environment at a temperature of about 35°C. The total amount of discharged cooling water is expected to be up to 312,000 m^3/day.

The discharged produced water may decrease seawater quality due to the introduction of chemicals and the discharged cooling water may alter the seawater temperature and density.

The produced water to be generated from topsides facilities on FPU is planned to be discharged to sea after it will satisfy the "Project Specific Discharge Standards", issued by the MoEUCC (Table 3-18 given in Chapter 3.10.2)

Environmental regulations for FPU in the Black Sea are primarily governed by the Convention on the Protection of the Black Sea Against Pollution, also known as the Bucharest Convention, which mandates that all necessary measures be taken to prevent, reduce, and control pollution of the marine environment from various sources, including offshore installations like FPU.

In regard to the cooling water discharged at a temperature of 35°C, it may alter the seawater characteristics as higher temperatures can increase the rate of chemical reactions in the water, potentially leading to the formation of harmful substances. For example, higher temperatures can enhance the bioavailability of Mercury, Cadmium and Arsenic[5].

For this impact, a model on the dispersion of processed water and dilution is being developed.

- **Use of seawater**

The FPU will withdraw a total of 294,000 m³/day of seawater, 144,000 m³/day for power generation cooling and 150,000 m³/day for topside equipment cooling.

For the vessel needs, the FPU will withdraw 18,000 m³/day using one pump at 100% capacity, with an installed capacity of 36,000 m³/day. Seawater will be the sole water source for the process, and fresh water used on the ship will also be obtained from seawater at a rate of 90 m³/day using a Reverse Osmosis (RO) unit, with an installed capacity of 180 m³/day. The FPU is equipped with a freshwater bunkering facility as a backup to the RO units, though it will likely never be needed.

The total amount of seawater withdraw in a year is equal to 107.310.000 m³/year.

Mitigation measures

The following mitigation measures shall be implemented to mitigate the effects of the impact factors.

Discharge of wastewater

The relative mitigation measures have been reported in the sediment section 7.3.1.2.

Minor leakage of contaminants into water

- All vessels used to be compliant with MARPOL.

Discharge of produced water

- Produced water shall be compliant with a number of international and national standards and regulations, including:

[5] https://phys.org/news/2024-10-heavy-metals-ocean-toxic-climate.html

- Bucharest Convention
  - **Protocol on Protection of the Black Sea Marine Environment Against Pollution from Land-Based Sources:** This protocol mandates that all necessary measures be taken to prevent, reduce, and control pollution from land-based sources, including offshore installations like FPU.
- **Annex I Substances:** The protocol lists specific substances that must be controlled or eliminated in discharges, such as heavy metals, persistent organic pollutants, and nutrients that can cause eutrophication.
  - **Monitoring and Reporting:** Continuous monitoring of water quality and regular reporting are required to ensure compliance with environmental standards.
- MARPOL Convention
  - **Annex I**: This annex addresses the prevention of pollution by oil and other harmful substances. FPU must comply with these regulations, which include requirements for the treatment and discharge of oily water.
  - **Guidelines for FPU**: The International Maritime Organization (IMO) provides specific guidelines for the application of MARPOL Annex I to FPU, ensuring uniform standards for the treatment and discharge of processed water.
- Turkish Ministry of Environment, Urbanization, and Climate Change (MoEUCC)
  - Project Specific Discharge Standards (refer to Table 3-18 given in Chapter 3.10.2).

Residual impacts

The table below summarizes the impacts caused by the identified impact factors on the component assessed.

Based on the baseline conditions of the assessed component, the project characteristics and actions, as well as the proper implementation of the mitigation measures proposed above, a potential low negative impact is expected on the seawater during the operation phase.

Table 7-13: Residual impact assessment matrix for the seawater during operation phase

Impact Factor	Impact Factor Features		Component Sensitivity	Impact Reversibility	Impact Value	Mitigation Effectiveness	Residual Impact Value
Minor leakage of contaminants into water	Duration:	Long	Medium-high	Short-term	**Low**	Medium-high	**Negligible**
	Frequency:	Frequent					
	Geo. Extent:	Local					
	Intensity:	Negligible					
Discharge of wastewater	Duration:	Long	Medium-high	Short-term	**Low**	Medium-high	**Negligible**
	Frequency:	Frequent					

Impact Factor	Impact Factor Features		Component Sensitivity	Impact Reversibility	Impact Value	Mitigation Effectiveness	Residual Impact Value
	Geo. Extent:	Local					
	Intensity:	Low					
Discharge of produced water	Duration:	Long	Medium-high	Short-mid-term	**Medium**	Medium-high	**Low**
	Frequency:	Continuous					
	Geo. Extent:	Regional					
	Intensity:	High					
Use of seawater	Duration:	Long	Medium-high	Short-term	**Low**	High	**Negligible**
	Frequency:	Continuous					
	Geo. Extent:	Local					
	Intensity:	Low					
Overall assessment		**Low**	Rationale: Using a strong precautionary approach, the highest residual impact value may be considered as a theoretical overall residual impact value.				

Monitoring measures

The following monitoring measure shall be implemented to assess the true effects of the project on the seawater during the operation and verify the effectiveness of the mitigation measures.

- Regular continuous monitoring at the discharge points in the Filyos river as illustrated in hydrology and surface water impact assessment will be useful also for the seawater as a consequence.
- In case of exceeding the thresholds defined in Appendix B at the discharge points, water samplings (i.e., by Niskin bottle close to the surface and close to the bottom) and analyses to be performed along a transect starting from the Filyos river mouth and directed offshore following the predominant current direction immediately after the detection of the exceeding and by one month after (i.e., a time interval from a week after to a month after is accepted). The exceeded parameter to be searched and quantified in laboratory as minimum.
- Seasonal water samplings (i.e., by Niskin bottle close to the surface and close to the bottom) and analyses to be performed along a transect starting from the Filyos river mouth and directed offshore following the predominant current direction. The same parameters as per the discharge points in the river (as stated in hydrology and surface water impact assessment and reported in Appendix B to be searched and quantified in laboratory.

- Instantaneous and continuous monitoring of water discharges from production facilities (including the FPU) within the scope of Continuous Discharge Monitoring Systems (SAİS) must be conducted in accordance with specified Project Specific Discharge Standards, issued by the MoEUCC.

This monitoring coupled with the one reported for hydrology and surface water impact assessment aim at both:

- Monitoring the input of contaminants from the river to the seawater; and
- Discriminating whether the source of the possible pollution (whether present) could be the project itself or other sources (e.g., other wastewater discharges in the area).

7.3.1.4 Physical oceanography

Based on the information collected for the definition of the baseline (see 6.3.1.4), it was assigned a **Medium-low** value of sensitivity to the component *physical oceanography* for the following reasons:

- Absence of relevant local upwelling phenomena; and
- Low probability of extreme wave events.

Impacts potentially affecting this component are assessed here below for the construction phase and operation phase.

7.3.1.4.1 Construction phase

Impact factors

The impact factors from the Project activities potentially affecting Physical oceanography (currents and waves) during construction phase are listed in the following table.

Table 7-14: Project actions and related impact factors potentially affecting physical oceanography during construction phase

Project actions	Brief descriptions	Impact factors
▪ Offshore excavation (trenching) and sediment storage	Includes the excavation of a trench in shallow water, in correspondence of the land approach.	▪ Presence of the cofferdams

The impact factor identified above is described below and assessed in the matrix that follows.

- <u>**Presence of the cofferdams**</u>

Such as previously stated, two series of cofferdams will be put in place during the excavation of the trench and subsequent pipeline laying. Those barriers will be erected from the sea bottom to above the sea level to prevent the trench to be refilled by the sediments coming from the Filyos River. The excavation of the coastal trenches is expected to be completed in approximately 75 days. After the trench is excavated, it is anticipated that the pipes will be laid within 14 days, while a total of days is expected to be required to cover the pipe with the dredged material. The total schedule for the dredging activities is approximately 303 days (please refer to chapter 3.2.4).

During its presence, the cofferdam may alter water circulation in the landfall area. However, this alteration is temporary and completely reversible, since the water circulation is expected to be immediately restored once the cofferdams are removed.

Mitigation measures

No mitigation measures are identified for the impact factor potentially affecting the physical oceanography during construction.

Residual impacts

The table below summarizes the impacts caused by the identified impact factors on the component assessed.

Based on the component information reported in Chapter 6.3.1.4, the project characteristics and actions, as well as the proper implementation of the mitigation measures proposed above, a potential **negligible negative impact** is expected on the physical oceanography during the construction phase.

Table 7-15: Residual impact assessment matrix for the physical oceanography during construction phase

Impact Factor	Impact Factor Features		Component Sensitivity	Impact Reversibility	Impact Value	Mitigation Effectiveness	Residual Impact Value
Presence of the cofferdams	Duration:	Medium	Medium-low	Short-term	Negligible	None	Negligible
	Frequency:	Continuous					
	Geo. Extent:	Local					
	Intensity:	High					
Overall assessment		Negligible	Rationale: Only one impact factor is expected to influence this component, therefore its residual impact value corresponds to the overall assessment for the component itself.				

Monitoring measures

No monitoring measures are required for the physical oceanography during construction.

7.3.1.4.2 Operation phase

No impacts generated by the operation phase of the project are expected on the physical oceanography.

7.3.1.5 Underwater noise

Based on the information collected for the definition of the baseline (see 6.3.1.5), it was assigned a **Medium-high** value of sensitivity to the component *underwater noise* for the following reasons:

- Presence of cetaceans; and
- High number of maritime routes (primarily in the outermost part of the project area).

Impacts potentially affecting this component are assessed here below for the construction phase and operation phase.

7.3.1.5.1 Construction phase

Impact factors

The impact factors from the Project activities potentially affecting Underwater noise during construction phase are listed in the following table.

Table 7-16: Project actions and related impact factors potentially affecting underwater noise during construction phase

Project actions	Brief descriptions	Impact factors
Offshore excavation (trenching) and sediment storage	Includes the excavation of a trench in shallow water, in correspondence of the land approach	Emission of underwater noise
Offshore pipeline laying	Refers to the offshore laying of the pipelines and the connection of the pipelines in the offshore gas field with the SPS	Emission of underwater noise

The impact factor identified above is described below and assessed in the matrix that follows.

- **Emission of underwater noise**

It is estimated that the construction operations at sea will require a total of 30 nautical units, of which 19 for offshore operations, 9 for nearshore operations, and 2 waste receiving ships (please refer to chapter 3.9.2.2 of the Project Description).

Such vessels are expected to be the main responsible for the emission of underwater noise, which tends to vary with the size, speed, engine type of the vessel.

Installation of the marine pipelines, as well as the deployment of the mooring and anchoring systems designated to maintain the FPU in position, may require multiple vessels including pipe laying vessels, anchor handling vessels and support vessels. Such vessels are generally large, potentially exceeding 150 m in length, and they generally operate using the so-called Dynamic Positioning (DP), a computer-controlled system used to automatically maintain a vessel's position and heading by using its own propellers and thrusters.

While the actual properties of the underwater vessel noise will depend on the vessels selected by the installation contractor, numerous studies have detailed the characteristics of various vessel types ranging from large DP vessels equivalent to the pipe laying and support vessels, to smaller tugs and guard vessels.

Vessel noise from large DP vessels is described as a low frequency broadband sound, with some tonal components ranging from 30Hz to 3kHz, with sound pressure levels reported between 180 to 197 dB re 1μPa at 1m (Talisman Energy, 2006; Wyatt, 2008; Xodus, 2014). Underwater noise generated by DP vessels does not vary significantly with speed, as a DP system relies on all thrusters working simultaneously, regardless of whether the vessel is moving or holding station. However, noise levels will vary with climatic and tidal conditions, which affect a vessels ability to maintain position, since these factors change the amount of thrust required to keep the vessel in position. In moderate wind, sea state and current; the noise levels can be expected to be lower than in more challenging conditions.

Smaller, non-DP vessels are reported as also emitting broadband noise with tonal components; however, the bandwidth is generally lower, concentrated between 50Hz and 2kHz. The reported sound pressure levels are lower than for the larger DP vessels, ranging between 170 to 180 dB re 1μPa at 1m (Richardson, 1995; Walker et al., 2018 & Wyatt, 2008). Unlike DP vessels, the sound level produced by smaller and faster vessels is highly dependent upon their speed, declining rapidly as a vessel slows from its normal cruising speed (Sakhalin Energy, 2003).

Nonetheless, it should be noted that, as illustrated in 6.3.1.5, the AoI is already crossed by several vessels all year long and that noise emissions, being on a logarithmical scale, are not summed arithmetically.

As such, the ambient underwater noise near the AoI may display a temporary increase, of few dB re 1 μPa, although baseline conditions shall be completely restored once the construction Phase 1s over.

Mitigation measures

The following mitigation measures shall be implemented to mitigate the effects of the impact factor.

- All vessels used to be compliant with MARPOL, to which Türkiye is signatory, whose regulations also have the objective of minimizing and preventing the noise pollution created by maritime traffic.

Residual impacts

Based on the component information reported in Chapter 6.3.1.5, the project characteristics and actions, as well as the proper implementation of the mitigation measures proposed above, a potential **low negative impact** is expected on the underwater noise during the construction phase.

Table 7-17: Residual impact assessment matrix for the underwater noise during construction phase

Impact Factor	Impact Factor	Features	Component Sensitivity	Impact Reversibility	Impact Value	Mitigation Effectiveness	Residual Impact Value
Emission of underwater noise	Duration:	Medium	Medium-high	Short-term	**Low**	Medium	**Negligible**
	Frequency:	Continuous					
	Geo. Extent:	Local					
	Intensity:	Medium					
Overall assessment		**Negligible**	Rationale: Only one impact factor is expected to influence this component, therefore its residual impact value corresponds to the overall assessment for the component itself.				

Monitoring measures

No monitoring measures are required for the underwater noise during construction.

7.3.1.5.2 Operation phase

Impact factors

The impact factors from the Project activities potentially affecting Underwater noise during operation phase are listed in the following table.

Table 7-18: Project actions and related impact factors potentially affecting underwater noise during construction phase

Project actions	Brief descriptions	Impact factors
FPU/infrastructure operation offshore	Includes technical and administrative activities (operation of the FPU/infrastructure, surveillance, monitoring, maintenance) to maintain the project offshore parts in operation according to standard operating procedures.	▪ Emission of underwater noise

The impact factor identified above is described below and assessed in the matrix that follows.

- **Emission of underwater noise**

Since the FPU will be moored in place, the emission of underwater noise will be primarily due to the periodic monitoring and maintenance activities of the offshore structures. Such operations are anticipated to be conducted using vessels whose propellers are expected to emit underwater noise.

Depending on the vessel used, an emission of 150-185 dB re 1 μPa at 1 m in the low frequency band (< 300 Hz) may be expected.

It must however be noted that these maintenance/repair operations are not performed continuously and do not require a large number of vessels and that noise emissions do not sum arithmetically, being on a logarithmical scale. In addition, all vessels must be compliant with MARPOL, to which Türkiye is signatory.

Mitigation measures

The following mitigation measures shall be implemented to mitigate the effects of the impact factor.

- All vessels used to be compliant with MARPOL, to which Türkiye is signatory, whose regulations also have the objective of minimizing and preventing the noise pollution created by maritime traffic.

Residual impacts

Based on the component information reported in Chapter 6.3.1.5, the project characteristics and actions, as well as the proper implementation of the mitigation measures proposed above, a potential **low negative impact** is expected on the underwater noise during the operation phase.

Table 7-19: Residual impact assessment matrix for the *underwater noise* during operation phase

Impact Factor	Impact Factor Features		Component Sensitivity	Impact Reversibility	Impact Value	Mitigation Effectiveness	Residual Impact Value
	Duration:	Long	Medium-high	Short-term	**Low**	Medium	**Negligible**
	Frequency:	Frequent					

Emission of underwater noise	Geo. Extent:	Local					
	Intensity:	Medium					
Overall assessment		**Negligible**	Rationale: Only one impact factor is expected to influence this component, therefore its residual impact value corresponds to the overall assessment for the component itself.				

Monitoring measures

No monitoring measures are required for the underwater noise during operation phase.

7.3.2 Biological Environment

7.3.2.1 Plankton

Based on the information collected for the definition of the baseline (see Chapter 6.3 of the Present ESIA, section 6.3.2.1), the biological component Plankton was assigned a **High** value of sensitivity for the following reasons:

- Presence of highly productive waters.

Impacts potentially affecting this component are assessed here below for the construction phase and operation phase.

7.3.2.1.1 Construction phase

The impact factors from the Project activities potentially affecting plankton during construction phase are listed in the following table.

Table 7-20: Project actions and related impact factors potentially affecting plankton during construction

Project actions	Brief description	Impact factors
Offshore excavation (trenching) and sediment storage	Excavation of a trench in shallow water in correspondence of the land approach; the sediment removed will be temporarily stored west of Filyos Port, east of the pipeline, and will be moved back to cover the pipeline (which was formerly used for temporary storage of dredged material during Phase 1 construction).	■ Minor leakage of contaminants into water ■ Emission of underwater noise ■ Handling of and resuspension of sediments ■ Discharge of wastewater
Offshore pipeline laying	The offshore laying of the pipeline and the connection of the pipeline in the offshore gas field with the SPS.	■ Minor leakage of contaminants into water ■ Emission of light ■ Emission of underwater noise ■ Discharge of wastewater
Pre-commissioning activities (e.g., pipeline hydrotesting, cleaning and gauging)	During the pre-commissioning phase, the pipelines will by hydrotested by pumping a chemical mixture.	■ Emission of contaminants into marine water

The impact factors identified above are described below and assessed in the matrix that follows.

- <u>**Minor leakage of contaminants into water**</u>

It is estimated that the construction operations at sea will require a total of 30 nautical units, of which 19 for offshore operations, 9 for nearshore operations (1.6 km from the coastline), and 2 waste receiving ships (see Chapter 3 of the present ESIA, section 3.9.2.2), during all the activities concerning the offshore section of the project.

When dealing with a vessel, the leakage of small amounts (i.e., negligible, but still present) of contaminants (mostly oily and greasy) from the engines is considered "physiological" and inevitable. Contaminants of such typology are mostly insoluble in water and tend to remain on the surface, potentially affecting marine organisms of the AoI, such as plankton. Indeed, depending on the amount, hydrocarbons may have severe effects on all marine organisms. A study showed that, while large amounts of oil can reduce photosynthesis and growth, as well as being lethal to phytoplankton, small amounts can on the opposite stimulate growth, which can result in excessive blooms. For zooplankton, sublethal effects may include impacts on feeding, behavior, reproduction, and development (Faggetter, 2011).

It must be noted, however, that all the vessels must be compliant with MARPOL, to which Türkiye is signatory, highly reducing the possibility of large leakages. In addition, the construction works should not last more than 2 years.

- **<u>Handling of and resuspension of sediments</u>**

The offshore excavation of the trench for the first 1.66 km of the pipeline corridor is expected to actively mobilize sediments to be stored at the temporary storage area before the backfill. The sediment removed will be temporarily stored west of Filyos Port, east of the pipeline, and will be moved back to cover the pipeline (which was formerly used for temporary storage of dredged material during Phase 1 construction). The excavation of the coastal trenches is expected to be completed in approximately 75 days. After the trench is excavated, it is anticipated that the pipes will be laid within 14 days, and then it will take approximately 167 days to cover the pipe with the dredged material form the temporary storage area. The trenching activity will be carried out using a backhoe excavator on a barge.

The mobilization of the substrate will presumably cause the suspension of the fine sediment, which can generate plumes of turbidity capable of persisting in the water column even for several hours or days, before settling (Blaas, 2007).

Differences in data emerge in the literature regarding the impacts of sediment suspension on the planktonic community: while some studies suggest that the increase in turbidity and the consequent decrease of light intensity may have a negative influence on phytoplankton primary production and algal blooms, others do not corroborate these results (Gameiro et al., 2011).

It is also conceivable that the negative effect resulting from reduced brightness could be partially mitigated and balanced by the supply of nutrients released through the process of sediment resuspension.

Regarding the zooplankton community, there are no clear data on the effects of sediment suspension.

While some studies suggest that resuspended sediment may limit the foraging of the zooplankton by adhering to their appendages or even exposing them to toxic substances released from sediments contaminated (Sullivan et al., 1977), other studies have not been able to correlate variations in zooplankton density and composition with sediment suspension (Rezai et al., 2003).

Resuspension of contaminated sediment could be an evaluable factor considering what said in 7.3.1.2 and 7.3.1.3. However, according to Taormina et al. (2018), the impacts resulting from sediment resuspension are however generally localized and short-term and can be considered globally negligible.

In addition, the presence of the Filyos river mouth already represents a sediment supply for the AoI.

- **Emission of light**

During the construction phase, pipelay activities are operations that are performed 16/24 hours. Therefore, night working, and the use of artificial light, will be required.

Night light pollution is known to affect marine organisms, their presence and space use. Indeed, plankton organisms are known to perform daily vertical migrations (zooplankton in particular, but phytoplankton as well: Gerbersdorf & Schubert, 2011), corresponding to their circadian rhythms where sunlight is the main limiting factor. Zooplankton, in fact, come to the surface during the night-time to feed and go back down during the day to avoid predation (Schiopca, 2018).

Considering that the pipelay operations are going to be performed continuously, the emission of light may cause the zooplankton descent in the water column preventing the organisms from feeding when the light itself is on (Schiopca, 2018). Even if continuously active for the whole pipelay duration (i.e., 12 months), such impact factor is limited to the vessel's circumscribed area and may be considered as affecting only few tens of meters from the vessels. In addition, even if the pipelay vessel is expected to proceed very slowly (i.e. 0.4 kn, as assumed in Phase 1), the impact may be considered as totally temporary, as the situation is expected to completely recover once the vessel has passed (i.e., every night the pipelay vessel is assumed to be 5 km apart).

- **Emission of underwater noise**

Any activity carried out in an offshore environment will have the potential to generate non-impulsive underwater noise, starting from navigation for the transport of components.

Installation of the marine pipelines, as well as the deployment of the mooring and anchoring systems designated to maintain the FPU in position, may require multiple vessels including pipe laying vessels, anchor handling vessels and support vessels. Such vessels are generally large, potentially exceeding 150 m in length, and they generally operate using the so-called Dynamic Positioning (DP), a computer-controlled system used to automatically maintain a vessel's position and heading by using its own propellers and thrusters.

It is estimated that the construction operations at sea will require a total of 30 nautical units, of which 19 for offshore operations, 9 for nearshore operations, and 2 waste receiving ships (see Chapter 3 of the present ESIA, section 3.9.2.2).

Such vessels are expected to be the main responsible for the emission of underwater noise, which tends to vary with the size, speed, engine type of the vessel (see 7.3.1.5).

Scientific literature documents a lower susceptibility to underwater noise in the earlier development stages of marine life (embryonic forms, larvae or fish juveniles) compared to the adult stages. This phenomenon could be attributable to the fact that organisms acquire the ability to perceive sounds in later development stages (Kunc et al., 2014).

The planktonic larval stages of some taxa, such as the nauplius larva of barnacles and the larval stages of scallops and some fish species, are however negatively influenced by the presence of low frequency noise, while others, such as those of mussels, are positively impacted.

For example, the metamorphosis and engraftment of barnacle larvae is inhibited under the exposure to prolonged (about 20 hours) low frequency sounds (30 Hz). In contrast, mussel larvae show a rate of about 40% faster settlement in sound conditions compared to silent control (Wilkens et al., 2012).

Nonetheless, it should be noted that, as illustrated in section 6.3.1.5 of Chapter 6.3 of the present ESIA, the AoI is already crossed by several vessels all year long and that noise emissions, being on a logarithmical scale, are not summed arithmetically.

As such, the ambient underwater noise near the AoI may display a temporary increase, of few dB re 1 µPa, although baseline conditions shall be completely restored once the construction Phase 1s over.

- **Emission of contaminants into marine water**

After the completion of the construction phase and before the pipelines are put into operations, all the pipes will be hydrotested by pumping liquids at 550 PPM into them to detect possible faults in the junctions and prevent leakage. Such test, is typically made by filtered seawater, or filtered seawater with chemical additive, such as RX-5255, containing a mixture of corrosion inhibitor, oxygen scavenger, biocide, and dye to prevent internal corrosion or to identify leaks, MEG or umbilical transportation liquid (see Chapter 3.0 of the present ESIA, section 3.10.1).

Ideally, the liquids used to hydrotest the pipelines are not supposed to leak and, therefore, affect the water column and the pelagic organisms of the oxygenated layers (i.e., from 0 to -100/-150 m). Still, this is an ideal scenario. It is not rare that pipelines just laid present small faults (mainly at the junctions) to be repaired before the operation phase. In such a case, a limited volume of the hydrotest liquid may leak, introducing chemicals that may alter the seawater quality (see 7.3.1.3.1).

Limited information is available about the effects of corrosion inhibitors or leak detection dyes on marine ecosystems. However, commercial corrosion inhibitors are known to show traces of heavy metals which has negative effects on living organisms (Amadi & Ukpaka, 2007). In addition, leak detection dyes include components that are classified as environmental hazard, whereas oxygen scavengers are reported to alter the water chemistry. In fact, they are commonly made of sodium bisulfide or ammonium bisulfide, which are reductive agent lowering the pH of the water. Regarding biocides, research has shown that it has a multitude of negative effects on marine organisms, showing decrease in growth and photosynthetic activity in phytoplankton and acute toxicity and mortality in zooplankton (Guardiola, Cuesta, Meseguer, & Esteban, 2012).

However, it should be mentioned that Staples et al. (2001) demonstrated that ethylene glycol (EG) undergoes rapid biodegradation in aerobic and anaerobic environments with approximately 100% removal of EG within 24 h to 28 days. Moreover, the results of the study showed that EG is practically non-toxic to aquatic organisms and does not bioaccumulate.

The hydrotest fluids are planned to be discharged deep sea, in correspondence to the SPS site (i.e., at a depth of 2,200 m), where they may cause alteration of the seawater quality (see Chapter 3.0 of the present ESIA, section 3.10.1). Nevertheless, as previously discussed, this alteration is not expected to affect marine life, since the discharge point is located in the anoxic water layer, where no life exists, which does not mix with the oxygenated layer.

This activity is however planned to be implemented very punctually and limited times, reducing the possibility of impacting the marine environment, thank also to the diluting power of seawater.

- **Discharge of wastewater**

As said in sections 7.3.1.2.1 and 7.3.1.3.1, sewage will be produced on board of the vessels used during the construction phase. However, and the generated sewage will be collected by waste ships and transferred to Zonguldak TTK Waste Reception Facility; therefore, it will not be discharged into the sea.

For what concern bilge water (leachate and oily wastewater from machinery spaces in vessels), will be collected and shipped to Zonguldak TTK Waste Reception Facility for disposal and will not be discharged into the sea. The remaining separated water will be discharged at sea.

Finally, ballast waters will be produced on board of the vessels during construction activities due to water pumped into and out of storage during loading and off-loading operations. However, ships will be compliant with Ballast Water Management Convention and Guidelines developed by International Maritime Organization (IMO). The ballast water exchange will take place at least 50 nautical miles (NM) from the nearest land and in water at least 200 m in depth.

Mitigation measures

The following mitigation measures shall be implemented to mitigate the effects of the impact factors.

- **Minor leakage of contaminants into water**
    - All vessels used to be compliant with MARPOL
    - Outdated engines to be avoided in favor of recent and well-maintained ones.
- **Handling and resuspension of sediments**

The relative mitigation measures have been reported in the sediment section 7.3.1.2.1.

- **Emission of underwater noise**
    - All vessels used to be compliant with MARPOL, to which Türkiye is signatory, whose regulations also have the objective of minimizing and preventing the noise pollution created by maritime traffic.
    - Outdated propellers to be avoided in favor of recent and well-maintained ones, possibly anti-cavitation.
- **Emission of light**
    - For external lighting, anti-glare technology will be used that has little or no impact on marine fauna, with shielded lighting fixtures, directed lights, and/or artificial or natural screens where possible.
    - Lights will be directed exclusively at work areas through the use of spotlights instead of floodlights.
    - The windows and portholes of naval units will be equipped with curtains to block artificial light emissions from the boats.
- **Emission of contaminants into marine water**

The relative mitigation measures have been reported in the sediment section 7.3.1.2.1.

- **Discharge of wastewater**

The relative mitigation measures have been reported in the sediment section 7.3.1.2.1

Residual impacts

The table below summarizes the impacts caused by the identified impact factors on the component assessed.

Based on the baseline conditions of the assessed component, the project characteristics and actions, as well as the proper implementation of the mitigation measures proposed above, a potential **Low- medium negative impact** is expected on plankton during the construction phase.

Table 7-21: Residual impact assessment matrix for plankton during construction phase

Impact Factor	Impact Factor Features		Component Sensitivity	Impact Reversibility	Impact Value	Mitigation Effectiveness	Residual Impact Value
Minor leakage of contaminants into water	Duration:	Medium	High	Short-mid-term	**Medium**	Medium-high	**Low**
	Frequency:	Infrequent					
	Geo. Extent:	Local					
	Intensity:	Medium					
Handling of and resuspension of sediments	Duration:	Medium	High	Short-mid-term	**Medium**	Medium-high	**Low**
	Frequency:	Continuous					
	Geo. Extent:	Local					
	Intensity:	Medium					
Emission of light	Duration:	Medium	High	Short-mid-term	**Medium**	Medium	**Low**
	Frequency:	Continuous					
	Geo. Extent:	Project footprint					
	Intensity:	Medium					
Emission of underwater noise	Duration:	Medium	High	Short-mid-term	**Medium**	Medium	**Low**
	Frequency:	Continuous					
	Geo. Extent:	Local					
	Intensity:	Medium					
Emission of contaminants into marine water	Duration:	Short	High	Short-mid-term	**Medium**	Medium-high	**Negligible**
	Frequency:	Infrequent					
	Geo. Extent:	Local					
	Intensity:	Medium					
Discharge of wastewater	Duration:	Medium	High	Short-mid-term	**Medium**	Medium-high	**Low**
	Frequency:	Frequent					
	Geo. Extent:	Local					
	Intensity:	Negligible					
Overall assessment:	**Low**		Rationale: Due to the compliance with relevant standards of the impact factors, even using a precautionary approach, the residual impact values are not expected to cumulate to a higher impact value. Therefore, the average residual impact value may be considered as a reference for the overall impact.				

Monitoring measures

The following monitoring measures shall be implemented to assess the true effects of the project on plankton during the construction and verify the effectiveness of the mitigation measures.

- Regular continuous monitoring at the wastewater treatment plant as illustrated in section 7.3.1.3.1 will be useful to inform about possible consequences on plankton.
- Water samplings (i.e., by Niskin bottle at the chlorophyll-a peak, quantified by probe) and zooplankton samplings (i.e., WP2 net), with subsequent plankton community identification, to be performed along a transect starting from the hydrotesting water discharge point and following the predominant current direction before the first wastewater discharge (in two opposite seasons, if practicable with the project timings) in the same sampling stations as per seawater. Results to be used in case of exceeding the thresholds (see the next bullet point).
- In case of exceeding the thresholds defined in Appendix B, water samplings (i.e., by Niskin bottle at the chlorophyll-a peak, quantified by probe) and zooplankton samplings (i.e., WP2 net), with subsequent plankton community identification, to be performed along a transect starting from the discharge point and following the predominant current direction immediately after the detection of the exceeding and in the opposite season (e.g., summer and winter) in the same sampling stations as per seawater. Results to be compared with the previous bullet point and among them.

7.3.2.1.2 Operation phase

Impact factors

The impact factors from the Project activities potentially affecting plankton during operation phase are listed in the following table.

Table 7-22: Project actions and related impact factors potentially affecting plankton during operation

Project actions	Brief description	Impact factors
FPU/infrastructure operation	FPU/infrastructure operation consist primarily in the extraction of the gas (SPS and other subsea facilities) and the processing onboard the FPU, for which a detailed description is available in Chapter 3 of the present ESIA (form section 3.2.3.7 to section 3.2.3.19), plus the structural facilities and operations necessary to the onboard staff.	■ Minor leakage of contaminants into water ■ Emission of underwater noise ■ Emission of light ■ Emission of electromagnetic fields (EMF) ■ Discharge of produced water ■ Use of seawater ■ Discharge of wastewater

The impact factors identified above are described below and assessed in the matrix that follows.

- **<u>Minor leakage of contaminants into water</u>**

Maintenance/repair operations of the SPS, FPU and pipelines are planned for the operation phase of the project. Such operations are always conducted using vessels that, such as previously stated, may lose small amounts of contaminants (mostly oily and greasy) from the engines, potentially altering the seawater quality and, by consequence, the plankton communities of the AoI.

However, it must be noted that these maintenance/repair operations are not performed continuously and do not require a large number of vessels. In addition, all vessels must be compliant with MARPOL, to which Türkiye is signatory; therefore, it is unlikely that this impact factor could severely affect the seawater to cause a community significant alteration or switch.

- **Emission of underwater noise**

The emission of underwater noise will be primarily due to the periodic monitoring and maintenance activities of the offshore structures (since the FPU will be moored in place, so no DP system is required). Such operations are anticipated to be conducted using vessels whose propellers are expected to emit underwater noise.

Depending on the vessel used, an emission of 150-185 dB re 1 μPa at 1 m in the low frequency band (< 300 Hz) may be expected.

It must however be noted that these maintenance/repair operations are not performed continuously and do not require a large number of vessels and that noise emissions do not sum arithmetically, being on a logarithmical scale. In addition, all vessels must be compliant with MARPOL, to which Türkiye is signatory.

- **Emission of light**

The emission of light during the operation phase will be generated by the lighting system installed onboard the FPU as the EIT facilities (see Chapter 3.0 of the present ESIA, section 3.2.3.5). Moreover, another source of nocturnal illumination (frequent but not continuous) would probably be the flaring system (essential for handling excess gas safely) onboard the FPU (see Chapter 3.0 of the present ESIA, section 3.2.3.19).

As regards the component under examination, it is conceivable that this impact factor could have some negative effects as already described in the construction phase (i.e. linked to the alteration of vertical migrations) and, more generally, comparable to those caused by night-time light pollution in coastal areas.

- **Emission of electromagnetic fields (EMF)**

Within Phase 2, a new SURF system (subsea umbilicals, risers and flowlines) will be installed to provide the infrastructure for transporting extracted gas and water liquid streams from the SPS to the FPU. The SURF system will consist of subsea flowlines, risers, a monoethylene glycol (MEG) line from the FPU to the manifold, a main umbilical between the FPU and the manifold, and well umbilicals for MEG injection. The main umbilical will connect the FPU and the manifold, enabling the transmission of electrical power, hydraulic control, and communication signals. This setup allows for monitoring and remote operation of the subsea systems, supporting production operations (See Chapter 3.0 of the present ESIA, section 3.2.2).

The presence of the umbilical line from the SPS to the FPU will therefore cause the emission of EMFs, which could be more or less intense in dependence to characteristic of the cable itself and of the current that flows within it.

Many marine organisms are able to detect these fields due to their magneto-sensitive or electro-receptive characteristics (Wiltschko & Wiltschko, 2005). However, there is no available data regarding detection by planktonic organisms. According to some studies, electromagnetic fields could affect the larval component of plankton, altering embryonic development and increasing the frequency of exogastrulation in sea urchins, as well as interfering with the larval settlement of barnacles (Levin & Ernst, 1997; Leya et al., 1999). However, such information is subject to discussion (Walker, 2001; Swedpower, 2003; Gill et al., 2014), being based only on laboratory evidence.

However, standard commercial cables can be effectively insulated to prevent the emission of electric fields (and improve their maintenance), but not of induced magnetic fields (Gill, 2005). In any case, it must be considered that EMFs' intensity decreases rapidly from the source, therefore the potential impact would be isolated to the immediate proximity of the FPU.

- **Discharge of produced water**

Produced water is any water separated during processing. Produced water derives essentially form the LP (*Low pressure*) Inlet Separator. This FPU facility separates liquids (rich MEG and produced water) from gas.

Produced water is expected to reach a maximum of 773 m^3/day based on peak gas production rates, though actual volumes are anticipated to be around 500 m^3/day. Additionally, cooling seawater will be 312,000 m^3/day, used for power generation, topsides, and ship needs combined.

All the water generated, and seawater used at the operation (including cooling seawater, produced water, with monovalent salt) are planned to be discharged into the Black Sea. The approval for the discharge of these generated waters to sea from MoEUCC is conditional to the compliance with the Project Specific Discharge Standards issued by the Ministry (refer to Table 3-18 given in Chapter 3.10.2).

Produced water is a complex mixture of dissolved and particulate organic and inorganic chemicals, including inorganic ions, organic acids, BTEX and benzenes (Polycyclic aromatic hydrocarbons and phenols), metals, radioisotopes (deriving from the production water[6]) and production chemicals (mainly corrosion inhibitors, scale inhibitors, biocides and gas treatment chemicals such as glycol and methanol). The physical and chemical properties of produced water vary widely depending on the geologic age, depth, and geochemistry of the hydrocarbon-bearing formation, as well as the chemical composition of the oil and gas phases in the reservoir, and production chemicals added to the production (Neff et al., 2011).

A discharge permit for produced water with monovalent salt is obtained from MoEUCC prior discharging into the sea. The potential impact of produced water discharging on plankton community depends mostly on the dispersion and dilution of the discharged water plum, which is itself influenced by factors such as the discharge rate, the depth from the sea surface, currents speed, turbulent mixing regime, water column stratification, water depth, and difference in density (as determined by temperature and total dissolved solids concentration) and chemical composition between the produced water and ambient seawater (Neff et al., 2011).

Therefore, in order to better understand the intensity of the possible impact that this factor could have on the plankton community a specific model is needed. However, dispersion modelling studies of the course of produced water differ in specific details, but all predict a rapid initial dilution of discharges by 30- to 100-fold within the first few tens of meters of the outfall (Neff et al., 2011). Moreover, it is to be considered also the

[6] Formation water is seawater or fresh water that has been trapped for millions of years with oil and natural gas in a geologic reservoir consisting of a porous sedimentary rock formation between layers of impermeable rock within the earth's crust. When a hydrocarbon reservoir is penetrated by a well, the produced fluids may contain this formation water, in addition to the oil, natural gas, and/or gas liquids ((Neff et al., 2011).

biodegradation/transformation rates of certain contaminants (e.g. ethylene glycol that undergoes rapid biodegradation in aerobic and anaerobic environments).

Concerning the possible effects on plankton component of contaminants discharged in seawater, continual chronic exposure may cause sub-lethal changes in populations and communities, including decreased community and genetic diversity, lower reproductive success, decreased growth and fecundity, respiratory problems, behavioral and physiological disorders, decreased developmental success and endocrine disruption (Neff et al., 2011). Among the chemicals of greatest environmental concern in produced water (as they can cause bioaccumulation and toxicity) aromatic hydrocarbons, certain alkylphenols, and some metals are included, while BTEX are rarely included when considering the effects of produced water since they evaporate rapidly from seawater (Bakke et al., 2013). Highly alkylated phenols, such as octyl- and nonyl-phenols, are recognized as endocrine disruptors, however, they are seldom found in produced water at concentrations high enough to harm organisms after initial dilution (Neff et al., 2011). Most metals and naturally occurring radionuclides in produced water exist in chemically reactive dissolved forms at levels comparable to, or only slightly above, those in seawater, making them unlikely to cause negative effects in the receiving water environment (Neff, 2002). Lastly, some production treatment chemicals are toxic and, if they are discharged at high concentration in produced water, could cause localized harm (Neff et al., 2011). However, in must be made clear that the Project will comply the performance standard stated by OSPAR Recommendation 2001/1 (dispersed oil of 30 mg/l for produced water discharged into the sea), Environmental, Health, and Safety Guidelines for Offshore Oil and Gas Development (oil and grease content must not exceed 42 mg/l daily maximum; 29 mg/L monthly average) and MARPOL regulation (oil content not exceeding 15 parts per million) (see Appendix C, and mitigation measures below).

Therefore, although an impact is attended on plankton community, it will be circumscribed to the immediate proximity of the FPU and is not expected to have basin-scale consequences.

Concerning the discharge of cooling water, it is stated that (regardless of the dilution capacity of the marine environment) the water to be discharged to the sea shall not exceed 35˚C (see Appendix C). Hot water discharges shall not raise the temperature of the seawater combined with it through the first dilution (D1) physically introduced by the diffuser, by more than 1˚C in the summer months from June to September and 2˚C in other months. However, if the temperature of the seawater is higher than 28˚C, the discharge of seawater used for cooling purposes may be permitted without any restriction on the discharge temperature, as long as the temperature of the receiving body is not raised by more than 3˚C. Moreover, a minimum discharge depth should be 20 meters, in accordance with Water Pollution Control Regulation Criteria for Deep Sea Discharge (see Appendix C).

The discharge of heated seawater could potentially cause alteration of the physiological processes (especially enzyme-mediated processes) of exposed organisms implying, in some cases, from minor physiological stress to potential mortality for prolonged exposure (Wolanski, 1994). So, in order to better understand the intensity of the possible impact that this factor could have on the plankton community a specific model is needed. Again, the entity of the impact essentially depends on the dispersion and dilution of the discharged cooling water plum, and therefore the time to which the plankton is subjected to the difference in temperature (considering that the discharge temperature will not exceed 35 °C, and after dilution difference will not exceed 1-2°C, maximum 3°C from the original conditions). The cooling seawater is planned to be discharged into the Black Sea after meeting the discharge temperature criteria issued by the Ministry of Environment, Urbanization and Climate Change. The temperature of the discharged cooling seawater will be continuously monitored.

- **Use of seawater**

Seawater will be the sole water source for the process. The FPU will withdraw a total of 294.000 m³/day of seawater, 144,000 m³/day for power generation cooling and 150,000 m³/day for topside equipment cooling. Cooling seawater will be a total of 312,000 m³/day for power generation, topsides, and ship needs combined. All the wastewater generated, and seawater used at the operation (including cooling seawater, produced water, with monovalent salt) are planned to be discharged into the Black Sea after meeting the discharge standards issued by the Ministry of Environment, Urbanization and Climate Change and MARPOL.

The impact on the plankton community is essentially due to the uptake of the seawater and its use for processing. Therefore, any organism present in the withdrawn water will be subjected to high temperature, chemical and biocides. However, total mortality case is essentially expected for microplankton organisms only and could be attenuated by water up-take from deeper in the water column, were the plankton primary and secondary production is lower. Macrozooplankton, and motile plankton in general (such as fish larvae, however not present in the central Black Sea area), will not be the target of this impact factor, especially with the installation of screens at the inlet of the cooling water risers and by keeping low the inlet current speeds (i.e. 0.5 m/s).

It is also understood that to serve as cooling water the seawater should be at a constant low temperature, therefore the seawater intake is planned to be positioned at a depth of at least about 300 m. This should guarantee no intake of plankton as the depth limit for distribution of planktonic species in the Black Sea is estimated at a depth of about 150 m.

- **Discharge of wastewater**

As said in sections 7.3.1.2.2 and 7.3.1.3.2, industrial wastewater and sewage will be produced on board of the vessels used during the operation phase. However, sewage will be collected by waste ships and transferred to Zonguldak TTK Waste Reception Facility; therefore, it will not be discharged into the sea.

The sewage generated by the personnel on board of the FPU (approximately 29.4 m³/day) will be treated in the Sewage Treatment Plant onboard and then discharged to sea, if international and local standards are met.

The bilge and slop water will be transferred to Zonguldak TTK Waste Reception Facility, thus, these will not be discharged into the sea.

Finally, ballast waters will be produced on board of the support vessels during operation activities due to water pumped into and out of storage during loading and off-loading operations. However, ships will be compliant with Ballast Water Management Convention and Guidelines developed by International Maritime Organization (IMO). The ballast water exchange will take place at least 50 nautical miles (NM) from the nearest land and in water at least 200 m in depth.

Infrequent ballast water discharge will be necessary during ballast water exchange on the FPU vessel. The ballast water will be stored in Water Ballast Tanks (WBT), which are isolated from contamination sources. When discharge is required, it will be released into the sea without treatment, provided no contamination is detected. If contamination is detected before discharge, the affected ballast water will be transferred onshore via PSV for proper disposal.

Mitigation measures

The following mitigation measures shall be implemented to mitigate the effects of the impact factors.

- **Minor leakage of contaminants into water**
  - All vessels used to be compliant with MARPOL.
- **Emission of underwater noise**
  - All vessels used to be compliant with MARPOL, to which Türkiye is signatory, whose regulations also have the objective of minimizing and preventing the noise pollution created by maritime traffic.
- **Emission of light**

The relative mitigation measures are the same of those reported in the construction phase 7.3.2.1.1.

- **Discharge of wastewater**

regard to the wastewater discharged shall be compliant with a number of international standards and regulations, including:

- Oil Pollution: MARPOL Annex I which addresses the prevention of pollution by oil from operational measures as well as from accidental discharges. FPU must comply with these regulations, which include requirements for the treatment and discharge of oily water.
- Safety and Pollution Prevention: The International Maritime Organization (IMO) provides guidelines for the safety, pollution prevention, and security of FPU.
- Local Standards: In addition to international regulations, FPU must comply with local environmental standards set by the coastal states where they operate, e.g. National Ballast Water Management Strategy for Türkiye.
- Industry Standards: The industry also follows best practices for the management of produced water and other wastewaters. This includes the use of advanced treatment technologies to remove contaminants and ensure that discharges meet environmental standards.
- Turkish Ministry of Environment, Urbanization, and Climate Change (MoEUCC)
  - Project Specific Discharge Standards (refer to Table 3-18 given in Chapter 3.10.2).

For what concern the ballast waters, the BWM Convention sets out specific standards to control and manage ships' ballast water and sediments. These standards are primarily defined in two regulations:

- Regulation D-1: Ballast Water Exchange Standard: Ships performing ballast water exchange must do so at least 200 nautical miles from the nearest land and in water at least 200 meters deep. If this is not possible, exchange should be done as far from the nearest land as possible, and in all cases at least 50 nautical miles from the nearest land and in water at least 200 meters deep.
- Regulation D-2: Ballast Water Performance Standard: this standard sets limits on the concentration of viable organisms in ballast water. Specifically, ships must ensure that ballast water discharged contains fewer than 10 viable organisms per cubic meter that are greater than or equal to 50 micrometers in

minimum dimension, and fewer than 10 viable organisms per milliliter that are between 10 and 50 micrometers in minimum dimension. Additionally, the discharge must meet specific limits for indicator microbes, including *E*. *coli*, intestinal enterococci, and *Vibrio cholerae*.

- **Discharge of produced water**

All the discharged produced water will apply the international and national regulation and limits, in particular (see Appendix C):

  - Any discharge into the sea of oil or oily mixtures from ships shall be prohibited unless the oil content of the effluent without dilution is <15 ppm and the oily mixture is processed through oil filtering equipment (MARPOL 73/78, Annex I)
  - Produced water discharges must meet both a daily maximum of 42 mg/l and a monthly average of 29 mg/l for oil and grease in order to suit the benchmarks for O&G content set by international standards and guidelines and regulatory requirements (MARPOL 73/78, Annex I).
  - No individual offshore installation should exceed a performance standard for dispersed oil of 30 mg/l for produced water discharged into the sea (OSPAR Recommendation 2001/1).

For what concern discharge of cooling water:

- It is stated that (regardless of the dilution capacity of the marine environment) the water to be discharged to the sea shall not exceed 35˚C (see Appendix C). Hot water discharges shall not raise the temperature of the seawater combined with it through the first dilution (D1) physically introduced by the diffuser, by more than 1˚C in the summer months from June to September and 2˚C in other months. However, if the temperature of the seawater is higher than 28˚C, the discharge of seawater used for cooling purposes may be permitted without any restriction on the discharge temperature, as long as the temperature of the receiving body is not raised by more than 3˚C.
- In accordance with Water Pollution Control Regulation Criteria for Deep Sea Discharge (see Appendix C) the minimum discharge depth should be 20 meters. However, considering that planktonic life in the Black Sea extends only to a depth of about 150 m, it is recommended that the discharge of cooling seawater is planned at a depth of around 200 m. Nevertheless, a more accurate discharge depth for the water discharge will be defined compared to the currently suggested one (200 meters), which was chosen based on bibliographic studies regarding the density, temperature, and salinity of the layers of the Black Sea;
  - A diffuser/s system should be designed based on the dispersion model and concentration limits of chemicals in the produced water.

- **Use of seawater**
  - The intake location of seawater for cooling purposes should be placed at a depth equal or greater than 300 m.

Residual impacts

The table below summarizes the impacts caused by the identified impact factors on the component assessed.

Based on the baseline conditions of the assessed component, the project characteristics and actions, as well as the proper implementation of the mitigation measures proposed above, a potential **medium negative impact** is expected on plankton during the operation phase.

Table 7-23: Residual impact assessment matrix for plankton during operation phase

Impact Factor	Impact Factor Features		Component Sensitivity	Impact Reversibility	Impact Value	Mitigation Effectiveness	Residual Impact Value
Minor leakage of contaminants into water	Duration:	Long	High	Short-mid-term	**Medium**	Medium-high	**Low**
	Frequency:	Frequent					
	Geo. Extent:	Local					
	Intensity:	Negligible					
Emission of underwater noise	Duration:	Long	High	Short-mid-term	**Medium**	Medium	**Low**
	Frequency:	Frequent					
	Geo. Extent:	Local					
	Intensity:	Negligible					
Emission of light	Duration:	Long	High	Short-mid-term	**Medium**	Medium	**Medium**
	Frequency:	Continuous					
	Geo. Extent:	Project footprint					
	Intensity:	Low					
Emission of electromagnetic fields (EMF)	Duration:	Long	High	Short-mid-term	**Medium**	None	**Medium**
	Frequency:	Continuous					
	Geo. Extent:	Project footprint					
	Intensity:	Low					
Discharge of produced water	Duration:	Long	High	Short-mid-term	**High**	Medium-high	**Low**
	Frequency:	Continuous					
	Geo. Extent:	Local					
	Intensity:	High					
Use of seawater	Duration:	Long	High	Short-mid-term	**High**	High	**Negligible**
	Frequency:	Continuous					
	Geo. Extent:	Project footprint					
	Intensity:	High					
Discharge of wastewater	Duration:	Long	High	Short-mid-term	**Medium**	Medium-high	**Low**
	Frequency:	Frequent					
	Geo. Extent:	Local					
	Intensity:	Negligible					
Overall assessment:		**Medium**	Rationale: The impact generated by the discharge of produced water and the use seawater, may be considered as a the most consistent impact factors, secondary the emission of light (for the reason described in the section above), and marginally the emission of CEMs (precautionary considered to have a medium impact value, but this case is improbable). However, the effectiveness of the mitigation measure defined for 'use of seawater' was considered 'high' since no planktonic life is detected under 150 m (while the seawater inlet will be placed at a minimum of 300 m depth).The same consideration is valid				

Impact Factor	Impact Factor Features	Component Sensitivity	Impact Reversibility	Impact Value	Mitigation Effectiveness	Residual Impact Value
		also for the discharge of cooling water (assessed in the 'discharge of produced water'), for which the mitigation effectiveness was rated as 'medium-high' because of the discharge point's depth (200 m, again, under the zone with presence of planktonic life). Therefore, due to the compliance with relevant standards of the impact factors, the residual impact values are not expected to cumulate to a higher impact value. Thus, the overall residual impact value may be considered as medium in a precautionary perspective.				

Monitoring measures

The following monitoring measures shall be implemented to assess the true effects of the project on plankton during the operation and verify the effectiveness of the mitigation measures.

- Regular continuous monitoring at the discharge points in the Filyos River as illustrated in hydrology and surface water impact assessment will be useful also to inform about possible consequences on plankton.
- Water samplings (i.e., by Niskin bottle at the chlorophyll-a peak, quantified by probe) and zooplankton samplings (i.e., WP2 net), with subsequent plankton community identification, to be performed along a transect starting from the Filyos River mouth and directed offshore following the predominant current direction before the first wastewater discharge into the river (in two opposite seasons, if practicable with the project timings). Results to be used in case of exceeding the thresholds (see the next bullet point).
- In case of exceeding the thresholds defined in Appendix B at the discharge points, water samplings (i.e., by Niskin bottle at the chlorophyll-a peak, quantified by probe) and zooplankton samplings (i.e., WP2 net), with subsequent plankton community identification, to be performed along a transect starting from the Filyos river mouth and directed offshore following the predominant current direction immediately after the detection of the exceeding and in the opposite season (e.g., summer and winter) in the same sampling stations as per seawater. Results to be compared with the previous bullet point and among them.
- Seasonal water samplings (i.e., by Niskin bottle at the chlorophyll-a peak, quantified by probe) and zooplankton samplings (i.e., WP2 net), with subsequent plankton community identification, to be performed along a transect starting from the Filyos river mouth and directed offshore following the predominant current direction in the same sampling stations as per seawater. Results to be compared among them.
- Instantaneous and continuous monitoring of water discharges from production facilities (including the FPU) within the scope of Continuous Discharge Monitoring Systems (SAİS) must be conducted in accordance with specified Project Specific Discharge Standards, issued by the MoEUCC.

In case the discharge of cooling water will not be positioned at deeper than 150 m of depth, a seasonal water samplings (i.e., by Niskin bottle at the chlorophyll-a peak, quantified by probe) and zooplankton samplings (i.e., WP2 net), with subsequent plankton community identification, is to be performed at 3 distances from the FPU (0 m, 100 m, and 300 m) along the main current direction and at the same depth as the discharge point.

7.3.2.2 Benthic communities (phyto- and zoobenthos)

Based on the information collected for the definition of the baseline (see chapter 6.3.3.2), the biological component Benthic communities was assigned a **Medium-high** value of sensitivity for the following reasons:

- Absence of protected, endemic or threatened species;
- Presence species of economical importance; and
- Potential presence of nursery area.

Impacts potentially affecting this component are assessed here below for the construction phase and operation phase.

7.3.2.2.1 Construction phase

Impact factors

The impact factors from the Project activities potentially affecting the benthic communities during construction phase are listed in the following table.

Table 7-24: Project actions and related impact factors potentially affecting benthic communities during

Project actions	Brief description	Impact factors
Offshore excavation (trenching) and sediment storage	Includes the excavation of a trench in shallow water, in correspondence of the land approach.	▪ Minor leakage of contaminants into water ▪ Handling and resuspension of sediments
Offshore pipelines and lines laying	The offshore laying of the pipelines and the connection of the pipelines in the offshore gas field with the SPS	▪ Minor leakage of contaminants into water ▪ Handling and resuspension of sediments ▪ Introduction of new offshore infrastructures

All the impact factors identified above are described below and assessed in the matrix that follows.

- <u>**Minor leakage of contaminants into water**</u>

The release of pollutants into the marine environment during the construction phase of the Project may be mainly due to limited leaks (i.e., negligible) of oils and hydrocarbons from the naval units moving to and from the Site Area. Benthic communities are particularly susceptible to the presence of hydrocarbons in the environment due to their ability to bind to sediment particles (adsorption) and bioaccumulate (Carman & Todaro, 1996; Mahmoudi et al., 2005).

Even if such leaks occur, considering the depth of the area, it is plausible that benthic organisms would not come into direct contact with the pollutants. Any leaks, already very limited in extent, would also be further diluted in the surrounding environment.

It must be noted, however, that all the vessels must be compliant with MARPOL, to which Türkiye is signatory, highly reducing the possibility of large leakages.

- **Handling and resuspension of sediments**

The offshore excavation of the trench for the first 1.66 km of the pipeline corridor is expected to actively mobilize sediments to be stored at the temporary storage area before the backfill. These actions are expected to cause direct mortality to benthic organisms located in the trench area by the mechanical action of the dredger, as well as to the benthic organisms at the temporary storage area, since even infaunal species are reported not to survive if buried beyond 20 cm of sediments.

Suspended sediments may remain in suspension for a period of hours or days before settling even at significant distances from the source of disturbance (although generally within hundreds of meters).

Resuspension of sediments is reported to impact benthic communities by creating a choking effect on bottom (Souza Dias, 2020) and by increasing the turbidity, which may affect the photosynthetic capabilities of the phytobenthic species.

Moreover, the temporary increase in water turbidity could negatively impact the feeding activities of filter-feeding organisms, as resuspended sediment particles could cause the obstruction of filtering organs (Taormina et al., 2018). According to Taormina et al. (2018), the impacts resulting from sediment resuspension are however generally localized and short-term and can be considered globally negligible.

In addition, the presence of the Filyos river mouth already represents a sediment supply for the AoI, and no seaweed and/or seagrasses were found in the AoI; therefore, these particular effects may be considered as negligible, if not completely absent.

As analyzed in chapter 3.2.4, for the laying activities of the pipeline in the shallow water section, a 3 m deep trench will be excavated in the planned pipeline corridor for an overall length of 1,660 m from the shore till approximately 19 m depth. Approximately 82.200 m^3 of material will be dredged and temporarily stored near the port area and subsequently redeposited along the trench area. The excavation of the coastal trenches is expected to be completed in approximately 75 days. After the trench is excavated, it is anticipated that the pipes will be laid within 14 days, and then it will take approximately 167 days to cover the pipe with the dredged material. The total schedule for the dredging activities is approximately 303 days (including weather delays).

Introduction of new offshore infrastructures

As previously discussed, besides the burial operations in the land approach, the pipelines will be simply laid upon the seafloor which, as shown in 7.3.1.2, consists mostly of fine sediments and host benthic communities typical of soft bottoms.

Such laying operations may cause direct mortality of the organisms by crushing due to the lay of the pipes. A limited habitat disruption, which is mainly composed by large sandy stretches, more or less covered or mixed with mud, is also expected by the introduction of hard substrates which will fragment the soft bottom habitats themselves. However, both impacts described are expected to be very limited since (i) beyond 80 m of depth the sediments are almost completely anoxic, (ii) the benthos of the oxygenated sections of AoI is mainly composed by highly resilient communities (see 6.3.3.2).

Conversely, no direct impact is anticipated both from the installation of the mooring and anchoring systems of the FPU and the MEG system, since they will be positioned at depths (2.100 – 2.200 m, see 6.3.1.1) that are prohibitive for the development of benthic fauna, which, as previously said, is found at depths less than 80 meters.

Mitigation measures

- **Minor leakage of contaminants into water**
  - All vessels used to be compliant with MARPOL
- **Handling and resuspension of sediments**

The relative mitigation measures have been reported in the sediment section 7.3.1.2.1

Residual impacts

The table below summarizes the impacts caused by the identified impact factors on the component assessed.

Based on the baseline conditions of the assessed component, the project characteristics and actions, as well as the proper implementation of the mitigation measures proposed above, a potential **low negative impact** is expected on benthic communities during the construction phase.

Table 7-25: Residual impact assessment matrix for benthic communities during construction phase

Impact Factor	Impact Factor Features		Component Sensitivity	Impact Reversibility	Impact Value	Mitigation Effectiveness	Residual Impact Value
Minor leakage of contaminants into water	Duration:	Medium-long	Medium-high	Short-mid-term	**Medium**	Medium-high	**Negligible**
	Frequency:	Infrequent					
	Geo. Extent:	Local					
	Intensity:	Low					
Handling and resuspension of sediments	Duration:	Medium	Medium-high	Short-term	**Low**	Medium-high	**Negligible**
	Frequency:	Continuous					
	Geo. Extent:	Local					
	Intensity:	Medium					
Introduction of new offshore infrastructures	Duration:	Medium	Medium-high	Short-term	**Low**	None	**Low**
	Frequency:	Continuous					
	Geo. Extent:	Local					

Impact Factor	Impact Factor Features		Component Sensitivity	Impact Reversibility	Impact Value	Mitigation Effectiveness	Residual Impact Value
	Intensity:	Low					
Overall assessment		**Low**	Rationale: Using a strong precautionary approach, the highest residual impact value may be considered as a theoretical overall residual impact value.				

Monitoring measures

No monitoring measures are required for benthic communities during construction.

7.3.2.2.2 Operation phase

Impact factors

The impact factors from the Project activities potentially affecting benthic communities during operation phase are listed in the following Table.

Table 7-26: Project actions and related impact factors potentially affecting benthic communities

Project actions	Brief description	Impact factors
FPU/infrastructure operation	During the operation phase, the pipeline will be present on the seabed.	▪ Presence of new offshore infrastructures

The impact factors identified above is described below and assessed in the matrix that follows.

- **Presence of new offshore infrastructures**

Such as stated in the project description (see Chapter 3), the offshore part of the project consists in the presence of cables to connect the SPS parts, one umbilical line and two pipelines from the SPS (around 2.200 m deepth) to the onshore facilities.

While such impact factor is considered negligible to even non-existent for the cables and the umbilical line, due to their diameter, the presence of the pipelines is expected to act as an artificial hard substrate upon the sandy seafloor. As stated for the construction phase (see 7.3.2.2.1), the introduction of the pipelines may alter the soft bottom habitats of the AoI.

However, the presence of hard 3D structures in marine habitats are reported to have the potentiality to create the so-called “reef effects” (Taormina, et al., 2018), resulting in a potential positive impact. In fact, hard structures located in areas dominated by soft bottoms are usually reported to act as environmental enrichments, potentially forming biodiversity oases, since they may attract different species by providing a shelter for benthic organisms that may settle there.

However, it should be noted that this is particularly reported of structures showing a complex and heterogeneous 3D structure, characterized by a high degree of rugosity. In addition, based on what stated in 6.3.3.2, the sediments of the AoI become anoxic beyond 80 m of depth, substantially preventing life and the first 1.66 km of the pipelines from the shoreline are planned to be buried. Therefore, due to those considerations, the positive impact should be very limited, but still present.

Mitigation measures

Neither mitigation measures nor optimization measures are identified for benthic communities during operation phase.

Residual impacts

Based on the baseline conditions of the assessed component, the project characteristics and actions, a potential **low positive impact** is expected on the benthic communities during the operation phase.

The table below summarizes the impacts caused by the identified impact factors on the component assessed.

Table 7-27: Residual positive impact assessment matrix for benthic communities during operation phase

Impact Factor	Impact Factor Features		Component Sensitivity	Impact Reversibility	Impact Value	Enhancement Effectiveness	Residual Impact Value
Presence of new offshore infrastructures	Duration:	Long	Medium-high	Short-term	Low	Low	Low
	Frequency:	Continuous					
	Geo. Extent:	Local					
	Intensity:	Negligible					
Overall assessment		Low	Rationale: Only one impact factor is expected to influence this component, therefore its residual impact value corresponds to the overall assessment for the component itself.				

Monitoring measures

No monitoring measures are required for benthic communities during operation.

7.3.2.3 Fish

Based on the information collected for the definition of the baseline (see Chapter 6.3 of the present ESIA, section 6.3.2.3), the biological component Fish was assigned a **High** value of sensitivity for the following reasons:

- Abundance of pelagic fish targeted by fisheries; and
- Presence of species of economic interest.

Impacts potentially affecting this component are assessed here below for the construction phase and operation phase.

7.3.2.3.1 Construction phase

Impact factors

The impact factors from the Project activities potentially affecting fish during construction phase are listed in the following table.

Table 7-28: Project actions and related impact factors potentially affecting fishes during construction

Project actions	Brief description	Impact factors
Offshore excavation (trenching) and sediment storage	Excavation of a trench in shallow water in correspondence of the land approach; the sediment removed will be temporarily stored west of Filyos Port, east of the pipeline, and will be moved back to cover the pipeline (which was formerly used for temporary storage of dredged material during Phase 1 construction).	▪ Minor leakage of contaminants into water ▪ Handling of and resuspension of sediments ▪ Emission of underwater noise ▪ Discharge of wastewater ▪ Emission of light
Offshore pipelines and lines laying	Offshore laying of the pipelines (gas pipeline and MEG line) and lines (seabed umbilical and flexible pipes), and their connection with the Subsea Production System (SPS).	▪ Minor leakage of contaminants into water ▪ Emission of light ▪ Discharge of wastewater
Pre-commissioning activities (e.g., pipeline hydrotesting, cleaning and gauging)	During the pre-commissioning phase, the pipelines will by hydrotested by pumping a chemical mixture.	▪ Emission of contaminants into marine water

The impact factors identified above are described below and assessed in the matrix that follows.

- **<u>Minor leakage of contaminants into water</u>**

It is estimated that the construction operations at sea will require a total of 30 nautical units, of which 19 for offshore operations, 9 for nearshore operations (1.6 km from the coastline), and 2 waste receiving ships (see Chapter 3 of the present ESIA, section 3.9.2.2), during all the activities concerning the offshore section of the project (2 years long).

When dealing with a vessel, the leakage of small amounts (i.e., negligible, but still present) of contaminants (mostly oily and greasy) from the engines is considered “physiological” and inevitable.

Fish usually get in touch with chemicals mostly during their larval stage (i.e., ichthyoplankton) and through the gills during adulthood. Such contaminants may cause toxicity effects (both acute and chronicle) and/or accumulate in their organisms. Oils, in particular, are known to affect developing fish by retarding growth, causing premature hatching, and causing developmental or genetic changes (Faggetter, 2011), whereas hydrocarbons do bioaccumulate in fish, potentially causing secondary effects along the trophic food chain (Porte & Albaigés, 1994).

In any case, the leakage of small amounts (i.e., negligible, but still present) of insoluble contaminants (mostly oily and greasy) from the engines is considered as “normal” and cannot be prevented, and it must be noted, however, that all the vessels must be compliant with MARPOL, to which Türkiye is signatory, highly reducing the possibility of large leakages.

- **Handling of and resuspension of sediments**

The offshore excavation of the trench for the first 1.66 km of the pipeline corridor is expected to actively mobilize sediments to be stored at the temporary storage area before the backfill. The sediment removed will be temporarily stored west of Filyos Port, east of the pipeline, and will be moved back to cover the pipeline (which was formerly used for temporary storage of dredged material during Phase 1 construction). The excavation of the coastal trenches is expected to be completed in approximately 75 days. After the trench is excavated, it is anticipated that the pipes will be laid within 14 days, and then it will take approximately 167 days to cover the pipe with the dredged material form the temporary storage area. The trenching activity will be carried out using a backhoe excavator on a barge.

The mobilization of the substrate will presumably cause the suspension of the fine sediment, which can generate plumes of turbidity capable of persisting in the water column even for several hours or days, before settling (Blaas, 2007).

According to many studies, resuspended sediment in the water column can limit foraging in planktivorous and carnivorous species due to reduced visibility and interfere negatively with the foraging ability of herbivorous species with benthic feeding habits (Reid et al., 1999; Wenger et al., 2017; Utne-Palm, 2002; De Robertis et al., 2003).

Other effects may include damage to gill tissue and contact with toxic substances (see 7.3.1.2.1). Specifically, suspended sediment could potentially cause damage to the tissue and structure of the gills, including epithelial lifting, hyperplasia, and increased oxygen diffusion distance in some species (Hess et al., 2015). Additionally, the suspension of organic matter could lead to a reduction in the amount of dissolved oxygen in the water, exacerbating direct physical damage to the gills (Henley et al., 2000).

However, according to Taormina et al. (2018), the impacts resulting from sediment resuspension are however generally localized and short-term and can be considered globally negligible.

In addition, the presence of the Filyos river mouth already represents a sediment supply for the AoI, and mitigation measure are implemented in order to attenuate the possible impact on fish community (see mitigations below).

- **Emission of underwater noise**

The operating vessels will emit underwater noise through their propellers while working and navigating in the AoI. It has been shown that fishes can suffer from acoustic stress (ISPRA, 2011). Continuous sounds generated by vessels could contribute to increase the overall sound level in the environment. If this happens for extended periods of time, it may change the acoustic environment to which a fish is adapted, with consequences in fish behaviour (Popper & Hawkins, 2018).

It must be noted, however, that this impact factor is common to any vessels navigating in the AoI and its proximity, which are areas already characterized by an intense maritime traffic (section 6.3.1.5 of Chapter 6.3 of the present ESIA). The fish fauna of the area is therefore considered as possibly "habituated" to the noise of the vessel propellers.

- **Emission of light**

During the construction phase, pipelay activities are operations that are performed 16/24 hours. Therefore, night working, and the use of artificial light, will be required.

Night light pollution is known to affect marine organisms, their presence and space use, mostly by attracting them. Fish are indeed attracted by the emission of underwater lights, which will cause behavioral changes, implying a cost in terms of energy expenditure (i.e., fish are mostly active at night, looking for food, and their attraction to light may prevent them from feeding) and exposure to predators (both predators and preys are attracted by light) (Davies, Duffy, Bennie, & Gaston, 2014).

However, even if continuously active for the whole pipelay duration (i.e., almost a year), such impact factor is limited to the vessel's circumscribed area and may be considered as affecting only few tens of meters from the vessels. In addition, even if the pipelay vessel is expected to proceed very slowly (i.e. 0.4 kn, as assumed in Phase 1), the impact may be considered as totally temporary, as the situation is expected to completely recover once the vessel has passed (i.e., every night the pipelay vessel is assumed to be 5 km apart).

- **Emission of contaminants into marine water**

After the completion of the construction phase and before the pipelines are put into operations, all the pipes will be hydrotested by pumping liquids at 550 PPM into them to detect possible faults in the junctions and prevent leakage. Such test, is typically made by filtered seawater, or filtered seawater with chemical additive, such as RX-5255, containing a mixture of corrosion inhibitor, oxygen scavenger, biocide, and dye to prevent internal corrosion or to identify leaks, MEG or umbilical transportation liquid (see Chapter 3.0 of the present ESIA, section 3.10.1).

Ideally, the liquids used to hydrotest the pipelines are not supposed to leak and, therefore, affect the water column and the pelagic organisms of the oxygenated layers (i.e., from 0 to -100/-150 m). Still, this is an ideal scenario. It is not rare that pipelines just laid present small faults (mainly at the junctions) to be repaired before the operation phase. In such a case, a limited volume of the hydrotest liquid may leak, introducing chemicals that may alter the seawater quality (see 7.3.1.3.1).

Even if limited information is available about the effects of corrosion inhibitors or leak detection dyes on marine ecosystems, such substances contain chemicals that may have negative effects on living organisms, such as heavy metals, oxygen scavengers and bisulfides (Amadi & Ukpaka, 2007). Regarding biocides, research has shown that it has a multitude of negative effects on marine organisms: in particular, it has acute toxicity effects to mortality in adult fish and juveniles, moreover, it shows bioaccumulation in fish (Guardiola, Cuesta, Meseguer, & Esteban, 2012).

However, as already discussed, it should be mentioned that Staples et al. (2001) demonstrated that ethylene glycol (EG) undergoes rapid biodegradation in aerobic and anaerobic environments with approximately 100% removal of EG within 24 h to 28 days. Moreover, the results of the study showed that EG is practically non-toxic to aquatic organisms and does not bioaccumulate.

The hydrotest fluids are planned to be discharged deep sea, in correspondence to the SPS site (i.e., at a depth of 2,200 m), where they may cause alteration of the seawater quality (see Chapter 3.0 of the present ESIA, section 3.10.1). Nevertheless, as previously discussed, this alteration is not expected to affect marine life, since the discharge point is located in the anoxic water layer, where no life exists, which does not mix with the oxygenated layer.

This activity is however planned to be implemented very punctually and limited times, reducing the possibility of impacting the marine environment, thank also to the diluting power of seawater.

- **Discharge of wastewater**

As said in sections 7.3.1.2.1 and 7.3.1.3.1, sewage wastewater will be produced on board of the vessels used during the construction phase. However, sewage will be collected by waste ships and transferred to Zonguldak TTK Waste Reception Facility; therefore, it will not be discharged into the sea.

Bilge water (leachate and oily wastewater from machinery spaces in vessels), will be instead collected on board and shipped to Zonguldak TTK Waste Reception Facility for disposal, thus it will not be discharged into the sea.

Finally, ballast waters will be produced on board of the vessels during construction activities due to water pumped into and out of storage during loading and off-loading operations. However, ships will be compliant with Ballast Water Management Convention and Guidelines developed by International Maritime Organization (IMO). The ballast water exchange will take place at least 50 nautical miles (NM) from the nearest land and in water at least 200 m in depth.

Mitigation measures

The following mitigation measures shall be implemented to mitigate the effects of the impact factors.

- **Minor leakage of contaminants into water**
  - All vessels used to be compliant with MARPOL.
- **Handling and resuspension of sediments**
  - Sediments to be gently placed at the temporary storage area in order to reduce the resuspension.
  - Dredged sediments to be stored in mapped sections at the temporary storage area so the backfill operation shall bring back the sediments at the proper location not to disrupt the sediment type distribution.
  - Presence of clay to be tolerated but its dominance in the upper layer (i.e., the first 20 cm) to be avoided to favour recolonization.
- **Emission of underwater noise**
  - The relative mitigation measures have been reported in the seawater section 7.3.2.1.1.
- **Emission of light**

The relative mitigation measures have been reported in the plankton section 7.3.2.1.1.

- **Emission of contaminants into marine water**

The relative mitigation measures have been reported in the plankton section 7.3.2.1.1.

- **Discharge of wastewater**

The relative mitigation measures have been reported in the plankton section 7.3.2.1.1.

Residual impacts

The table below summarizes the impacts caused by the identified impact factors on the component assessed.

Based on the baseline conditions of the assessed component, the project characteristics and actions, as well as the proper implementation of the mitigation measures proposed above, a potential **low negative impact** is expected on fishes during the construction phase.

Table 7-29: Residual impact assessment matrix for fish during construction phase

Impact Factor	Impact Factor Features		Component Sensitivity	Impact Reversibility	Impact Value	Mitigation Effectiveness	Residual Impact Value
Minor leakage of contaminants into water	Duration:	Medium	High	Short-mid-term	**Medium**	Medium-high	**Low**
	Frequency:	Continuous					
	Geo. Extent:	Local					
	Intensity:	Low					
Handling of and resuspension of sediments	Duration:	Medium	High	Short-mid-term	**Medium**	Medium-high	**Low**
	Frequency:	Continuous					
	Geo. Extent:	Local					
	Intensity:	Medium					
Emission of underwater noise	Duration:	Medium	High	Short-term	**Low**	Medium	**Low**
	Frequency:	Continuous					
	Geo. Extent:	Local					
	Intensity:	Medium					
Emission of light	Duration:	Medium	High	Short-term	**Low**	Medium	**Low**
	Frequency:	Continuous					
	Geo. Extent:	Project footprint					
	Intensity:	Medium					
Emission of contaminants into marine water	Duration:	Short	High	Short-mid-term	**Low**	Medium-high	**Low**
	Frequency:	Infrequent					
	Geo. Extent:	Local					
	Intensity:	Low					
Discharge of wastewater	Duration:	Medium	High	Short-mid-term	**Medium**	Medium-high	**Low**
	Frequency:	Frequent					
	Geo. Extent:	Local					
	Intensity:	Negligible					
Overall assessment:		**Low**	Rationale: Due to the compliance with relevant standards of the impact factors and the applied mitigation measures, even using a precautionary approach, the residual impact values are not expected to cumulate to a higher impact value. Therefore, the average residual impact value may be considered as a reference for the overall impact.				

Monitoring measures

No monitoring measures are required for fishes during construction.

7.3.2.3.2 Operation phase

Impact factors

The impact factors from the Project activities potentially affecting fish during operation phase are listed in the following table.

Table 7-30: Project actions and related impact factors potentially affecting fish during operation

Project actions	Brief description	Impact factors
FPU/infrastructure operation offshore	FPU/infrastructure operation consist primarily in the extraction of the gas (SPS and other subsea facilities) and the processing onboard the FPU, for which a detailed description is available in Chapter 3 of the present ESIA (form section 3.2.3.7 to section 3.2.3.19), plus the structural facilities and operations necessary to the onboard staff.	■ Minor leakage of contaminants into water ■ Emission of underwater noise ■ Emission of electromagnetic fields (EMF) ■ Discharge of produced water ■ Presence of new infrastructures offshore ■ Discharge of wastewater

The impact factors identified above are described below and assessed in the matrix that follows.

- **<u>Minor leakage of contaminants into water</u>**

Maintenance/repair operations of the SPS, FPU and pipelines are planned for the operation phase of the project. Such operations are always conducted using vessels that, such as previously stated, may lose small amounts of contaminants (mostly oily and greasy) from the engines, potentially altering the seawater quality and, by consequence, the plankton communities of the AoI.

However, it must be noted that these maintenance/repair operations are not performed continuously and do not require a large number of vessels. In addition, all vessels must be compliant with MARPOL, to which Türkiye is signatory; therefore, it is unlikely that this impact factor could severely affect the seawater to cause a community significant alteration or switch.

- **<u>Emission of underwater noise</u>**

The emission of underwater noise will be primarily due to the periodic monitoring and maintenance activities of the offshore structures (since the FPU will be moored in place, so no DP system is required). Such operations are anticipated to be conducted using vessels whose propellers are expected to emit underwater noise.

Depending on the vessel used, an emission of 150-185 dB re 1 µPa at 1 m in the low frequency band (< 300 Hz) may be expected.

It must however be noted that these maintenance/repair operations are not performed continuously and do not require a large number of vessels and that noise emissions do not sum arithmetically, being on a logarithmical scale. In addition, all vessels must be compliant with MARPOL, to which Türkiye is signatory.

- **Emission of electromagnetic fields (EMF)**

Within Phase 2, a new SURF system (Subsea Umbilicals, Risers and Flowlines) will be installed to provide the infrastructure for transporting extracted gas and water liquid streams from the SPS to the FPU. The SURF system will consist of subsea flowlines, risers, a monoethylene glycol (MEG) line from the FPU to the manifold, a main umbilical between the FPU and the manifold, and well umbilicals for MEG injection. The main umbilical will connect the FPU and the manifold, enabling the transmission of electrical power, hydraulic control, and communication signals. This setup allows for monitoring and remote operation of the subsea systems, supporting production operations (See Chapter 3.0 of the present ESIA, section 3.2.2).

The presence of the umbilical line from the SPS to the FPU will therefore cause the emission of EMFs, which could be more or less intense in dependence to characteristic of the cable itself and of the current that flows within it.

Fish, and in particular Chondrichthyes, are well known to be sensitive to EMFs (England & Robert, 2022). The sensorial systems used to perceive magnetic fields, electric fields, and therefore also magnetically induced electric fields have a variety of ecological functions such as the orientation in large- and small-scale migrations, predation and inter- and intraspecific communication (England & Robert, 2022).

The electroreception and magnetoreception of fish and the impact that anthropogenic electromagnetic fields (EMFs) may have on this ability and the health of animals, is still an emerging field of study. Encountering submarine power cables could temporarily influence the behaviour of organisms over short distances, causing, for example, disorientation and interference in prey localization (Normandeau and Gill, 2011).

However, it is unlikely that such an impact factor could have repercussions on the component under examination, as most of the fish biodiversity is located in coastal areas, thus outside the influence area of the FPU (see Chapter 6.3 of the present ESIA, section 6.3.2.3).

- **Discharge of produced water**

Produce water is any water separated during processing. Produced water derives essentially form the LP (Low pressure) Inlet Separator. This FPU facility separates liquids (rich MEG and produced water) from gas.

Produced water is expected to reach a maximum of 773 m^3/day based on peak gas production rates, though actual volumes are anticipated to be around 500 m^3/day. Additionally, cooling seawater will be 312,000 m^3/day, used for power generation, topsides, and ship needs combined.

All the water generated, and seawater used at the operation (including cooling seawater, produced water with monovalent salt) are planned to be discharged into the Black Sea. The approval for the discharge of these generated waters to sea from MoEUCC is conditional to the compliance with the Project Specific Discharge Standards issued by the Ministry (refer to Table 3-18 given in Chapter 3.10.2).

As described in section 7.3.2.1.2, it is important the production of a specific dispersion and dilution model of the discharged water plum in order to better understand the intensity of this impact factor on the biota.

The contaminants cited in 7.3.2.1.2 may, in fact, result harmful to fish. Fish growth may be affected by aryl hydrocarbon receptor (AhR) agonists such as PAHs, some PAHs may form DNA adducts and neoplasia in fish liver through metabolic intermediates, phenols may have hormone-disrupting effects (Bakke et al., 2013).

However, it is unlikely that such an impact factor could have repercussions on the component under examination, as most of the fish biodiversity is located in coastal areas, thus outside the influence area of the FPU (see Chapter 6.3 of the present ESIA, section 6.3.2.3). The only case in which this impact factor could have repercussions is if the FPU will be used as an aggregating device by the rare offshore fish community, with a prolonged permanence (see next paragraph).

Regarding the discharge of cooling water, the inlet of heated seawater is not to be considered a potential impact factor, both for the mainly costal distribution of fish and because fish usually demonstrate a behavioral response of avoidance (Black et al., 1994).

- **<u>Presence of new offshore infrastructures</u>**

Such as stated in the project description (see Chapter 3 of the present ESIA), the offshore part of the project consists in the presence of cables to connect the SPS parts, one umbilical line and two pipelines from the SPS (around 2,200 m deep) to the onshore facilities.

While such impact factor is considered negligible to even non-existent for the cables and the umbilical line, due to their diameter, the presence of the pipelines is expected to act as an artificial hard substrate upon the sandy seafloor. As stated for the construction phase (see 7.3.2.2.1), the introduction of the pipelines may disrupt the soft bottom habitats of the AoI.

However, the presence of hard 3D structures in marine habitats are reported to have the potentiality to create the so-called “reef effects” (Taormina, et al., 2018), resulting in a potential positive impact. In fact, hard structures located in areas dominated by soft bottoms are usually reported to act as environmental enrichments, potentially forming biodiversity oases, since they may attract different species by providing a shelter for benthic organisms that may settle there, and therefore the fish community associated (more opportunities for predation, foraging, hiding, refuging, mating, etc.).

However, it should be noted that this is particularly reported of structures showing a complex and heterogeneous 3D structure, characterized by a high degree of rugosity. In addition, based on what stated in 6.3.3.2, the sediments of the AoI become anoxic beyond 80 m of depth, substantially preventing life and the first 1.66 km of the pipelines from the shoreline are planned to be buried. Therefore, due to those considerations, the positive impact should be very limited, but still present.

On the other hand, the planned prohibition of fishing and anchoring in the pipeline area will be a possible positive impact on the fish community, promoting the ‘spillover effect’[7].

Lastly, the stable presence of the FPU could act as aggregating device by the rare offshore fish community (e.g. highly migratory fish species), by providing, for example shaded and encountering areas (Snodgrass et al., 2020).

[7] The spillover effect for fish communities refers to the benefits that fish populations can gain from marine protected areas (MPAs) or other zones where fishing is limited or prohibited. When fish in these protected areas increase in number and size, they can migrate to surrounding areas, thereby improving fish populations outside the MPAs as well.

- **Discharge of wastewater**

As reported in sections 7.3.1.2.2 and 7.3.1.3.2, the bilge water and slop water produced in the FPU will be transferred to shore via vessels for disposal at Zonguldak TTK Waste Reception Facility, thus, these will not be discharged into the sea.

The sewage generated by the personnel on board of the FPU (approximately 29.4 m^3/day) will be treated in the Sewage Treatment Plant onboard and then discharged into the sea, if international and local standards are met.

Bilge water on support vessels (leachate and oily wastewater from machinery spaces in vessels), will becollected on board and shipped to Zonguldak TTK Waste Reception Facility for disposal, thus it will not be discharged into the sea.

Finally, ballast waters will be produced on board of the support vessels during operation activities due to water pumped into and out of storage during loading and off-loading operations. However, ships will be compliant with Ballast Water Management Convention and Guidelines developed by International Maritime Organization (IMO). The ballast water exchange will take place at least 50 nautical miles (NM) from the nearest land and in water at least 200 m in depth.

Infrequent ballast water discharge will be necessary during ballast water exchange on the FPU vessel. The ballast water will be stored in Water Ballast Tanks (WBT), which are isolated from contamination sources. When discharge is required, it will be released into the sea without treatment, provided no contamination is detected. If contamination is detected before discharge, the affected ballast water will be transferred onshore via PSV for proper disposal.

Mitigation measures

- **Minor leakage of contaminants into water**
  - All vessels used to be compliant with MARPOL.
- **Emission of underwater noise**
  - All vessels used to be compliant with MARPOL, to which Türkiye is signatory, whose regulations also have the objective of minimizing and preventing the noise pollution created by maritime traffic.
- **Discharge of wastewater**

The relative mitigation measures have been reported in the plankton section 7.3.2.1.2.

- **Discharge of produced water**

The relative mitigation measures have been reported in the plankton section 7.3.2.1.2.

Residual impacts

The table below summarizes the impacts caused by the identified impact factors on the component assessed.

Based on the baseline conditions of the assessed component, the project characteristics and actions, as well as the proper implementation of the mitigation measures proposed above, a potential **low negative impact** and **low positive impact** is expected on fishes during the operation phase.

Table 7-31: Residual impact assessment matrix for fish during operation phase

Impact Factor	Impact Factor Features		Component Sensitivity	Impact Reversibility	Impact Value	Mitigation Effectiveness	Residual Impact Value
Minor leakage of contaminants into water	Duration:	Long	High	Short-mid-term	**Medium**	Medium-high	**Low**
	Frequency:	Frequent					
	Geo. Extent:	Local					
	Intensity:	Low					
Emission of underwater noise	Duration:	Long	High	Short-mid-term	**Medium**	Medium	**Low**
	Frequency:	Frequent					
	Geo. Extent:	Local					
	Intensity:	Low					
Emission of electromagnetic fields (EMF)	Duration:	Long	High	Short-term	**Low**	None	**Low**
	Frequency:	Continuous					
	Geo. Extent:	Project footprint					
	Intensity:	Negligible					
Discharge of produced water	Duration:	Long	High	Short-mid-term	**High**	Medium-high	**Low**
	Frequency:	Continuous					
	Geo. Extent:	Local					
	Intensity:	Medium					
Discharge of wastewater	Duration:	Long	High	Short-mid-term	**Medium**	Medium-high	**Low**
	Frequency:	Frequent					
	Geo. Extent:	Local					
	Intensity:	Negligible					
Overall assessment:		**Low**	Rationale: The impact generated by the discharge of produced water may be considered as a the most consistent impact factor (precautionary considered to have a low residual impact value, but this case only for the presence of fish in offshore area, which is minority or sporadic, concentrated in the nearshore costal area). Moreover, the mitigation measures for the discharge of cooling water (assessed in the 'discharge of produced water'), is considered to have a good effectiveness (rated as 'medium-high'), since the discharge point's depth will be under 200 m, thus under the zone with presence of pelagic life. Therefore, due to the compliance with relevant standards of the impact factors, the residual impact values are not expected to cumulate to a higher impact value. Thus, the average residual impact value may be considered as a reference for the overall impact.				

Table 7-32: Residual positive impact assessment matrix for fish during operation phase

Impact Factor	Impact Factor Features		Component Sensitivity	Impact Reversibility	Impact Value	Enhancement Effectiveness	Residual Impact Value
Presence of new infrastructures offshore	Duration:	Long	High	Short-term	**Low**	Low	**Low**
	Frequency:	Continuous					
	Geo. Extent:	Project footprint					
	Intensity:	Negligible					

Impact Factor	Impact Factor Features		Component Sensitivity	Impact Reversibility	Impact Value	Enhancement Effectiveness	Residual Impact Value
Overall assessment:		**Low**	Rationale: The presence of new offshore infrastructures is the only impact factor identified for such component in the operation phase.				

Monitoring measures

No monitoring measures are required for fish during operation.

7.3.2.4 Marine mammals

Based on the information collected for the definition of the baseline (see 6.3.3.4), the biological component Marine mammals was assigned a **High** value of sensitivity for the following reasons:

- Presence of protected and/or threatened species;
- Presence of feeding grounds; and
- Potential presence of breeding ground.

Impacts potentially affecting this component are assessed here below for the construction phase and operation phase.

7.3.2.4.1 Construction phase

Impact factors

The impact factors from the Project activities potentially affecting marine mammals during construction phase are listed in the following table.

Table 7-33: Project actions and related impact factors potentially affecting marine mammals during construction

Project actions	Brief description	Impact factors
Offshore excavation (trenching) and sediment storage	Excavation of a trench in shallow water in correspondence of the land approach; the sediment removed will be temporarily stored west of Filyos Port, east of the pipeline, and will be moved back to cover the pipeline.	▪ Presence of working and moving vessels ▪ Emission of underwater noise
Offshore pipelines and lines laying	Offshore laying of the pipelines (gas pipeline and MEG line) and lines (seabed umbilical and flexible pipes), and their connection with the Subsea Production System (SPS).	▪ Presence of working and moving vessels ▪ Emission of underwater noise

All the impact factors identified above are described below and assessed in the matrix that follows.

- **Presence of working and moving vessels**

It is estimated that the construction operations at sea will require a total of 30 nautical units, of which 19 for offshore operations, 9 for nearshore operations, and 2 waste receiving ships (see Chapter 3 of the present ESIA, section 3.9.2.2).

The physical presence of moving vessels may possibly affect marine mammal species in the AoI. It should be reported, in fact, that collisions between vessels and large sized species are frequently observed (Panigada et al., 2006), mostly exceeding 14 kn of speed (Laist et al., 2001). However, it is worth mentioning that no large cetacean species occurs in the Black Sea, whose population is composed by three small subspecies only (see 6.1.2.4) and that the pipelay vessel is expected to proceed very slowly (almost still; 0.4 kn are assumed, considering the CastorOne technical sheet, as previously assumed for Phase 1). Taking these factors into account, along with the documented behavior of small delphinids, which often engage in bow-riding[8] across vessels of various sizes, and the capacity of porpoises to exhibit area avoidance in response to elevated vessel activity and speed, resuming normal use of the area once the disturbance has passed (Akkaya et al., 2017), this impact factor is unlikely to pose a significant threat to the marine mammal populations within the AoI.

- **Emission of underwater noise**

The operation of vessels will result in the emission of underwater noise due to their propellers. Generally, vessels produce sound at low frequencies (below 1 kHz) because of their high power, deep draft, and slow-turning engines and propellers (<250 rpm) (Richardson et al., 1995). This noise can travel up to 1.5 nautical miles (approximately 3 km) from the ship (Pricop et al., 2018). The underwater noise generated during pipeline installation is reported to be from negligible to unrecordable, as it is masked by the noise from the vessels' propellers. Similarly, dredging activities, which also emit low-frequency noise depending on the dredger and the substrate, may be overshadowed. The highest noise may be caused by the vessel propellers' cavitation, which has peak power near 0.05-0.15 kHz (at blade rates and their harmonics) (Ross, 1976; Gray & Greeley, 1980; Arveson & Vendittis, 2000). Considering that cetaceans (which are the only marine mammals occurring in the area) highly rely on the acoustics, underwater noises have the potentiality to interfere with primary functions of such species, masking acoustic signals (e.g., echolocation of prey, vocalizations, social interactions, mating) (Tyack, 2008). However, this can occur only if the underwater noise falls within the frequency range that overlaps with the hearing and vocal abilities of the species (Southall et al., 2007; Clark et al., 2009; Hatch et al., 2012; Southall et al., 2019). Such low frequency activities may potentially affect Low Frequency (LF) cetaceans (i.e., baleen whales) (Southall et al., 2019), which are however completely absent in the Black Sea. Instead, considering the marine mammals present or potentially present within the AoI, it must be noted that, according to Southall et al. (2019), *Tursiops truncatus ponticus* and *Delphinus delphis ponticus* are classified as High Frequency (HF) cetaceans (hearing range: 0.1 to 165 kHz and 0.3 to 44 kHz for social vocalizations, respectively; 23 to 102 kHz and 25 to 35 kHz for echolocation sounds, respectively), whereas *Phocoena phocoena relicta* is classified as Very High Frequency (VHF) cetacean (hearing range: 125 to 200 kHz for echolocation sounds[9]). Taking these considerations into account, it can be confidently stated that the noise produced during the construction phase does not overlap with the hearing abilities of marine mammals and is therefore not expected to pose a problem for this biological component. In addition, noise emission should be

[8] Dolphins have a habit of riding the bow waves of boats, likely an adaptation from surfing on large waves and nearshore breakers. While it has been suggested that this behavior makes travel easier, it is more likely that dolphins engage in bow-riding simply for fun or play.

[9] Social sounds emitted by the harbour porpoise are poorly studied but considered as insignificant. Authors like Hansen, Wahlberg, & Madsen (2008) even stated that there is no evidence that the species produces communication whistles.

limited, especially if dated propellers are avoided, allowing a quick restoration of the basic environmental conditions. Therefore, this impact factor is unlikely to seriously affect cetaceans of the AoI.

Mitigation measures

Being part of the ACCOBAMS area, mitigation measures need to be implemented to safeguard cetaceans and minimize any possible impact.

No specific procedures are outlined for offshore pipeline laying activities. Therefore, a set of **mitigation measures** aimed at minimizing the risk of affecting cetaceans is proposed, taking into account the "General guidelines", Guidelines for coastal and offshore construction works" and "Guidelines for shipping" issued by ACCOBAMS guidelines (res. 7.13, 2019), which report "Designers, shipbuilders, and ship operators are encouraged to also consider technologies and operational measures not included in these Guidelines, which may be more appropriate for specific applications". This set of actions shall be implemented within the AoI to mitigate the impact factors of the Project and shall include the following mitigation measures.

Therefore, the following mitigation measures shall be implemented to mitigate the effects of the impact factors.

- **Presence of working and moving vessels**
  - Defined routes to be used for all the vessels.
  - A dedicated and trained member of the crew should be in charge to scan the sea surface aboard each vessel during all activities involving the vessels navigating over 10 kn of speed to early detect the presence of cetaceans and avoid possible collisions.
  - Implement reduced speed limits for vessel/ship to decrease and/or avoid any risk of injury and mortality to aquatic fauna from vessel collisions.
  - Feeding or attracting any wild animal shall be strictly prohibited.
- **Emission of underwater noise**
  - All vessels used must comply with MARPOL regulations.
  - Unnecessary anthropogenic noise that does not contribute to work activities should be avoided to minimize disturbance to marine mammals.
  - Work activities should be planned to ensure that the noisiest tasks are, as much as possible, scheduled outside of dusk and dawn, when marine mammals are more active.

Residual impacts

The table below summarizes the impacts of the identified factors on the assessed component.

Based on the baseline conditions of the assessed component, the project characteristics and actions, as well as the proper implementation of the mitigation measures proposed above, a potential low negative impact is expected on marine mammals during the construction phase.

Table 7-34: Residual impact assessment matrix for marine mammals during construction phase

Impact Factor	Impact Factor Features		Component Sensitivity	Impact Reversibility	Impact Value	Mitigation Effectiveness	Residual Impact Value
Presence of working and moving vessels	Duration:	Medium-long	High	Short-term	**Low**	High	**Negligible**
	Frequency:	Continuous					
	Geo. Extent:	Local					
	Intensity:	High					
Emission of underwater noise	Duration:	Medium-long	High	Short-term	**Low**	Medium	**Low**
	Frequency:	Continuous					
	Geo. Extent:	Local					
	Intensity:	Medium					
Overall assessment		**Low**	Rationale:	Only one impact factor is expected to influence this component, so its residual impact value corresponds to the overall assessment of the component.			

Monitoring measures

The following monitoring measures will be implemented to assess the actual effects of the project on marine mammals during the construction and to verify the effectiveness of the mitigation measures.

- A Marine Fauna Monitoring report shall be prepared, detailing all visual and acoustic detections of cetacean species observed during the construction activities.
- A logbook with the occurred vessel collisions with the marine mammals, as well as the near-miss, shall be compiled indicating the species involved (or taking diagnostic photographs where identification is not feasible), date and time, coordinates, weather conditions and name of the vessel involved in the event.

7.3.2.4.2 Operation phase

Impact factors

The impact factors from the Project activities potentially affecting marine mammals during operation phase are listed in the following table.

Table 7-35: Project actions and related impact factors potentially affecting marine mammals during operation

Project actions	Brief description	Impact factors
FPU/infrastructure operation offshore	FPU/infrastructure operation consist primarily in the extraction of the gas (SPS and other	▪ Presence of working and moving vessels

Project actions	Brief description	Impact factors
	subsea facilities) and the processing onboard the FPU, for which a detailed description is available in Chapter 3 of the present ESIA (form section 3.2.3.7 to section 3.2.3.19), plus the structural facilities and operations necessary to the onboard staff.	▪ Emission of electromagnetic fields (EMF) ▪ Emission of underwater noise

All the impact factors identified above are described below and assessed in the matrix that follows.

- **Presence of working and moving vessels**

As previously stated, the offshore infrastructures are expected to be periodically monitored and maintained. Such operations are always conducted using vessels whose presence may expose marine mammals to the risk of collision. It must be noted, though, that the maintenance/repair operations are not performed continuously and do not require a large number of vessels. All operations may be periodic but always temporary (i.e., never lasting more than 2 weeks) and are performed in an already maritime route “congested” area. Therefore, no big issues are expected for this impact factor.

Nevertheless, it is necessary to account for the routine operations involving the FPU, which regularly has crew members on board. As a result, the traffic associated with these activities may exceed the typical levels observed during standard maintenance operations.

However, as assessed for the construction phase (see 7.3.2.4.1), this risk may be considered as significantly low due to the habits of the marine mammal species inhabiting the area.

Therefore, no big issues are expected for this impact factor.

- **Emission of underwater noise**

Underwater noise will mainly result from propeller cavitation, associated with the periodic monitoring and maintenance activities of the offshore structures. However, as stated above, these operations are not performed continuously and involve a limited number of vessels. Additionally, the resulting noise levels do not sum arithmetically, as sound intensity follows a logarithmic scale. Moreover, the FPU will be anchored in place and will not require a dynamic positioning (DP) system, therefore lowering the noise generation. It is worth noting, though, that the presence of personnel on board may lead to a slight increase in maritime traffic. Nonetheless, depending on the specific type of vessel employed, sound emissions are expected to range from 150 to 185 dB re 1 μPa at 1 m, predominantly within the low-frequency range (< 300 Hz). Therefore, the noise produced by the propellers is characterized by low-frequency sound. As previously indicated for the construction phase (refer to section 7.3.2.4.1), cetaceans inhabiting the AoI are primarily High-Frequency (HF) and Very High-Frequency (VHF) species. As a result, no significant overlap in sound frequency ranges is anticipated, and therefore, no substantial impacts on marine life are expected, especially given that the area is already regularly trafficked by numerous vessels. Furthermore, all ships are required to comply with MARPOL regulations, to which Türkiye is a signatory.

- **Emission of electromagnetic fields (EMFs)**

As stated in 7.3.2.3.2, in Phase 2, a new SURF system (subsea umbilicals, risers, and flowlines) will be installed to facilitate the transportation of extracted gas and water liquid streams from the SPS to the FPU. The umbilical line from the SPS to the FPU will emit electromagnetic fields (EMFs), the intensity of which will depend on the characteristics of the cable and the current flowing through it. These EMFs may, therefore, affect marine mammals in the Area of Interest (AoI) by influencing their behavior and space usage.

Cetaceans' relationship with EMFs is still poorly studied. They appear to use the Earth's magnetic field for migration parallel to the contours of the local field topography and as a timer based on the regular fluctuations in the field allowing animals to monitor their progress on this map. However, cetaceans do not appear to use the Earth's magnetic field for directional information (Klinowska 1990).

The orientation of a cable relative to the geomagnetic field can lead to a local reduction in the magnetic field. However, when considering a single EMF-emitting cable, the probability that this change would affect a sufficiently large area to significantly alter a cetacean's course or cause stranding appears to be low (Normandeau et al., 2011).

Potential responses could include a temporary change in swim direction or a deviation from a migratory route (Gill et al. 2005).

It's however rather clear that cable influence on marine mammal species depends on the benthic-feeding habits of the species itself. The bottlenose dolphin (*Tursiops truncatus*, whose subspecies *T. truncatus ponticus* is present in the area) is reported shoeing a sensitivity threshold of < 0.05 μT, perceived at a range defined as 50 m plus above the cable, and 48 to 68 m along the sea floor. Indeed, this species is typically a benthic feeder. However, those data are not specific to the Black Sea, where dolphin are unlikely to present benthic-feeding habits because of the anoxia of the sediments from roughly 80 m of depth and the rich pelagic environment.

Therefore, adopting a strong precautionary approach, the emission of EMFs is considered to potentially affect marine mammals in the AoI, even if limitedly. Additionally, it is expected that the original conditions will recover rather quickly once the umbilical line ceases operation.

Mitigation measures

The following mitigation measures shall be implemented to mitigate the effects of the impact factors.

- **Presence of working and moving vessels**
  - Defined routes to be used for all the vessels.
  - A dedicated and trained member of the crew should be in charge to scan the sea surface aboard each vessel during all activities involving the vessels navigating over 10 kn of speed to early detect the presence of cetaceans and avoid possible collisions.
  - Implement reduced speed limits for vessel/ship to decrease and/or avoid any risk of injury and mortality to aquatic fauna from vessel collisions.
  - Feeding or attracting any wild animal shall be strictly prohibited.
- **Emission of underwater noise**
  - All vessels used must comply with MARPOL regulations.

- Unnecessary anthropogenic noise that does not contribute to work activities should be avoided to minimize disturbance to marine mammals.
- Work activities should be planned to ensure that the noisiest tasks are, as much as possible, scheduled outside of dusk and dawn, when marine mammals are more active.

Residual impacts

The table below summarizes the impacts caused by the identified impact factors on the component assessed.

Based on the baseline conditions of the assessed component, the project characteristics and actions, as well as the proper implementation of the mitigation measures proposed above, a potential **low negative impact** is expected on marine mammals during the operation phase.

Table 7-36 Residual impact assessment matrix for marine mammals during operation phase

Impact Factor	Impact Factor Features		Component Sensitivity	Impact Reversibility	Impact Value	Mitigation Effectiveness	Residual Impact Value
Presence of working and moving vessels	Duration:	Long	High	Short-term	**Low**	High	**Negligible**
	Frequency:	Frequent					
	Geo. Extent:	Project footprint					
	Intensity:	Medium					
Emission of underwater noise	Duration:	Long	High	Short-term	**Low**	Medium	**Low**
	Frequency:	Frequent					
	Geo. Extent:	Local					
	Intensity:	Medium					
Emission of electromagnetic fields (EMF)	Duration:	Long	High	Short-term	**Low**	None	**Low**
	Frequency:	Continuous					
	Geo. Extent:	Local					
	Intensity:	Medium					
Overall assessment		**Low**	Rationale:	Only one impact factor is expected to influence this component, so its residual impact value corresponds to the overall assessment of the component.			

Monitoring measures

The following monitoring measures will be implemented to assess the actual effects of the project on marine mammals during the operation and to verify the effectiveness of the mitigation measures.

- A logbook with the occurred observations and vessel collisions with the marine mammals, as well as the near-miss, shall be compiled indicating the species involved (or taking diagnostic photographs where identification is not feasible), date and time, coordinates, weather conditions and name of the vessel involved in the event.
- Cetacean stranding networks shall be periodically consulted to verify the absence of suspicious cetacean deaths.

7.3.2.5 Marine habitats

Based on the information collected for the definition of the baseline (see Chapter 6.3, section 6.3.2.5), the biological component Marine habitats was assigned a **Low** value of sensitivity for its subcomponent Benthic habitats and a **High** value of sensitivity for its subcomponent Pelagic habitats. The reasons are listed here below:

- **Benthic habitats (Low):**
  - Simple communities dominated by few species; and
  - Absence of bioconstructions and seagrasses.
- **Pelagic habitats (High):**
  - Productive pelagic habitats highly rich in species;
  - Probable feeding area; and
  - Presence of protected species.

Impacts potentially affecting this component are assessed here below for the construction phase and operation phase.

However, considering that habitats are both natural and artificial environments having physical and biological features where given species may live, shelter, feed and/or reproduce, potential impacts on marine habitats may be considered as an integration of all the physical and biological components assessed previously. For such reason, no impact assessment matrices are given here, since they may result as redundant.

7.3.2.5.1 Construction phase

Impact factors

In general, it can be stated that all the project actions for both construction and operation phases can potentially impact habitats. For this reason, all the impact factors already analyzed for the previous physical and biological components may be considered as potentially impacting habitats.

It can be excluded that the project will lead to physical habitat destruction as a true balance. In fact, while some actions are expected to generate **benthic habitat**[10] destruction during construction (i.e., dredging), those

[10] Benthic habitats are here reminded to be limited to the bathymetric range of 0-80 m of depth, beyond which anoxic conditions of the sediments are observed.

actions are planned to be completed with a total restoration (i.e., backfill). Benthic communities are in fact the only component concurring in benthic habitats, and the residual impact value for this was assed as 'low', regarding in particular the impact factor '*Introduction of new offshore infrastructures'*. The offshore excavation of the trench for the first 1.66 km of the pipeline corridor is expected to actively mobilize sediments to be stored at the temporary storage area before the backfill, which will potentially impact negatively the feeding activities of filter-feeding organisms. However, the planned mitigation measures are considered as highly effective.

A limited habitat disruption, which is mainly composed by large sandy stretches, more or less covered or mixed with mud, is therefore expected by the introduction of hard substrates which will fragment the soft bottom habitats themselves (limitedly disrupt the habitat homogeneity because of the introduction of the being-laid pipelines). However, both impacts described are expected to be very limited since (i) beyond 80 m of depth the sediments are almost completely anoxic, (ii) the benthos of the oxygenated sections of AoI is mainly composed by highly resilient communities (see 6.3.3.2).

No destruction is expected for the **pelagic habitats**[11] as well rather than a degradation. In fact, as discussed in the previously sections, pelagic habitats of the AoI may be affected by:

- Emission of light by the pipelay vessel;
- Emission of underwater noise by the by the working vessels' propellers and DPS;
- Presence of working and moving vessels;
- Minor leakage of contaminants into water, mainly caused by the working vessels' engines;
- Emission of particulates and chemicals in water from the hydrotesting activities.
- Discharge of wastewater.
- Handling of and resuspension of sediments due to the trenching activities.

The following table reports the residual value for each impact factor over the components that concurs in pelagic habitats (plankton, fish and marine mammals).

Table 7-37 Residual impact values of the impact factors identified as affecting biological components concurring in pelagic habitat during construction phase

Impact factor	Component	Residual impact value
▪ Emission of light by the pipelay vessel	Plankton	**Low**
	Fish	**Low**
▪ Emission of underwater noise	Plankton	**Low**
	Fish	**Low**
	Marine mammals	**Low**

[11] Pelagic habitats are here reminded to be limited to the bathymetric range of 0-100 m of depth (max. 150 m of depth), beyond which anoxic conditions of the seawater are observed.

Impact factor	Component	Residual impact value
▪ Presence of working and moving vessels	Marine mammals	**Negligible**
▪ Minor leakage of contaminants into water	Plankton	**Low**
	Fish	**Low**
▪ Emission of particulates and chemicals in water	Plankton	**Low**
	Fish	**Low**
▪ Discharge of wastewater	Plankton	**Low**
	Fish	**Low**
▪ Handling of and resuspension of sediments	Plankton	**Low**
	Fish	**Low**

An overall low residual impact value, as assessed from the table, may cause habitat degradation. The biological components of pelagic habitat mainly impacted could in fact be plankton and fish. However, it is not expected a compromission of the ecological functions and thus of the pelagic habitat (e.g. permanent shift in communities, changes in the food chain, loss of biodiversity). Moreover, all the impacts are limited to the only duration of the construction phase, and few months after its end for restoration.

7.3.2.5.2 Operation phase

Such as discussed for the construction phase, all the impact factors already analyzed for the previous physical and biological components may be considered as potentially impacting habitats.

As far as what concerns **benthic habitats**, such as stated in the project description (see Chapter 3 of the present ESIA), the offshore part of the project consists in the presence of cables to connect the SPS parts, one umbilical line and two pipelines from the SPS (around 2,200 m deep) to the onshore facilities.

While such impact factor is considered negligible to even non-existent for the cables and the umbilical line (2,200m deep, the sediments of the AoI become anoxic beyond 80 m of depth, substantially preventing life, in fact habitats are reported as essentially thanatocoenosis) the presence of the pipelines is expected to have a low residual impact by the "*Introduction of new offshore infrastructures*", which may limitedly disrupt the habitat homogeneity because of the introduction of the being-laid pipelines. This impact factor is however expected to be marginal or negligible since the first 1.66 km of the pipelines from the shoreline (nearshore area characterized by basic benthic habitat) are planned to be buried.

However, the unburied section of the pipeline, as assessed in 7.3.2.2.1 and 7.3.2.2.2, is considered to have a low positive impact: being an artificial hard substrate upon the sandy seafloor (above the 80 m), it may act as a limited environmental enrichment, by attracting species and proving shelter (see 7.3.2.2.2 and 7.3.2.3.2).

No habitat destruction (*sensu stricto*) may happen on **pelagic habitats** by definition. However, a habitat degradation may be experienced if all the residual impacts on plankton, fishes and marine mammals are combined together. In particular, as discussed in the previously sections, pelagic habitats of the AoI, during operation, may be affected by:

- Emission of underwater noise by the by the working vessels' propellers used for the maintenance;
- Emission of light by the FPU lighting and flaring activity;
- Presence of working and moving vessels;
- Minor leakage of contaminants into water, mainly caused by the working vessels' engines;
- Discharge of wastewater from the FPU;
- Discharge of produced water from the FPU;
- Emission of electromagnetic fields (EMFs) from the main umbilical;
- Use of seawater by the FPU facilities (processing and ship maintenance use).

The following table reports the residual value for each impact factor over the components that concurs in pelagic habitats (plankton, fish and marine mammals as biotic components, and seawater as physical component).

Table 7-38Residual impact values of the impact factors identified as affecting biological components concurring in pelagic habitat during operation phase

Impact factor	Component	Residual impact value
▪ Emission of light	Plankton	**Medium**
▪ Emission of underwater noise	Plankton	**Low**
	Fish	**Low**
	Marine mammals	**Low**
▪ Presence of working and moving vessels	Marine mammals	**Negligible**
▪ Minor leakage of contaminants into water	Plankton	**Low**
	Fish	**Low**
▪ Discharge of wastewater from the FPU	Plankton	**Low**
	Fish	**Low**
▪ Discharge of produced water from the FPU	Plankton	**Low**
	Fish	**Low**
▪ Emission of electromagnetic fields (EMFs)	Plankton	**Medium**
	Fish	**Low**
	Marine mammals	**Low**

Impact factor	Component	Residual impact value
▪ Use of seawater	Plankton	**Negligible**

A medium residual impact value (in a precautionary prospective), as assessed from the table, may cause habitat degradation, especially for what concern the project actions related to the FPU activities and the deriving impact factors (i.e. use of seawater, produced water discharging and emission of lights) over, in particular, the plankton component (see sections above). These activities are planned to be continuous during the whole lifetime of the FPU (20 years, and 20-45 years for the activity of the Sakarya gas field). Thus, he proper execution of the mitigation and monitoring measures, indicated in the previous sections, will be essential, with the possibility to address the necessity of implementing new measures to safeguard the pelagic habitats. Moreover, it is assessed a potential low positive impact from the FPU presence (7.3.2.3.2).

However, it must be noted that the potential long-term degradation of pelagic habitat would be isolated to the immediate proximity of the FPU.

Lastly, combining the impact assessment performed for the previous components, a **low impact** for benthic habitat and **medium impact** for pelagic habitats may be considered for the AoI (plus a **low positive impact** for both benthic and pelagic habitats).

7.3.2.6 Critical Habitats

Such as assessed in the baseline (see Chapter 6.3 of the present ESIA, section 6.3.2.7), Critical Habitat (CH) is triggered by:

- *Phocoena phocoena relicta* (under Criteria C1a and C3);
- *Tursiops truncatus ponticus* (under Criteria C1a and C3); and
- *Delphinus delphis ponticus* (potential Critical Habitat under Criteria C1b and C3).

Considering that all the three species are marine mammals, reference to the relevant impact assessment can be made (see 7.3.2.4). Based on that assessment, a **low residual impact** is considered for both construction and operation phase.

Based on IFC PS6 and GN6, No Net Loss and Net Gain shall be reached for Critical Habitats.

Even if a low residual impact is expected for the species triggering CH during both construction and operation, this does not necessarily mean a Net Loss. In fact, all the three species inhabit the pelagic habitats of the AoI and, as previously stated for the assessment on marine habitats (see 7.3.2.5), no habitat destruction can be expected on pelagic habitats by definition. It is very rare a pelagic habitat to be lost; it can be rather subjected to degradation.

Based on the impact assessment carried out, in fact, for both construction and operation, the following impact factors are expected to affect the species triggering CH:

- Presence of working and moving vessels;
- Emission of underwater noise.

In addition, the following impact factor is expected to affect species triggering CH for operation phase only:

- Emission of electromagnetic fields (EMFs).

Impacts generated by the mentioned impact factors are assessed in the *Marine mammals section* (7.3.2.4). All have a low or negligible residual impact value mainly because of the project's long-lasting nature. Therefore, the following considerations can be made.

- The *Presence of working and moving vessels* may result in collisions with the animals, but this is mostly linked with large cetaceans, such the three species triggering Critical Habitat are not. Indeed, these species are known to bow-ride vessels for fun and travelling. In addition, this impact assessment is considered to be completely temporary and linked to the presence of the vessels. Once passed, the situation is expected to fully recover.
- The *Emission of underwater noise* as well is strictly linked to the presence of the vessels and their propellers in operation. Such noise is in the low frequency band, which does not overlap with the hearing and vocalization abilities of the three species, being *P. phocoena relicta* a VHF (Very High Frequency) cetacean and *T. truncatus ponticus* and *D. delphis ponticus* HF (High Frequency) cetacean. In addition, those cetaceans are reported to actively move away from noise sources and return once the emission stops. This impact assessment is considered to be completely temporary and linked to the presence of the vessels as well. Once the emission stops, the situation is expected to fully recover.
- The *Emission of electromagnetic fields* (EMFs) is caused by the presence and the operation of the main umbilical line connecting the SPS to the FPU. It is an impact factor expected to be active for the whole lifetime of the project. However, EMFs are reported not to affect dolphin behavior and habits over 50 m of distance from the source. In addition, as assessed in section 7.3.2.4.2, dolphins are not reported to be sensitive to EMFs. This impact factor, despite being continuously active during operation, will stop its effects immediately after its interruption at the end of the life of the project. Once stopped, the situation is expected to fully recover.

Given all these assumptions, a true habitat loss is not expected. Rather, a habitat degradation may be experienced but likely in a negligible manner, considering that the area is highly exploited and the three species triggering CH are known to easy to get habituated. For this reason, **No Net Loss is assessed for the Critical Habitats triggered by *P. phocoena relicta*, *T. truncatus ponticus* and *D. delphis ponticus***. The table below highlights the extent of CH potentially subject to the temporary degradation assessed.

Table 7-39 Critical Habitat degraded for the three species triggering it (EAAA definition is reported in 6.3.2.7 and AoI in 6.3.3.4)

Species	Common name	EAAA [km^2]	AoI [km^2]	CH degraded [%]
P. phocoena relicta	Black Sea harbour porpoise	153,846.86	3,714	2.5
T. truncatus ponticus	Black Sea bottlenose dolphin	225,983.04	3,714	1.5
D. delphis ponticus	Black Sea common dolphin	316,504.07	3,714	1

In addition, to reach **the Net Gain condition**, the following measure shall be implemented:

- Promotion of raising awareness programs among the population e.g., at schools and/or to fishermen targeted at the conservation of the cetaceans frequenting the Black Sea Turkish coasts and their role in regulating the ecosystems by acting as ultimate predators for the basin.