Asian Infrastructure Investment Bank (AIIB)

People's Republic of China

Beijing-Tianjin-Hebei Low Carbon Energy Transition and Air Quality Improvement Project

Environmental and Social Impact Assessment and Environmental and Social Management Plan

Construction unit：Beijing Gas Group Co.,Ltd.

Compilation unit：TIWTE Environmental Technology Development (Tianjin) Co., Ltd.

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1 Overview

1.1 Project background

China is now the world's largest exporterand manufacture, also the world's second-largest economy. Attributed to its energy-intensive growth in the past, , China has beenfacing critical challenges of environmental pollution. This by estimationwhich costs around 3-10% of its GDP , in which a large part arises from air pollution.To address such an obsolete and unsustainable growth model, the Chinese government has proposed a green development model which focuses on decoupling economic growth with resource oversupply as well as high carbon emissions with and environmental damage. Since then, green development has become a top priority in China's development policy.

Reducing coal consumption is at the heart of China's green development agenda. Being limited by natural resource reserves, China has relied heavily on coal to boost its economy. . However, coalis a polluting and unsustainable energy source, and pollutants from coal combustion have become the main source of air pollution. To improve air quality, it is urgent   to replace coal with clean fuels such as natural gas and renewable energy. In 2012, the State Council promulgated new environmental air quality standards to reduce the concentration of six major atmospheric pollutants. In 2013, the National Comprehensive Plan of Action for the Prevention and Control of Air Pollution (CAAP, 2013-2017) was launched, outlining the most stringent air pollution control measures in China's history. In 2016, Plan 45 (2016-2020) began implementing mandatory targets for local air quality improvement. In 2018, the State Council announced a three-year action plan for the Blue Sky Campaign, requiring local governments to take measures to achieve more in air pollution control, and to promote clean energy use for heating in the winter in North China, accelerate the phase out of small coal-fired boilers and increase rail freight transport in and around the Beijing-Tianjin-Hebei region, the Yangtze River Delta, the Fenhe River and the Weihe River Plain. Air quality has generally improved over the past few years through strong interventions, but levels of air pollution remain high compared to OECD countries.

According to the Paris Agreement, carbon dioxide (CO_2) emissions are expected to peak by 2030, as coal combustion is the single largest source of air pollution and CO. Global carbon emissions soared to record in 2018, which sets a remarkable milestone. This also underscored the need to accelerate and fasten climate change with stronger actions. Therefore, energy system transformation is needed to meet growing demand while curtailing emissions to address climate change and air pollution.. The project aims to to replace coal with natural gas in the Beijing-Tianjin-Hebei region, which is expected to largely reduce carbon emissions upon completion. This is not in line with commitments from international community in fighting against climate change, but also comply with government's policy priority in reducing CO_2 emissions and improving regional air quality. In light of its foreseeable benefits to the environment , this program has attained strong support from the central government.

Beijing-Tianjin-Hebei and its surrounding areas (such as Henan, Shandong, Shanxi and Liaoning provinces) are the key engines of economic development in China. Together, they face dual challenges of increasing energy supplies and tackling air pollution. Beijing-Tianjin-Hebei is a highly industrial area with high energy and pollution intensity. . It also has been experiencing poor air quality, mainly due to heavy reliance on coal in the energy mix , and concentration of heavy duty trucks as well as inadequate monitoring of environmental standards. Air pollution, especially high levels of PM 2.5 , can potentially lead to many negative health effects and increase the risk of cardiovascular disease, respiratory disease and ischemic heart disease. Children, patients and the elderly are most vulnerable to such adverse effects. With increasing public awareness of environmental protection and the frequent red warning of air pollution in the Beijing-Tianjin-Hebei region, coal reduction and resulting poor air quality have always been the core of environmental policy discussions among governments, academia and governments. Therefore, it is necessary to reduce coal consumption in the Beijing-Tianjin-Hebei region and switch from coal to natural gas for a more sustainable low-carbon development path, which will bring substantial environmental benefits for improving air quality and reducing carbon emissions.

According to the " Implementation Plan for the Construction of LNG Storage and Transportation System in Bohai Rim Region (2019-2022) ", the capacity f the LNG terminal is able to back up gas supply that to 5% of enterprises’ demand for and 3 days of government’s demand emergency gas storage capacity of local governments. At present, there are 2 LNG receiving terminal in the Beijing-Tianjin-Hebei region, namely Tianjin floating LNG from CNOOC and Tianjin LNG from Sinopec, with a gasification capacity of 4300 × 104 nm 3/d, and Tangshan LNG supply to the Beijing-Tianjin-Hebei region with a gasification capacity of 4200 × 104 nm 3/d . The expansion of the Tangshan LNG Receiving terminal and Tianjin LNG Receiving terminal from CNOOC is planned for 2022 with a total gasification capacity of 27900 × 104 nm 3/d . considering the radiation area of the send-out pipeline, the supply of the Beijing-Tianjin-Hebei region will be about 16978 × 104 Nm3/d in 2025, the demand of the Beijing-Tianjin-Hebei region will be 36885 × 104 Nm3/d in 2025, and the total supply capacity of the pipeline gas source will be 32452 × 104 Nm3/d.

With the development of national economy, the gap between China's natural gas resources and demand is becoming larger, and imported gas will increase year by year, especially in the Bohai Rim region where energy is relatively scarce while economy is well developed. With the increasing demand for energy, importing LNG will play an important role in optimizing China's energy structure, improving energy securiand addressing ecological environment conservation , and achieving sustainable economic and social development. The rated capacity of LNG Receiving terminal is 5 Mt/year, equivalent to 6.937 billion cubic meters , which can replace 8,5 million tons of standard coal. This amounts to 272 Mt reduction of sulfur dioxide per year, 676.99 Mt reduction of soot peryear, 7.5 Mt043 reduction of carbon dioxide per year and 784.41Mt3 reduction of nitrogen oxides per year.

In this context, Beijing Gas Group Ltd. is convinced ends to develop this project. The completion of the project is expected to provide back up for gas supply as well as meet peak demand for the Beijing-Tianjin-Hebei region, which can effectively relieve the winter supply shortage in this region. , In the meanwhile, it can also promote pipeline interconnections, secure gas supply for the Bohai Sea region, reduce carbon emissions and improve air quality.

1.2 Working procedure

In accordance with the relevant requirements of the Environmental and Social Framework of the Investment Bank, the Environmental Protection Law of the People's Republic of China, the Environmental Impact Assessment Law of the People's Republic of China and the relevant provisions of the Administrative Regulations on Environmental Protection of Construction Projects No. 253 of the State Council Order, the Beijing Gas Group Limited Company commissioned the Environmental Science and Technology Development (Tianjin) Ltd. of Tianyuan to conduct environmental impact assessment on the project. After accepting the entrustment, the EIA unit has carried on the deep l analysis and research to the work result of the project in the early stage, has collected the relevant data extensively, the EIA unit is involved in the project in advance in the feasibility design, pays attention to the whole process risk management, attaches importance to the ecological sensitive area protection problem, has carried on the public participation investigation according to the relevant regulations of the country. The present report has been prepared on the basis of a synthesis of project-related thematic findings, expert advice and public participation.

The present report has been prepared in accordance with the requirements of the AIIB Framework for Environment and Society. According to China's " Environmental Impact Assessment Technical Guidelines", "Environmental Impact Assessment Technical Guidelines for Atmospheric Environment", "Environmental Impact Assessment Technical Guidelines for Surface Water Environment ", " Environmental Impact Assessment Technical Guidelines for Sound Environment " (HJ 2.4-2009), " Environmental Impact Assessment Technical Guidelines for Groundwater Environment", "Environmental Impact Assessment Technical Guidelines for Soil Environment " (for Trial Implementation), " technical Guidelines for Environmental Risk Assessment of Projects, Regulations for Environmental Impact Assessment of Port Construction Projects and Technical Guidelines for Environmental Risk Assessment of Oil Spill on Water, etc. The methods of environmental impact assessment, such as data collection, status survey, remote sensing analysis, numerical simulation and analogy, were adopted.

The following environment-related technical results were mainly referenced and referenced during the preparation of the report :

(1) Report on Mathematical Model Calculation of Tidal Flow in the Terminal Project of Beijing Gas Tianjin Nangang LNG Terminal, Nanjing Water Conservancy Research Institute, September 2018 ;

(2) Mathematical Model Calculation Report on Cold Discharge of Beijing Gas Tianjin Nangang LNG Terminal Project, Nanjing Water Conservancy Research Institute, September 2018 ;

(3) Report on Demonstration of Sea Area Use of LNG Emergency Reserve Project of Nangang, Tianjin City, Beijing Gas (for approval), Guangdong Sanhai Environmental Protection Science and Technology Ltd., May 2019 ;

(4) Report on the Marine Environmental Impact of the LNG Emergency Reserve Project in Nangang, Tianjin City, Beijing Gas (for review), Guangdong Sanhai Environmental Protection Science and Technology Ltd., August 2019 ;

(5) Report on the Impact of Beijing Gas Tianjin Nangang LNG Emergency Reserve Project on the National Aquatic Germplasm Resources Reserve in Laizhou Bay of Bohai Bay, Liaodong Bay.

1.3 Compliance analysis with related planning

1.3.1 Compliance with the Key Layout Plan for LNG Terminals in the Bohai Rim (2022)

The berth of this project is one of the two new LNG berths planned for the Dagang Port Area of Tianjin Port . It is consistent with the specific scheme of " Key Layout Plan of LNG Terminal in Bohai Rim Region (202) ", and uses the channel of Dagang Port Area and anchorage No. 8 of Tianjin Port to meet the safety requirements of setting up special navigation channels or alignment systems proposed in the plan, and setting safety measures for special anchorages. The project will construct LNG tank areas, pipe corridors and corresponding ancillary facilities behind the LNG berths to form a system capacity coordinated with the terminals.

In summary, the construction of this project implements Xi Jinping's thought of ecological civilization. From the perspective of ensuring the safety of natural gas supply and transportation in the northern region and improving the layout of LNG terminals in the Bohai Rim region, the project construction is in line with the key layout plan for the LNG terminal in the Bohai Rim region (2022).)".

1.3.2 Compliance with Tianjin Marine Functional Regionalization (2011-2020)

On October 10, 2012, the State Council officially approved the Division of Ocean Functions in Tianjin (2011-2020). The marine functional zoning of Tianjin and the LNG terminal operation area of Dagang Port are analyzed . The LNG terminal operation area is located in the southern port shipping area of Tianjin Port (A2-02) . The adjacent marine functional areas are Dagang Binhai Wetland Marine Special Reserve (A6-02), Gaoxaling Tourism and Recreation Area (A5-05), Agriculture and Fisheries Area (A1-03) and so on. See Table 15.1-2 for details.

The sea type used in this project is other industrial seas in the industrial sea classification (code: 27). This type of sea use is mainly used for the construction of LNG jetty, work ship docks, harbor basins, and water intakes and outfalls, which are in line with the functional positioning of the adjacent waters of Dagang.

The proposed LNG jetty, basin, water intake and outfall and receiving terminal of the project are located in the port shipping area of the south port of Tianjin Port (code: A2-02), and the send-out pipeline passes through the industrial and urban sea area of the south port of Tianjin Port (code: A3-04). According to the analysis of Section 6.1.2 , the sea used for the project is in accordance with the port shipping area of the south port of Tianjin Port (code: A2-02) and the industrial and urban sea area of the south port (code: requirements for the management of the use of the sea area and the protection and management of the marine environment.

To sum up, the sea used for this project meets the requirements of sea area management and marine environment protection of the port shipping area (code: A2-02) and the industrial and urban sea area (code: A3-04) of Tianjin Port.

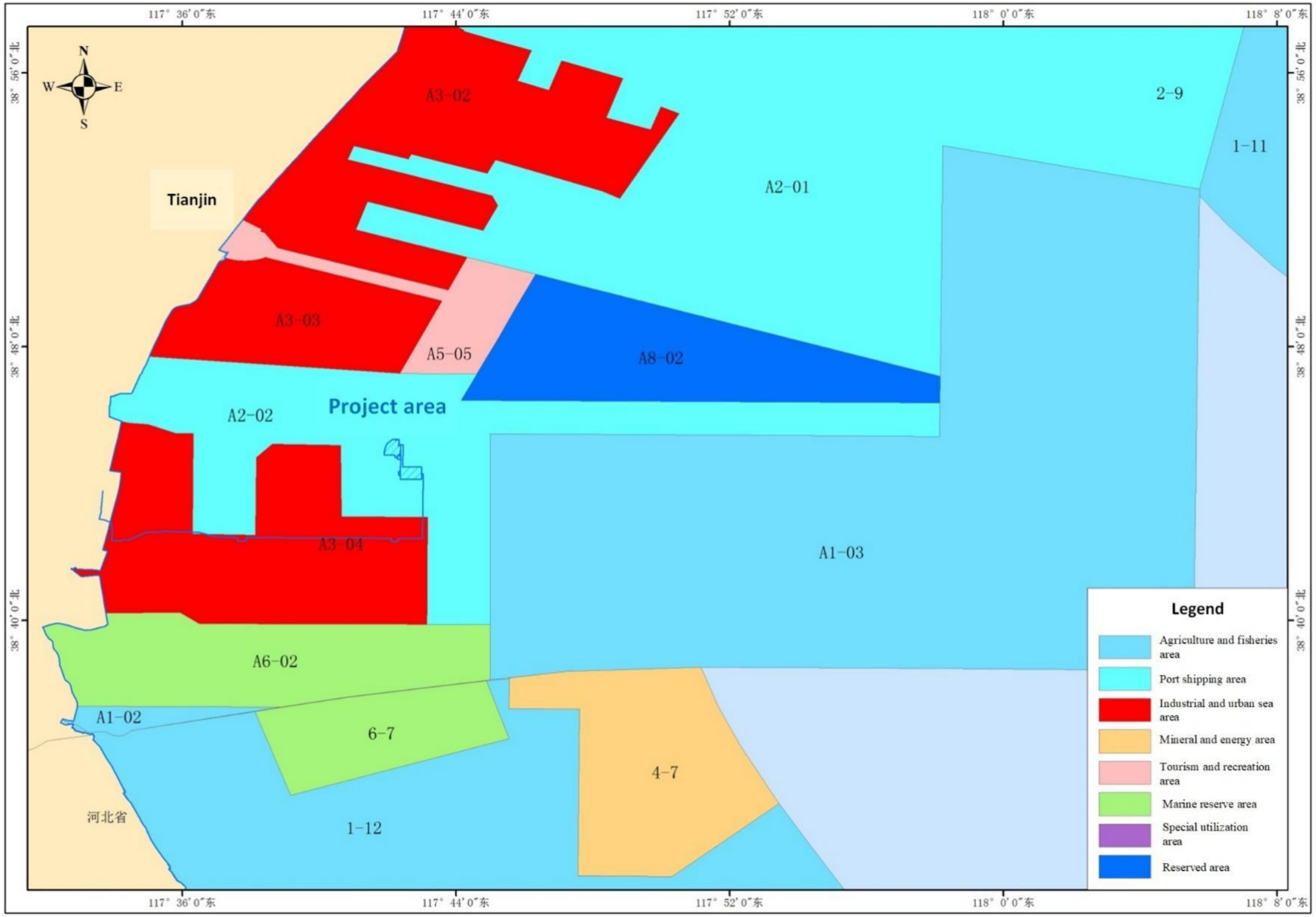


Figure 1.3-1 Proposed construction project and marine functional zoning map of the surrounding sea area

Table 1.3-1 Conformity analysis with marine functional zoning

S. N	Code	Functional Area Name	Geographic scope	Functional Area Type	Area	Shore section	Management requirements		Relative position	Conformity analysis
					Ha	Meters	Sea area use management	Marine environmental protection		
5	A2-02	South Port of Tianjin Port Port shipping area	To the south of Duliujian River treatment line, including the port area and waterway area already built and planned in Nangang industrial zone. E 38° 46 ' 22 " N at 117 ° 58 ' 09 " ; E 38°45'27 " N at 117 °45'00 ; E 38° 39 ' 53 " N at 117 ° 45 ' 00 ; E 38° 43 ' 01 " N at 117 ° 43 ' 11 " ; E 38°45'23 " N at 117 ? 58'09 " ; E 38° 42 ' 32 " N at 117 ° 36 ' 18 " ; A 117 ° 34 ' 10 " E38° 45 ' 51 " N ; A 117 ? 35 ' 03 " E38° 47 ' 43 " N.	Port shipping area	14894	4743	To ensure the safety of traffic and transportation, to be suitable for port and waterway use, to ensure the safety of industrial water intake, and to ensure the safety of port shipping, compatible with oil and gas to open and use the sea. It is allowed to moderately change the natural attributes of the sea area. The port project encourages the use of jetties and structures. The docks and storage areas can be reclaimed. It should be gradual, economical, intensive, and optimized. To ensure the management requirements of flood control, it is forbidden to construct structures that impede flood discharge within the scope of Duliujian River treament line and to ensure the safety of flood discharge..	Guarantee the water depth conditions and hydrodynamic environment at the front of the port area ; Strengthen supervision and prevent various types of risk accidents such as oil spills; Waste and sewage must reach the standard to be discharged to sea. The quality of seawater is not inferior to the four categories of standards, the quality of marine sediments and the quality of marine organisms are not inferior to the three categories of standards. The waters in the eastern part of Nangang Industrial and Urban Sea Area (about 2.6km from east to west) are buffered waters adjacent to agricultural and fishery areas and protected areas. Seawater quality, marine sediment quality and marine biological quality are not inferior to Class II standards.	All within this functional area	Match

3	A 1-03	Southeast Tianjin Agro-fishery area	South harbor industrial zone east sea area, harbor anchorage south sea area. E 38° 38 ' 15 " N at 117 ° 45 ' 00 ; E 38°45'27 " N at 117 °45'00 ; E 38°45'23 " N at 117 ? 58'09 " ; E 38° 53 ' 53 " N at 117 ° 58 ' 14 " ; A 118 degree 05 ' 44 " E38° 52 ' 37 " N ; At 118 ? 05 ' 33 " E38° 38 ' 32 " N.	Agro-fishery area	53632	0	Suitable for aquaculture sea, fishery resource conservation and fishing operations; the northern sea is compatible with waterway; the southern sea is compatible with small-scale platform oil and gas exploration and submarine cable pipelines. Strictly restrict the change of the natural attributes of the sea area; prohibit the land reclamation and the construction of structures and structures that hinder the maritime traffic; reserve certain waters on both sides of the channel for fishing activities; pay attention to coordination with the functional areas of the neighboring provinces.	Focus on the protection of offshore aquatic spawning grounds and migratory species, and the restoration of China's shrimp, Portunus trituberculatus, economic species and shellfish resources ; In the East China Sea, the expansion of barracuda, economic shellfish and other fishery resources. Strengthen the monitoring of oil spills and pollution discharge at sea to prevent pollution accidents ; Sea water quality is not inferior to the second standard, marine sediment quality and marine life quality is not inferior to the first standard ; Marine activities such as oil and gas exploitation, navigation channels and cable pipelines should ensure the requirements of marine environmental quality management in agro-fishery areas.	East 2.6 km	Match The land for Receiving terminal has been formed, the LNG ship uses the existing channel in Dagang Port area, and the influence scope of the construction of the terminal hydraulic structure is limited to the vicinity of the construction area. The wastewater and solid waste generated during the operation period of the project are collected and treated centrally, and no pollutants are discharged directly into the sea. Match The land for the receiving terminal has been formed. The LNG ship enters and exits the port by using the existing channel of Dagang Port Area. Theconstruction impact of the hydraulic structure in the port is limited to the vicinity of the construction area, and disappears with the end of the construction period. There is basically no impact on the agricultural and fishery areas in southeastern Tianjin. The sewage and solid waste generated during the operation period of the project are collected and treated in a centralized manner, and no pollutants are discharged into the sea directly, which is in line with the sea area use management and marine environmental protection requirements of the functional area.

9	A3-03	Gao Sha Ling Industrial and urban sea area	The area east of GaoSha Ling coastline, south of Lingang economic zone, north of Duliujian River treatment line. E 38? 47 ' 46 " N at 117 ? 35 ' 04 ; E 38° 50 ' 36 " N at 117 ° 37 ' 15 " ; E 38° 49 ' 21 " N at 117 ° 43 ' 36 " ; E 38? 47 ' 13 " N at 117 ° 42 ' 22 ".	Industrial and urban sea area	5232	6586	Ensure the use of the sea for industrial and urban construction, and use the sea for compatibility with oil and gas. Under the premise that the basic functions have not been realized, it is compatible with the fishery sea according to the actual situation. It is allowed to moderately change the natural attributes of the sea area, scientifically arrange the sea time series, save intensive use of the sea, optimize the graphic design and shoreline layout of the reclamation, moderately increase the public pro-coastal section, and strengthen dynamic monitoring and tracking management. The embankment reconstruction and landscape restoration will be carried out. The deployment of constructed wetlands will be considered in the park, and an ecological isolation corridor will be built.	Strengthen the dynamic monitoring and tracking management of the project construction area, implement waste, sewage treatment and reuse of water, and strictly guard against the occurrence of marine environmental pollution, disasters and risk accidents. Set the buffer range of the adjacent sea area to strictly control the environmental impact on the adjacent sea area; the sea water quality is not inferior to the standard Class III, and the marine sediment quality and marine biological quality are not inferior to the standard Class II.	North 3.8 km	Match The distance is far away, and there is basically no influence on the functional area, which is in line with the sea area usage management and marine environmental protection requirements of the functional area.
10	A3-04	South Port Industry and Urban Area	The south of the Duliujian river treatment line, the north of the Qingjing Huang treatment line, the east of the coastline and within Nangang industrial zone planning area A 117 ° 36 ' 20 " E38° 45 ' 28 " N ; E 38° 42 ' 32 " N at 117 ° 36 ' 18 " ; E 38° 44 ' 46 " N at 117 ° 38 ' 10 " ; A 117 ° 40 ' 38 " E38° 45 ' 08 " N ; E 38° 43 ' 02 " N at 117 ° 40 ' 39 " ; E 38° 43 ' 01 " N at 117 ° 43 ' 11 " ; E 38° 39 ' 53 " N at 117 ° 43 ' 09 ; E 38° 40 ' 13 " N at 117 ° 33 ' 46 " ; A 117 ° 34 ' 13 " E 38? 45 ' 49 " N.	Industrial and urban sea area	10456	13623	To ensure the use of the sea for Nangang's industrial and urban construction, it is compatible with oil and gas and adopts the sea. Under the premise that the basic functions have not been realized, it is compatible with the fishery sea according to the actual situation. It is allowed to moderately change the natural attributes of the sea area, scientifically arrange the sea time series, save intensive use of the sea, optimize the graphic design and shoreline layout of the reclamation, moderately increase the public pro-coastal section, and strengthen dynamic monitoring and tracking management. Carry out embankment reconstruction and landscape restoration, consider the deployment of constructed wetlands in the park, and construct an ecological isolation corridor	Strictly control the impact on adjacent marine special protection areas and agricultural and fishery areas, properly deploy marine environmental monitoring stations; implement waste, sewage treatment and reuse of water, it is necessary to discharge the sea to reach the standard discharge on the east side, and need to carry out deep drainage Argument. The quality of seawater is not inferior to the standard Class III, and the quality of marine sediments and the quality of marine organisms are not inferior to the Class II. The south side and the east side should be constructed according to the plane layout of the project construction. It is strictly forbidden to discharge and natural inflow to the adjacent functional area.	South 2.3 km West 2.4 km	Match Basically no impact on the functional area, in line with the sea area use management and marine environmental protection requirements of the functional area

15	A 5-05	Gao Sha Ling Tourism Recreation Area	Near Gao Sha Ling, the former beach and the area to the east. A 117 ° 46 ' 20 " E38° 50 ' 07 " N ; A 117 ° 44 ' 37 " E38° 47 ' 13 " N ; A 117 ? 42'22 " E38°47'13 " N ; E 38° 49 ' 21 " N at 117 ° 43 ' 36 " ; It is 117 ? 37 ' 03 " E 38? 51 ' 28 " N.	Tourist Recreation Area	2746	2636	It is suitable for tourism and entertainment in the sea and is moderately compatible with the sea for official duties and yachts; to ensure the safety of industrial water intake and water conveyance corridors, and to prohibit the construction of new sewage outlets. Under the premise that the basic functions have not been realized, it is compatible with the fishery sea according to the actual situation. Strictly restrict the change of the natural attributes of the sea area, rectify and repair the landscape shoreline, and build the landscape ecological trail and the public hydrophilic shore section by relying on the outer embankment.	Destructive development activities are strictly prohibited and domestic garbage should be properly disposed of. Seawater quality, marine sediment quality and marine biological quality are not inferior to Class II standard.	North 3.8 km	Match The distance is far away, and there is basically no influence on the functional area, which is in line with the sea area usage management and marine environmental protection requirements of the functional area.
17	A 6-02	Dagang Binhai Wetland Marine Special Reserve Area	Stable mouth coastline east, south port industrial area south, north line jin jizhi. E 38° 39 ' 53 " N at 117 ° 45 ' 00 ; E 38° 38 ' 15 " N at 117 ° 45 ' 00 ; E 38° 37 ' 28 " N at 117 ° 38 ' 53 " ; E 38° 37 ' 30 " N at 117 ° 32 ' 56 " ; E 38° 39 ' 49 " N at 117 ° 31 ' 55 " ; At 117 ? 33 ' 46 " E38° 40 ' 13 " N.	Marine protected area	7633	8206	Ensure that the marine protected areas use the sea, are compatible with the exploitation of fishery resources and the sea for submarine cable pipelines, and prohibit the construction of new sewage outlets. Strictly restricting the change of the natural attributes of the sea area, the fishery infrastructure depends on the land space, and the fishing boats are docked and the sheltered waters remain open. Gradually rectify the intertidal zone pattern in the estuary area, ensure the flood control management requirements, and prohibit the construction of permanent structures and structures that impede flooding in the Qingjing Yellow and North Drainage River control lines to ensure the safety of flood discharge.	Focus on protecting coastal wetlands, shellfish resources and their habitats, and restore the tidal wetland ecological environment and shallow sea biodiversity gene pool. Strengthening environmental monitoring, seawater quality is not inferior to Class II standard, marine sediment quality and marine biological quality are not inferior to Class I standard; marine activities such as oil and gas cable pipelines should ensure environmental quality management requirements for marine special protected areas.	South 8.1 km	Match The distance is far away, and there is basically no influence on the functional area, which is in line with the sea area usage management and marine environmental protection requirements of the functional area.
21	A 8-02	Gao Sha Ling East Reservation Area	Located east of Gaoxaling. E 38° 46 ' 22 " N at 117 ° 58 ' 09 " ; A 117 ° 44 ' 09 " E38° 46 ' 26 " N ; A 117 ° 46 ' 20 " E38° 50 ' 07 " N ; E 38? 47 ' 09 " N at 117 ? 58 ' 10 ".	Reserved area	8164	0	Strengthen management and limit development within the zoning period. It is strictly forbidden to develop at random. If it is necessary to change the natural attributes of the sea area for development and utilization, the "Divisions" should be modified first, and the functions of the reserved areas should be adjusted and submitted for approval according to the procedures.	The quality of the marine environment should be maintained at a level not inferior to the status quo.	North East 2.75 km	Match There is no development activity in this functional area, and the functional area has basically no impact, which is in line with the sea area usage management and marine environmental protection requirements of the functional area.

1.3.3 Compliance with " Program Adjustment for LNG Terminal Operation Area in Dagang Port Area of Tianjin Port "

In this project, one LNG berth will be built on the west side of the existing LNG berth, and the berth length will be 380m. A working boat berth will be built on the south side of the LNG berth. The land area that has been reclaimed from the rear of the berth. It will be used to construct LNG receiving terminal, arrange LNG tank areas, pipe corridors and corresponding ancillary facilities. The layout of the project is in line with the requirements of the “Tianjin Port Dagang Port Area LNG Terminal Operation Area Planning Adjustment".

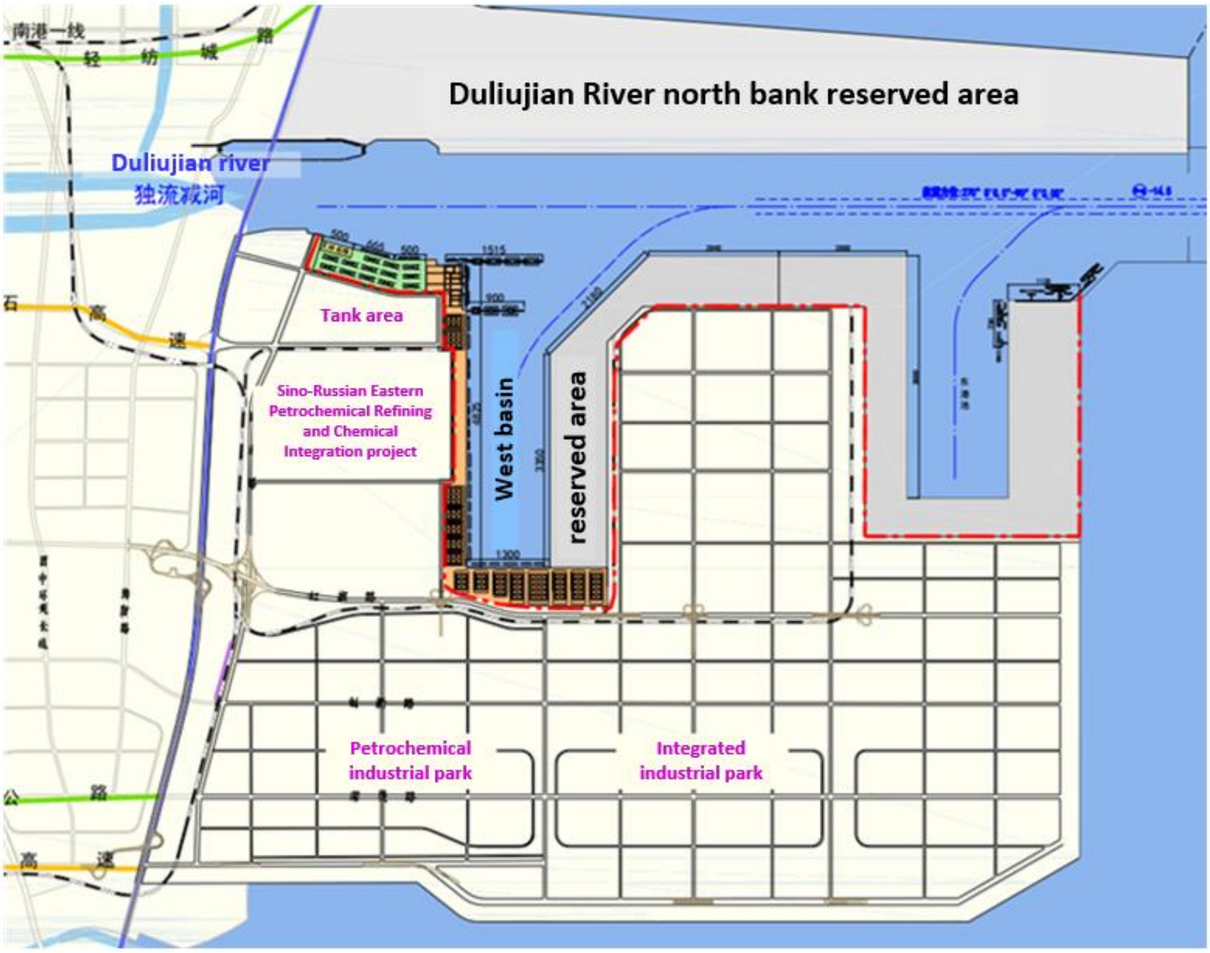


Figure 1.3-2 Adjustment Plan of LNG Terminal Operation Area in Dagang Port Area of Tianjin Port

1.3.4 Compliance with the Red Line of Tianjin Marine Ecological Protection

The project does not have any development activities in the Tianjin Dagang coastal wetland red line area, which meets the requirements of the control measures of the red line area; according to the environmental impact analysis in the previous section, the project construction and normal operation will not directly affect the red line area. The coastal wetlands, shellfish resources and their habitats protected by the district have no impact. Therefore, this project is in line with the Tianjin Marine Ecological Protection Red Line.

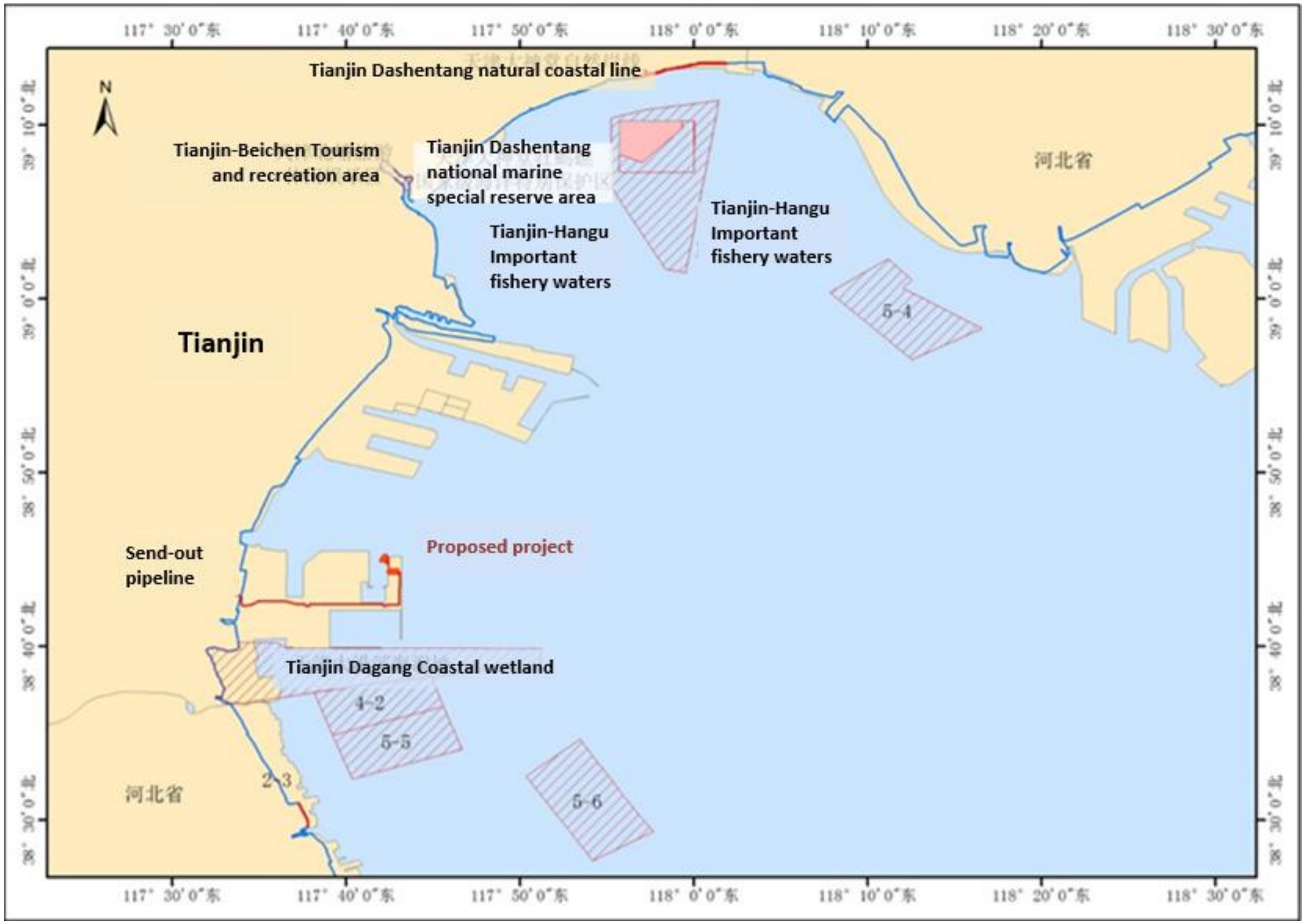


Figure 1.3-3 Distribution map of marine ecological red lines in the sea area near the project (Hebei and Tianjin)

1.3.5 Conformity with " Tianjin Ocean Main Function Area Planning "

This project is all located in the optimized development area, located in the Dagang Port area of Tianjin Port, and will further promote the process of optimizing the layout of the marine space in the Nangang industrial area, in line with the " Tianjin Ocean Main Functional Area Plan ".

1.3.6 Conformity with " Environmental functional zoning of Tianjin coastal waters "

The project is located in four types of environmental functional areas, in line with the Tianjin coastal area environmental functional zoning.

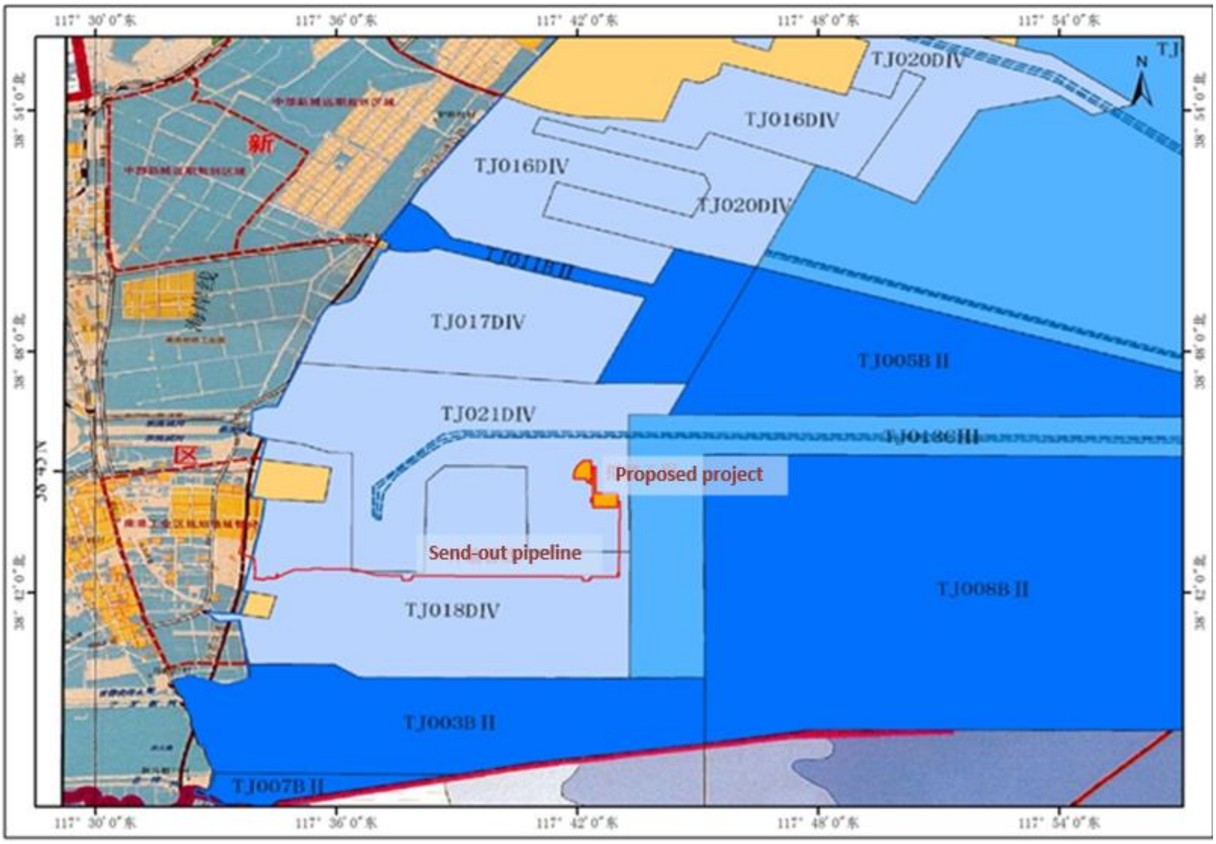


Figure 1.3-4 zoning map of environmental function of Tianjin coastal waters

1.3.7 Compliance with the Implementation Plan of Tianjin Marine Ecological Environment Protection

The project does not involve the newly-enclosed reclamation and does not occupy the natural shoreline. The pollutants generated by the inbound vessels are received and processed by qualified units, and the construction of the LNG operation area will cause certain loss of fishery resources. The construction unit will use the relevant funds to carry out ecological compensation based on the relevant assessment report. For the construction of the terminal's emergency capability, the corresponding oil spill emergency equipment will also be equipped according to the “Requirement for Emergency Preparedness of Water Pollution Accidents at Ports and Terminals” (JT/T451-2017). At the same time, the construction of this project in Dagang Port Area is also in line with the positioning of the development of petrochemical industry in Nangang Industrial Zone. In summary, the project meets the main mission requirements of the Tianjin Marine Ecological Environmental Protection Implementation Plan and is consistent with the plan.

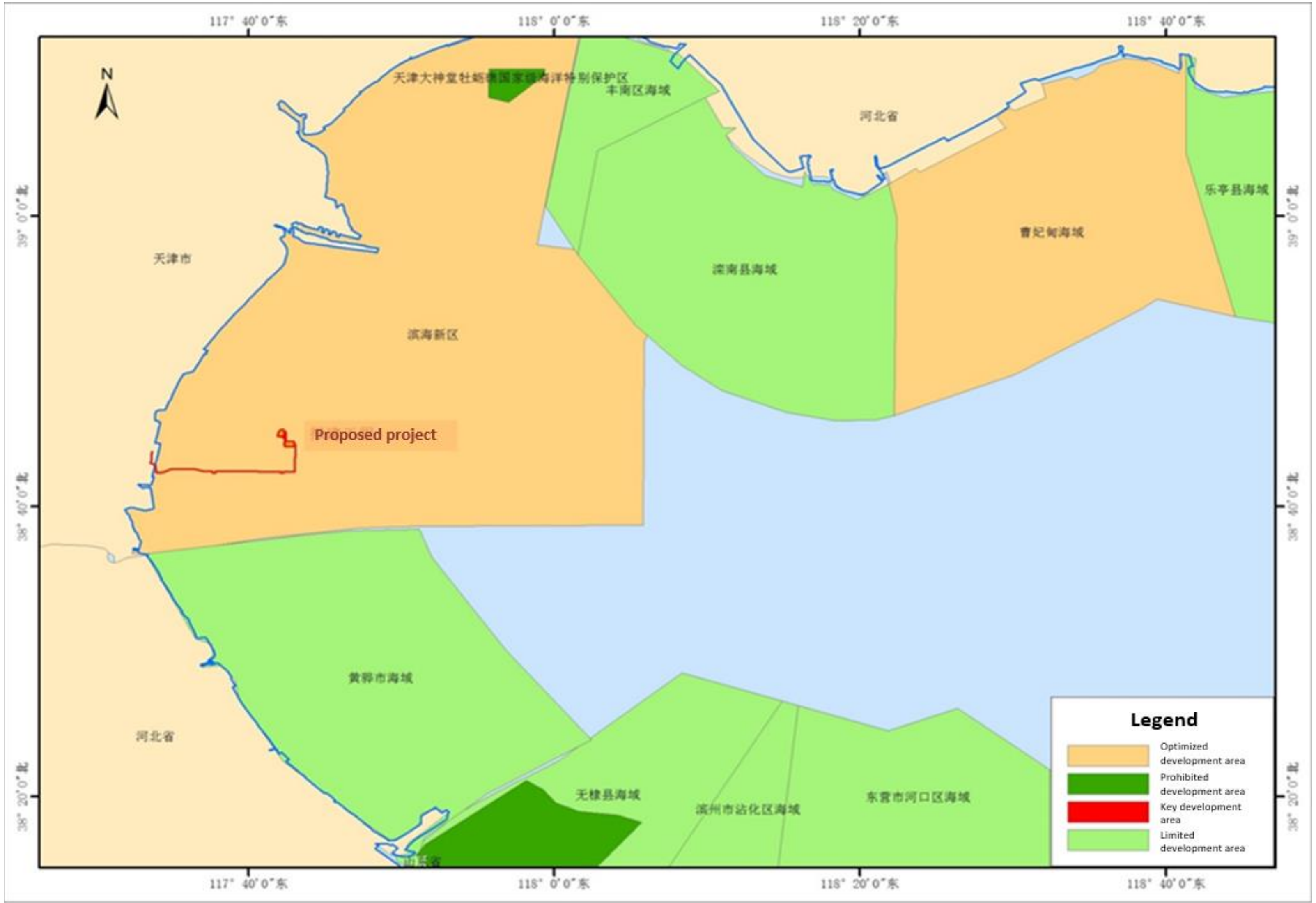


Figure 1.3-5 Position relationship of main marine functional area planning map in the sea area where the port is located

1.3.8 Conformity with " Tianjin " No.13rd 5-Year " Ecological Environment Protection Plan

The project can meet the specific environmental protection requirements of the " the 13rd 5-Year " ecological environment protection plan of Tianjin, and is in accordance with the plan.

1.3.9 Conformity with " Environment Protection No 13rd 5-Year Plan of Tianjin Binhai New Area"

The project can meet the specific environmental protection requirements of the "13rd 5-Year " plan of Tianjin Binhai New Area, which is in accordance with the plan.

Table 1.3-2 Conformance Analysis of Projects with "No.13rd 5-Year " Ecological Environment Protection Plan in Tianjin

Project	Ecological Environment Protection Plan of "No.13rd 5-Year" in Tianjin	This project	Conformity analysis
Improve ambient air quality	Increase the proportion of clean energy use. Implement natural gas supply and supporting pipe network protection to ensure the completion of the change of fuel.	To improve the LNG transportation capacity in Tianjin and the whole Bohai Sea area, and provide guarantee for natural gas supply.	Match
	All coal-fired boilers in the central city, including the coal-fired boilers, Binhai New Area and Huancheng District, all 35 steam tons and below, and all coal-fired boilers with 10 steam tons and below were cleared.	Receiving terminal adopts gas-fired boiler	Match
	Conduct air pollution control of ships, establish a list of air pollution sources for ships in Tianjin Port and implement dynamic updates, promote the implementation of ship shore power and low-sulfur oil measures, and promote the renewal or clean-up of port operations machinery. Carry out surveillance of marine pollution of drones and severely crack down on illegal sewage discharges.	In accordance with the requirements of the "13rd 5-Year " plan, this evaluation will put forward measures and requirements for setting up port air pollution source discharge list and implementing dynamic updating, promoting the construction of the power project on the shore, using qualified fuel oil for inbound and outbound vessels, and prohibiting illegal discharge of ships.	Reconcile
	Strict industrial park planning EIA review and tracking evaluation system	Planned to conduct environmental assessment	Match
Improving water body environmental quality	Actively control ship pollution, and forcefully discard ships exceeding the service life according to law, and strictly implement relevant environmental protection standards for national ships and their facilities and equipment.	The LNG ships entering the port are mainly 14-180,000 square ships, which can meet the national environmental protection requirements of ships.	Match
	Incorporate the sanitation facilities and sewage treatment facilities of ports and ship repair plants into urban facilities	The oily sewage, domestic sewage and garbage discharged by the inbound vessels shall be received and treated by the port area or a	Match

	construction planning. Strengthen the supervision of ship pollution discharge environment, and discharge the oily sewage and domestic sewage from ships to the corresponding pollution discharge standards.	qualified company, and shall not be discharged.	
	Enhance the ability of port terminal pollution prevention, speed up the construction of garbage receiving, transshipment and treatment facilities, and improve the ability of receiving and disposing of oily sewage, chemical washing water, and emergency response to pollution accidents.	This project does not involve chemical washing water, but other liquefaction terminals in Dagang Port Area have the ability to receive and dispose of chemical washing water and pollution accidents.	Match
Protect First, Promote Ecological Restoration	Construction of constructed wetlands and ecological banks in Nangang Industrial Zone. Increase the remediation and restoration of the wetland habitats in the estuary of the sea, and focus on the restoration works at the estuaries such as Haihe River, Duliujian River and Ziyaxin River.	The artificial wetland has been constructed in Nangang Industrial Zone, and the ecological embankment and the river estuary restoration project are pending.	Match
	Strengthen the protection of marine biodiversity in the city, and actively promote the construction of marine blue and pastures in the Hanyu agricultural and fishery areas and the agricultural and fishery areas in southeastern Tianjin through measures such as proliferation and release, artificial reefs, etc., and restore major marine life such as barracuda, economic shellfish and prawns. Habitats where resources are bred and grown.	Ecological compensation has been reserved for the existing projects in Dagang Port Area.	Match
	Strictly implement the relevant regulations on the prohibition and restriction of the implementation of reclamation in the core areas of the marine nature reserve, buffer zones, ecologically sensitive and sensitive areas, and strengthen the management and supervision of reclamation.	The reclamation of Dagang Port Area does not involve marine nature reserves, ecologically sensitive areas, etc.	Match
	Promote the remediation and restoration of marine ecological environment. Use coastal reinforcement, vegetation revetment and artificial seawall to renovate the Great Shentang, the central fishing port, the Nangang Industrial Zone and other shores to enhance the coast's ability to withstand natural disasters.	The safety level of the East Breakwater in Nangang Industrial Zone is Grade 2, and the design wave adopts the design wave element of the 50-year return period, which meets the protection standard of 50 years and can effectively improve the ability to withstand natural disasters.	Match

Manage and Control the Whole Course, Strengthen Environmental Risk Prevention	Establish an early warning and monitoring platform for heavy chemical parks such as typical venture source enterprises, Lingang Economic Zone and Nangang Industrial Zone.	The LNG project has been built with flammable gas detector and hazard source monitoring system (distributed control system for Receiving terminal process control, safety instrument system, fire and gas leakage alarm system, emergency parking system, process package control system, storage and transportation) Monitoring and management system, tank area data collection and anti-rolling prediction system, vehicle loading monitoring management system, intelligent instrument equipment management system, unit monitoring system). This evaluation suggests that the project should also build a corresponding early warning monitoring platform.	Match
	Strengthen emergency management of emergency environmental incidents. Improve the emergency response plan management system at the city and district levels, deepen the emergency coordination mechanism for sudden environmental incidents across regions and departments, and improve the comprehensive emergency rescue system. Establish and improve the on-site command and coordination system for sudden environmental incidents, and improve the information reporting and disclosure mechanism for sudden environmental incidents. Regularly carry out emergency drills for sudden environmental incidents, achieve unified command and coordination of environmental emergency response, unified resource allocation, and unified data management, improve the emergency level of environmental emergencies, and ensure rapid response to emergencies. Supplement and improve marine pollution emergency facilities and equipment, build pollution emergency resource management system and marine pollution prevention and control monitoring platform, and improve marine environmental pollution emergency response capabilities.	The emergency plan for marine pollution accidents in Tianjin Nangang Industrial Zone and the maritime search and rescue emergency plan for Nangang Industrial Zone have been prepared, and the emergency command, prevention and early warning, emergency response, information release, post-disposal, safeguard measures, training and exercises have been clearly defined. Description. The established LNG project has also prepared risk assessment report, emergency material investigation report and emergency response plan for emergencies. This evaluation suggests that the project should also prepare a corresponding risk assessment report and emergency plan.	Match
of Environ mental Governa nce and	Establish a list of air pollution sources for ships in Tianjin Port and implement dynamic updates;		
	Promote the use of shore power and low-sulfur oil for ships		
	Promote the renewal or clean-up of port operations machinery	Evaluation requires port operations machinery to use clean energy	Reconcile

	All the industrial agglomeration areas of the city have realized centralized treatment of sewage and installed automatic online monitoring devices.	All domestic sewage and production sewage generated by the LNG receiving terminal are sent to the sewage treatment plant of Nangang Industrial Zone for centralized treatment. The sewage plant is equipped with automatic online monitoring device.	Match
	Newly built reclaimed water supply pipe network to improve the utilization rate of reclaimed water in the city	The Nangang Industrial Zone Reclaimed Water Plant has been completed and has the conditions to provide reclaimed water. This evaluation requires the project to build a reclaimed water supply network.	Reconcile
	Implement the coastal water pollution control program and strictly control the total discharge of major pollutants into the sea. Clean up illegal or unreasonable sewage outlets		
Landscape forest field lake ecological engineering	Strictly observe the marine ecological red line, the marine natural shoreline has a minimum of 18 kilometers	Unoccupied natural shoreline and marine ecological red line	Match
	Complete the construction of the ecological wetland park in Nangang Industrial Zone	Built	Match

Table 1.3-3 Conformance Analysis of Project with "No.13rd 5-Year " Plan for Environmental Protection of Tianjin Binhai New Area

Project	Environmental Protection "No.13rd 5-Year" Plan of Tianjin Binhai New Area	Adjustment of LNG Terminal Operation Area Planning Scheme in Dagang Port Area of Tianjin Port	Conformity analysis
Strengthening prevention and control of coastal area pollution	To strengthen the pollution control of port ships, the discharge of oily wastewater and domestic sewage from ships will meet the corresponding pollution discharge standards. The residual oil and waste oil of the ship will be recycled according to the regulations, and it is forbidden to discharge into the water body. It is forbidden to dump the ship's garbage into the water body and gradually carry out the monitoring of ship pollutant discharge. .	The oily sewage, domestic sewage and garbage discharged by the inbound vessels shall be received and treated by the port area or a qualified company, and shall not be discharged.	Match
	Strengthen the port terminal pollution prevention and control capabilities, and guide the operators of ports, terminals, and loading and unloading stations to formulate contingency plans for preventing and controlling the polluted water environment of ships and related activities.	The emergency plan for marine pollution accidents in Tianjin Nangang Industrial Zone and the maritime search and rescue emergency plan for Nangang Industrial Zone have been prepared, and the emergency command, prevention and early warning, emergency response, information release, post-disposal, safeguard measures, training and exercises have been clearly defined. Description.	Match
	Improve the ability of receiving and disposing of oily sewage, chemical washing water, etc.	The established LNG project has also prepared risk assessment reports, emergency materials investigation reports and emergency response plans for emergencies.	Match
Promoting prevention and control of motor vehicle and ship pollution	To build a database of air pollution source emissions inventory of Tianjin port ships, improve the proportion of shore power usage of port ships, comprehensively promote the use of low-sulfur oil for ships, and reduce air pollution emissions from port ships.	This evaluation suggests that the project should also prepare corresponding risk assessment reports and emergency plans.	Match

1.4 Main environmental issues and environmental impacts of project characteristics and concerns

The main environmental issues concern in the project evaluation are the exhaust gas, wastewater, noise generated by the project construction phase and operation phase, and the impact of solid waste on the surrounding environment, and the rationality of site selection. Among them, the gas pipeline project, the transport medium is clean natural gas, and the environmental impact is mainly concentrated in the construction period. This evaluation combines the characteristics of the construction project, the impact of the jetty construction on the marine environment, the impact of the gas pipeline construction on the ecological environment along the line, the impact of the outlet of the receiving terminal during the project operation period on the marine environment, and the pollutants in the project exhaust gas. The impact of the atmospheric environment and environmental risk assessment are the focus. The main concerns are: the environmental impact of the project gas pipeline crossing on the Beidagang Wetland Nature Reserve, the ecological red line, and the permanent ecological protection area, the environmental feasibility of the pipeline route and site selection, environmental protection measures, and operation period. Risk prevention measures.

The main environmental impacts of this project are :

During the construction period of the project, the focus of this evaluation is the impact of pollutants generated during construction and construction on seawater quality, marine sediments and marine ecological environment. After analysis and prediction, the impact of the project construction on hydrodynamic conditions The main performance is the depth of the dredging area. The influence of the project implementation on the tidal field is mainly reflected by the influence of the deep convection on the flow state and the flow velocity. The magnitude and scope of the impact are small and will not affect the surrounding hydrodynamic environment.

The reclamation of the land area of the project has been completed, and only the depth of the harbor basin will have a slight impact on the sedimentation and sedimentation environment of the sea area. According to the numerical simulation results, it is known that the flow area of the Nangang Industrial Zone is relatively large and the waves are not covered, resulting in obvious erosion of the shoal waters, especially the north side of the navigation channel, and the navigation channel as a whole shows back siltation along the way. The maximum silt of the main channel is roughly located at the junction of the Donggangchi Channel, and the siltation is gradually reduced along the axis of the Donggangchi Channel. It will not have a significant impact on the scouring and silting environment near the project; the adverse impact on the marine ecological environment during the construction period is mainly the negative impact of the construction of hydraulic structures, dredging and water intake, and the main impact is the dredging construction on benthic organisms. The adverse effects of zooplankton and phytoplankton and the impact of suspended solids on fishery resources. The spread of suspended solids will not adversely affect the protection objectives. In response to various aspects of the impact, this assessment proposes ecological construction needs and At the same time, the project has developed an ecological restoration plan to compensate and repair the marine ecological environment; in addition, the wastewater receiving treatment during the construction period is not directly discharged, and will not directly adversely affect the surrounding seawater quality environment; Waste and domestic garbage are collected and transported to the waste treatment plant for disposal, avoiding direct discharge into the sea, and will not adversely affect the marine environment.

During the project operation period, the focus of this evaluation is on the impact of various pollutants in the project's exhaust gas on the atmospheric environment, the impact of seawater cold drainage caused by open rack vaporizer (ORV) on the marine environment, LNG unloading and Environmental risk levels and risk prevention measures during storage and transportation. According to the forecast and analysis, the contribution concentration of each pollutant in the exhaust gas emitted during the project operation period has not exceeded the standard. With the implementation of the regional reduction plan, the regional ambient air quality is improved overall after the project is completed, and the impact on the atmospheric environment is acceptable; In the spring, summer and autumn open rack vaporizer (ORV), the residual chlorine and temperature difference in the seawater cold drainage will not have a significant impact on the seawater quality; at the same time, according to the analysis and calculation of the project environmental risk, after the project has a LNG leakage accident, The influence range of methane diffusion in air is small, and the main influence range is in the plant area. After the flashover accident of LNG leakage, the influence range of associated/secondary NO2 diffusion is mainly concentrated within the 60m boundary of the plant area, and there is no environmental sensitive target within the scope; After the ship has an oil spill accident, it will have certain impact on the marine environment. The project has formulated corresponding risk prevention measures and equipped with corresponding risk emergency materials and equipment to prevent such accidents.

This evaluation focuses on environmental risk assessment during the operation period. The main issues of concern are: atmospheric environmental impacts and environmental protection measures, and risk prevention measures during the operation period.

1.5 Main findings of the environmental impact report

The LNG receiving terminal project is economic and social development in the Beijing-Tianjin-Hebei region, and the demand for clean energy such as LNG continues to grow. The implementation of the “Beijing-Tianjin-Hebei and surrounding areas 2017 air pollution prevention action plan” and the “Northern winter clean heating plan (2017) -2021) and the “Overall Plan for Gas Source Reconstruction of Coal to Gas in Winter in the Key Areas of Northern China” to accelerate the promotion of the “coal to gas” project in parts of North China. In line with the "Opinions of the General Office of the Ministry of Transport on Printing and Distributing the Key Layout of LNG Terminals in the Bohai Rim Region (2022)" and the Ministry of Ecology and Environment" on the "Environmental Impact Report on the Adjustment of the Plan for the LNG Terminal Operation Area of Tianjin Port Dagang Port Area" (Circular [2019] No. 35), "Tianjin Marine Main Functional Area Planning", "Tianjin Marine Functional Zoning (2011-2020)", "Tianjin Coastal Sea Environmental Functional

Zoning", "Tianjin Ecology" Protection Red Line, Tianjin Marine Ecological Red Line, Tianjin Marine Ecological Environmental Protection Implementation Plan, Tianjin 13th Five-Year Ecological Environmental Protection Plan, and Tianjin Binhai New Area Environmental Protection 13th Five-Year Plan Claim".

After the completion of the project, it can promote the development of the local economy and society. The environmental protection measures to be adopted are technically sound and economically feasible. Meet the basic principles of standard discharge, total quantity control, and cleaner production. The environmental quality status near the proposed site is suitable for project construction. The environmental impact prediction results show that the project construction has little impact on the surrounding environment, and the site selection is reasonable from the perspective of environmental protection.

Therefore, under the conditions of comprehensively strengthening supervision and management, strictly implementing the “three simultaneous” environmental protection system and conscientiously implementing various environmental protection measures, from the perspective of environmental protection, the construction of this project is feasible.

2 General provisions

2.1 Basis of preparation

2.1.1 National laws on environmental protection

（1）Environmental Protection Law of the People's Republic of China (April 2014);

（2）Law of the People's Republic of China on Environmental Impact Assessment (December 2018);

（3）Law of the People's Republic of China on Prevention and Control of Water Pollution (2017 Revision) ;

（4）Law of the People's Republic of China on Prevention and Control of AtmosphericPollution (October 2018);

（5）Law of the People's Republic of China on Prevention and Control of Pollution from Environmental Noise (2018) (December 2018);

（6）Law of the People's Republic of China on the Prevention and Control of Environment Pollution Caused by Solid Wastes (2016 Revision) ;

（7）Law of the People's Republic of China on Water and Soil Conservation (March 2011);

（8）Marine Environment Protection Law of the People's Republic of China (2017 Revision);

（9）Land Administration Law of the People's Republic of China (August 2004);

（10）Fisheries Law of the People's Republic of China (August 2004);

（11）Forest Law of the People's Republic of China (January 2011);

（12）Agricultural Law of the People's Republic of China (January 2013);

（13）Urban and Rural Planning Law of the People's Republic of China (April 2015);

（14）Grassland Law of the People's Republic of China (June 2013);

（15）Wild Animal Conservation Law of the People's Republic of China (July 2016);

（16）Law of the People's Republic of China on Ports (2017 Amendment) ;

（17）Law of the People's Republic of China on the Administration of Sea Area (January 2001);

（18）Maritime Traffic Safety Law of the People's Republic of China (2016 Revision);

（19）Law of the People's Republic of China on Flood Control (2017 Amendment) ;

（20）Law of the People’s Republic of China on Work Safety (November 2011);

（21）Clean Production Promotion Law of the People's Republic of China (June 2002);

（22）Circular Economy Promotion Law of the People's Republic of China (October 2010);

（23）Energy Conservation Law of the People's Republic of China (October 2018);

（24）Emergency Response Law of the People's Republic of China (November 2017);

（25）Oil and Natural Gas Pipeline Protection Law of the People's Republic of China (October 2010).

（26） Law of the People's Republic of China on the Prevention and Control of Occupational Diseases (December 2018);

（27）Labor Law of the People's Republic of China (December 2018).

2.1.2 Relevant national regulations and documents

（1）Opinions of the CPC Central Committee and the State Council on Accelerating the Construction of Ecological Civilization (No.12 [2015], CPC Central Committee) ;

（2）Notice on Further Strengthening of Environmental Impact Assessment Administration and Environmental Risk Prevention (No.77 [2012], State Environmental Protection Administration) ;

（3）Notice on the Effective Strengthening Risk Prevention and Strict Environmental Impact Assessment Administration (No.98 [2012], State Environmental Protection Administration) ;

（4）Notice of Issuing the Measures for the Administration of Contingency and plans and recordation for environmental emergency for Enterprises and Public Institutions (for Trial Implementation) (No.4 [2011], State Environmental Protection Administration)

（5）Measures on environmental emergency response management (The Ministry of Environmental Protection, June 2015) ;

（6）Three-Year Action Plan to Win the Battle for a Blue Sky (No. 22 [2018], State Council) ;

（7）Notice of the State Council on Issuing the Air Pollution Prevention and Control Action Plan (No. 37 [2013], State Council);

（8）Notice of the State Council on Issuing the Action Plan for Prevention and Control of Water Pollution (No. 17 [2015], State Council) ;

（9）Notice of the State Council on Issuing Soil Pollution Prevention and Control Action Plan (No. 31 [2016], State Council) ;

（10）Circular of the State Council on the Issuing of 13th Five-Year Plan for the Protection of Ecological Environment (No. 65 [2016], State Council) ;

（11）Notice of the State Council on the Issuing the Outline of the Plan for Ecological Protection in China (No. 151 [2016], Enviromental Ecology)

（12）Regulations on the Implementation of Water and Soil Conservation Law of the People's Republic of China (No. 130, [1993], State Council) ;

（13）Regulations of the People's Republic of China on the Dumping of Wastes at Sea (No. 545 [2018], State Council) ;

（14）Regulations of the People's Republic of China on the Protection of Basic Farmlands (2011.1) ;

（15）Regulations of the People's Republic of China on the Administration of River Courses (2017.3) ;

（16）Regulations of the People's Republic of China on Wild Plants Protection (1997.1) ;

（17） Administrative Regulation on the Prevention and Control of Pollution Damages to the Marine Environment by Coastal Engineering Construction Projects of the People's Republic of China (No.507 [2007] State Council) ;

（18）Regulations of the People's Republic of China on the prevention of Pollution Damage to the Marine Environment by Land-Based Pollutants (No. 61, [1990], State Council) ;

（19）Regulation on the Prevention and Control of Vessel-induced Pollution to the Marine Environment (Order No. 561 of the State Council [2009], 2017 revision) ;

（20）Implementation Programme for Promoting the Construction of Transportation Ecological Civilization (No. 45, [2017], the Ministry of Transport) ;

（21）Opinions of the Ministry of Transport on the Implementation of " comprehensively Tightening Ecological and Environmental Protection and resolutely and victoriously fight the uphill battle for Prevention and Control of Pollution " (No. 81, [2018], the Ministry of Transport) ;

（22）Implementation Plan on the Special Campaign to Prevent and control of Pollution for Vessel and Ports (2015-2020) (No. 133, [2015], the Ministry of Transport) ;

（23）Implementation Plan for Ship Emission Control Areas in the Pearl River Delta, Yangtze Delta, and Bohai Sea (Beijing-Tianjin-Hebei) Water areas (No. 177 [2015], the Ministry of Transport) ;

（24）MARPOL 73 / 78 and its annexes I, II, IV, V, and VI ;

（25）Notice on Issues Concerning the Implementation and Planning Environmental Impact Assessment of Transport Sector (No. 457 [2004] the Ministry of Transport) ;

（26）Regulations of the People's Republic of China on Administration of Sea Lanes(No. 545,[2008], State Council) ;

（27）Regulations of the People's Republic of China on Nature Reserves (2017 revision) ;

（28）Regulations on the Safe Management of Hazardous Chemicals (No. 344, [2002], State Council, Revision 2013.12) ;

（29）Measures for the Administration of Permit for Operation of Dangerous Wastes (No. 408, [2004], State Council, Revision 2013.12) ;

（30）Directory of National Hazardous Wastes (Order No. 39 of the Ministry of Environmental Protection, 1 August 2016) ;

（31）Announcement on Issuing the Guidelines for environmental impact assessment of hazardous wastes in construction projects (No.43,2010, the Ministry of Environmental Protection)

（32）Regulation on the Administration of Construction Project Environmental Protection (October 2017) ;

（33）Catalog of Guidance on Industrial Restructuring (Order No. 21 of the National Development and Reform Commission [2013]) ;

（34） Provisions on the Administration of Domestic Water Transport (Order No. 5 of the Ministry of Transport [2015]) ;

（35）Interim Measures for the Administration of Aquatic Germplasm Resources Conservation Zones (Order of the Ministry of Agriculture [2011] No. 1) ;

（36）Classified Administration Catalogue of Environmental Impact Assessment of Construction Projects (implemented on 1 September 2017), 18 April 2018, Decision on Amending certain content of Classified Administration Catalogue of Directory of Classification Management for Environmental Impact Assessment of Construction Projects;

（37）Official Reply on the Master Plan of the Tianjin Port (2011-2030) (No. 800 [2011] the Ministry of Transport) ;

（38）Review of the Environmental Impact Report on the Master Plan of the Tianjin Port (Letter No. 90 [2011] of the State Environmental Protection Administration) ;

（39）Notice by the General Office of the Ministry of Transport of issuing on the Key Layout Plan for LNGReceiving Terminal in the Bohai Rim (2022) (Review No 92 [2018] of the State Environmental Protection Administration) ;

（40）Review opinions on Environmental Impact Report on Planning Scheme Adjustment of LNG Terminal Operating Area in Dagang Port Area of Tianjin Port (Review No 35 [2019] of the State Environmental Protection Administration) ;

（41）Measures for Public Participation in Environmental Impact Assessment (Order No. 4 of the Ministry of Ecology and Environment) ;

（42）Notice on coordinating the environmental impact assessment system and the emission permits system ([2017] 84, 环办环评) ;

（43） Notice on issuing Work Plan for the Prevention and control of volatile organic compounds during the 13th Five-Year Plan period (NO.121 [2017] the Ministry of Environmental Protection)

（44）Implementation Opinions on Tightening Interim and Ex-Post Regulation of Environmental Impact Assessment of Construction Projects (EIA No. 11 [2018] of the State Environmental Protection Administration) ;

（45）Notice on Strengthening Protection of Coastal Wetlands and Strict Control of Reclamation (No 24 [2018], State Council) ;

（46）Notice by the Ministry of Natural Resources on Further Clarification of Requirements for addressing the historical legacy of reclamation (Regulation No.7 [2018] of the Ministry of Natural Resources) ;

（47）Notice on Further Strengthening the protection of aquatic Biological Resources and Strict Environmental Impact Assessment Management (No 86[2013] State Environmental Protection Administration) ;

（48）Notice by the State Forestry Administration on forest land use issues related to oil and gas pipeline construction (No 105 [2010] the State Forestry Administration) ;

（49）Notice by the State Forestry Administration and the Ministry of Finance on issuing the Measures for Administration of National Public Forests (No1162 [2013] the State Forestry Administration)

（50）Notice by nine ministries and commissions including the National Development and Reform Commission of Issuing the Guiding Opinions on Strengthening the control of Resource environment ecological red line, (No.11662 [2016] on the Environment and Resources Issued by the National Development and Reform Commission).

2.1.3 Local regulations and documents

（1）Regulations of Tianjin Municipality on Environmental Protection 28 November 2017 Amendment) ;

（2）Regulations of Tianjin Municipality on the Administration of River Courses (effective October 1, 2011) ;

（3）A decision on Amending the regulations of Tianjin Municipality on Marine Environment Protection, (November 27, 2015)

（4）Regulations of Tianjin Municipality on the Prevention and Control of Atmospheric Pollution (1 March 2015) ;

（5）Regulations of Tianjin Municipality on the Prevention and Control of Water Pollution (1 March 2016) ;

（6）Administrative Measures of Tianjin Municipality on Prevention and Control of Pollution From Environmental Noise (No. 6 of the Tianjin Municipal People's Government [2003]) ;

（7）Measures for the Administration of Environmental Protection of Construction Projects in Tianjin Municipality (No. 20 [2015] of the Tianjin Municipal People's Government) ;

（8）Measures for the Prevention and Control of Hazardous Wastes Pollution in Tianjin Municipality (1 July 2004) ;

（9）Notice on the issuance of technical requirements for the standardization of pollution source sewage outlets. (No 57 [2007] of Tianjin Environmental Protection Supervision）

（10）Official Reply on nearshore environmental function zoning (Letter No. 66 [2013] of the Tianjin Municipal People's Government) ;

（11）Reply of the State Council on the marine functional zoning in Tianjin Municipality (2011-2020) (No. 159 [2012] State Council) ;

（12）Letter of issuing on Applicable zoning of Acoustic quality standard in Tianjin Municipality (New version) 》(Letter 590 [2015] of Tianjin Enviromentl Protection)

（13）Notice on the Issuing of the Clean Air Action Plan in Tianjin Municipality (No.35 [2013] of the Tianjin Municipal People’s Government) ;

（14）Notice on Issuing and Implementing the report of Marine ecological red line region in Tianjin Municipality (No 164 [2014]164 of Marine enviroment of Tianjin）

（15）Decision of the Standing Committee of the Tianjin Municipal People's Congress to Ratify the Delineation of permanent ecological protection areas s (1 March 2014) ;

（16）Notice of the Tianjin Municipal People's Government on Issuing Provisions on Administration of Tianjin Municipality for the Permanent Ecological Protection Areas (No. 13 [2014] of the Tianjin Municipal People’s Government) ;

（17）Notice of the General Office of the Tianjin Municipal People's Government on Issuing the Implementation Plan for the Protection of the Marine Ecological Environment in Tianjin Municipality (letter No.47 [2018]from the Tianjin Administrative Office of the Tianjin Municipal People’s Government) ;

（18）Letter from the Municipal Environmental Protection Bureau on the Implementation of Special Emission Restrictions on Atmospheric Pollutants in Key Industries (Letter No 388 [2017] of Tianjin Enviromentl Protection,26 September 2017) ;

（19）Notice of the Municipal Environmental Protection Bureau on the Specific Requirements for the Implementation of coherence between the Environmental Assessment Document and the Emission Permit System (Note No22 [2018] of Tianjin Enviromentl Protection, 15 January 2018) ;

（20）Notice of the Tianjin Municipal People's Government on Issuing the Red Line for Ecological Protection of Tianjin Municipality (Tianjin Municipal People's Government, 3 September 2018).

（21）Letter on issuing the Implementation Plan for the Prevention and control of volatile organic compounds during the 13th Five-Year Plan period(Letter No 18 [2018] of Tianjin Enviromentl Protection）.

（22）Noticer of Tianjin Municipal People's Government on Issuing the main functional zone planning for the marine areas of Tianjin Municipality (No. 8 [2017] Tianjin Municipal People's Government) ;

（23）Notice of the Municipal Development and Reform Commission on the Issue of Plan for Protection of the Ecological Environment in Tianjin Municipality during the 13th

Five-Year Plan period (Plan No. 335 [2017] of Tianjin Municipal Development and Reform Commission) ;

（24）Regulations of Tianjin Municipality on Wild Animals Protection (28 November 2017 Amendment) ;

（25）Regulations of Tianjin Municipality on the Protection of Wild Plants (24 May 2006).

2.1.4 Technical Guidelines and Related Standards

（1）Technical Guidelines for Plan Environmental Impact Assessment-General principles (HJ 2.1-2016) ;

（2）Technical Guidelines for Environmental Impact Assessment-Atmospheric Environment (HJ 2.2-2018) ;

（3）Technical Guidelines for Environmental Impact Assessment-Surface-water environment (HJ 2.3-2018) ;

（4）Technical Guidelines for Environmental Impact Assessment on the Sound Environment (HJ 2.4-2009) ;

（5）Technical Guidelines for Environmental Impact Assessment -Groundwater Environment (HJ 610-2016) ;

（6）Environmental Impact Assessment Technical Guidelines-Soil Environment (On Trial) (HJ 964-2018) ;

（7）Technical Guidelines for Environmental Impact Assessment-Ecological Impact (HJ19-2011) ;

（8）Technical Guidelines for Environmental Risk Assessment of Construction Projects (HJ 169-2018) ;

（9）Standard for Environmental Impact Assessment of Port Construction Projects (JTS 105-1-2011) ;

（10）Technical Specifications for Emergency Monitoring in Abrupt Environmental Accidents (HJ 589-2010) ;

（11）Identification of Major Hazard Installations for Hazardous Chemicals (GB 18218-2018) ;

（12）Classification method for environmental accident risk of an enterprise (HJ 941-2018) ;

（13）National Catalogue of Hazardous Wastes (effective 1 August 2016) ;

（14）Identification standards for solid wastes General rules (GB 34330-2017) ;

（15）Requirements on preparedness capabilities to pollution incidents at waters for ports and terminals (JT/T 451-2017) ;

（16）Design Code of Environment protection for Port Engineering (JTS 149-1-2007) ;

（17）Technical Guidelines for Environmental Risk Assessment of Oil Spill on Water (JT/T 1143-2017) ;

（18）Technical guidelines for the preparation of the Red Line for Ecological Protection, the Bottom Line for Environmental Quality, the Upper Line for Resource Utilization and the Negative List of Environmental Access (On Trial).

2.1.5 Relevant planning and zoning documents

（1）Key Layout Plan for LNG Receiving Terminal in the Bohai Rim Region (2022) (No. 92 [2018] Traffic planning) ;

（2）Outline of the 13th Five-Year Plan for National Economic and Social Development of Binhai New Area of Tianjin.

（3）Marine Functional Zonings of Tianjin Municipality (2011-2020) (No. 159 [2012], State Council) ;

（4）The Red Line for Ecological Protection of Tianjin Municipality (No. 21 [2018] of of the General Office of Tianjin Municipal People’s Government) ;

（5）Report of Tianjin Municipality on the Red Line Area of Marine Ecology (No. 164 [2014] Marine ennviroment of Tianjin) ;

（6）Planning of Tianjin Municipality Major Marine Functional Zoning (No. 8, [2017] of of the General Office of Tianjin Municipal People’s Government) ;

（7）Nearshore Environmental functional zoning of Tianjin Municipality (letter No.66 [2013] of the General Office of Tianjin Municipal People’s Government) ;

（8）Implementation Plan for the Protection of the Marine Ecological Environment in Tianjin Municipality (letter No.47 [2018] of the General Office of Tianjin Municipal People’s Government) ;

（9）Plan for Protection of the Ecological Environment of Tianjin Municipality during the 13th Five-Year Plan period (Plan No. 335 [2017] of Tianjin Municipal Development and Reform Commission) ;

（10）Plan for Protection of the Ecological Environment of Binhai New Area of Tianjin during the 13th Five-Year Plan period

（11）Planning Scheme Adjustment of LNG Terminal Operating Area in Dagang Port Area of Tianjin Port, Planning and Research Institute of Ministry of Transportation, August

2018.

2.1.6 Technical data

（1）Feasibility Study of Beijing Gas Group-Tianjin Nangang LNG Emergency Reserve Project - Auxiliary Terminal Project (Volume 3, Section 1), CCCC First Harbor Consultants Co., LTD in January 2019 ;

（2）Feasibility Study of Beijing Gas Group-Tianjin Nangang LNG Emergency Reserve Project- LNG Terminal Specification, China Petroleum Pipeline Engineering Co., Ltd., January 2019 ;

（3）Feasibility Study of Beijing Gas Group-Tianjin Nangang LNG Emergency Reserve Project -Specification of Pipeline Projects, China Petroleum Pipeline Engineering Co., Ltd., January 2019 ;

（4） Numerical modeling of Tidal Current -Auxiliary Terminal project of Beijing Gas Group-Tianjin Nangang LNG Terminal. , Nanjing Hydraulic Research Institute, September 2018 ;

（5）Numerical modeling of cooling water discharge of the Auxiliary Terminal project of Beijing Gas Group-Tianjin Nangang LNG Terminal, Nanjing Hydraulic Research Institute, September 2018 ;

（6）Geotechnical Investigation Report on the ground treatment of Tianjin LNG Terminal Emergency Reserve Project, Beijing Gas Group Ltd., December 2018 ;

（7）Geological investigation report on the Auxiliary Terminal of the Beijing Gas Group-Tianjin Nangang LNG Emergency Reserve Project. , Tianjin Institute of Geotechnical Investigation Surveying, December 2018 ;

（8）Measuring Technique Report on Auxiliary Terminal of the Beijing Gas Group-Tianjin Nangang LNG Emergency Reserve Project. , CCCC First Harbor Consultants Co., LTD, December 2018

（9）Demonstration Report on Sea Area Use of Beijing Gas Group-Tianjin Nangang LNG Emergency Reserve Project. (Draft for Approval), Guangdong Sanhai Environmental Protection Technology Co. Ltd., May 2019 ;

（10）Environmental Impact Assessment in the marine environment of Beijing Gas Group-Tianjin Nangang LNG Emergency Reserve Project. (for review), Guangdong Sanhai Environmental Protection Technology Co. Ltd., August 2019 ;

（11）Special Demonstration Report on the Impact of Beijing Gas Tianjin Nangang LNG Emergency Reserve Project on the National Aquatic Germplasm Resources Protection

Area of Laizhou Bay in the Bohai Bay of Liaodong Bay, Yellow Sea Fisheries Research Institute, Chinese Academy of Fishery Sciences, February 2019.

2.1.7 AIIB related requirements

(1）Definitions

• Client means the recipient of the Bank financing for a Project and any other entity responsible for implementation of the Project.

• Project means the specific set of activities for which the Bank financing is provided, as defined in the agreement governing such financing, regardless of the financing instrument or the source of such financing or whether the Project is financed in whole or in part by the Bank.

The Environmental and Social Framework comprises：

•Environmental and Social Policy (ESP). This comprises mandatory environmental and social requirements for each Project.

•Environmental and Social Standards. Three associated mandatory environmental and social standards (ESSs) set out more detailed environmental and social requirements relating to the following:

ESS 1：Environmental and Social Assessment and Management;

ESS 2：Involuntary Resettlement; and

ESS 3：Indigenous Peoples.

•Environmental and Social Exclusion List. The Bank will not knowingly finance a Project that involves activities or items specified in this list (Exclusion List).

Scope of Application：The ESP applies to all Projects. The Bank requires each Client to manage the environmental and social risks and impacts associated with its Project in a manner designed to meet the ESP and the applicable ESSs in accordance with the environmental and social management plan (ESMP), and environmental and social management planning framework (ESMPF), as applicable, required for the Project under this ESP and ESSs.

(2) Categories

The Bank assigns each proposed Project to one of the following four categories:

•Category A. A Project is categorized A if it is likely to have significant adverse environmental and social impacts that are irreversible, cumulative, diverse or unprecedented. These impacts may affect an area larger than the sites or facilities subject to physical works and may be temporary or permanent in nature. The Bank requires the Client to conduct an environmental and social impact assessment (ESIA)or equivalent environmental and social assessment, for each Category A Project and to prepare an ESMP or ESMPF, which is included in the ESIA report for the Project. The ESIA for a Category A Project examines the Project’s potentially negative and positive environmental and social impacts, compares them with those of feasible alternatives (including the “without Project” situation), and recommends any measures needed to avoid, minimize, mitigate, or compensate for adverse impacts and improve environmental and social performance of the Project.

•Category B. A Project is categorized B when: it has a limited number of potentially adverse environmental and social impacts; the impacts are not unprecedented; few if any of them are irreversible or cumulative; they are limited to the Project area; and can be successfully managed using good practice in an operational setting. The Bank requires the Client to conduct an initial review of the environmental and social implications of the Project. On the basis of this review, the Bank, in consultation with the Client, determines the appropriate instrument for the Client to assess the Project’s environmental and social risks and impacts, on a case-by-case basis. The Bank may determine that an environmental and social assessment or another similar instrument is appropriate for the Project. The scope of the assessment may vary from Project to Project, but it is narrower than that of the Category A ESIA. As in the case of a Category A Project, the assessment examines the Project's potentially negative and positive environmental impacts and recommends any measures needed to avoid, minimize, mitigate, or compensate for adverse impacts and improve environmental performance of the Project.

•Category C. A Project is categorized C when it is likely to have minimal or no adverse environmental and social impacts. The Bank does not require an environmental and social assessment, but does require the Client to conduct a review of the environmental and social implications of the Project.

•Category FI. A Project is categorized FI if the financing structure involves the provision of funds to or through a financial intermediary (FI) for the Project, whereby the Bank delegates to the FI the decision-making on the use of the Bank funds, including the selection, appraisal, approval and monitoring of Bank-financed subprojects. The Bank requires the FI Client, through the implementation of appropriate environmental and social policies and procedures, to screen and categorize subprojects as Category A, B or C, review, conduct due diligence on, and monitor the environmental and social risks and impacts associated with the Bank-financed subprojects, all in a manner consistent with this ESP. A Project categorized as FI is also subject to: (a) the Environmental and Social Exclusion List and applicable host country national laws for all the Bank-financed subprojects; and (b) the applicable ESSs for the Bank-financed subprojects that are classified as Category A subprojects (and if the Bank so determines, some or all of the Bank-financed subprojects that are classified as Category B subprojects).

(3) Environmental and Social Assessment

When the Bank has determined, in consultation with the Client, that the Project has potentially adverse environmental or social risks and impacts, it requires the Client:

•To conduct an environmental and social assessment relating to these risks and impacts, and design appropriate measures to avoid, minimize, mitigate, offset or compensate for them, all as required under ESS 1.

•If the Project would result in Involuntary Resettlement, to address this in the social section of the assessment report, complemented by more in-depth coverage, as required under ESS 2. The Client covers Involuntary Resettlement in a resettlement plan or resettlement planning framework (RPF), which is provided to the Bank as a freestanding document, an annex to the assessment report, or incorporated into the report as a recognizable element.

•If the Project would affect Indigenous Peoples, to address this in the social section of the assessment report, complemented by more in-depth coverage, as required under ESS 3. The Client covers impacts on Indigenous Peoples in an Indigenous Peoples plan or Indigenous Peoples planning framework (IPPF), which is as a freestanding document, an annex to the assessment report, or incorporated into the report as a recognizable element.

(4) Involuntary Resettlement.

Involuntary Resettlement.：Involuntary Resettlement covers physical displacement (relocation, loss of residential land or loss of shelter) and economic displacement (loss of land or access to land and natural resources; loss of assets or access to assets, income sources or means of livelihood)

The Bank screens each Project to determine whether or not it involves Involuntary Resettlement (which covers both physical and economic displacement, as defined in ESS 2). Where it is not feasible to avoid Involuntary Resettlement, the Client is required to ensure that resettlement activities are conceived and executed as sustainable development programs, providing sufficient resources to enable the persons displaced by the Project to share in Project benefits.

If the Project involves Involuntary Resettlement, the Bank requires the Client to prepare a resettlement plan or RPF (as applicable) that is proportional to the extent and degree of the impacts. The degree of impacts is determined by: (a) the scope of physical and economic displacement; and (b) the vulnerability of the affected people. The resettlement plan or RPF complements the broader coverage of social risks and impacts in the environmental and social assessment and provides specialized guidance to address the specific issues associated with Involuntary Resettlement, including land acquisition, changes in land use rights, displacement and need for livelihood restoration.

The Bank does not endorse illegal settlement; however, it recognizes that significant populations already inhabit both urban and rural land without title or recognized land rights in its countries of operation. Given this situation, the Bank requires the Client to ensure that

displaced persons without title to land or any recognizable legal rights to land, are eligible for, and receive, resettlement assistance and compensation for loss of non-land assets, in accordance with cut-off dates established in the resettlement plan, and that they are included in the resettlement consultation process.

Associated Facilities. Associated facilities (Associated Facilities) are activities that are not included in the description of the Project set out in the agreement governing the Project,but that the Bank determines, following consultation with the Client, are: (a) directly and materially related to the Project; (b) carried out or planned to be carried out, contemporaneously with the Project; and (c) necessary for the Project to be viable and would not be constructed or expanded if the Project did not exist.

Associated Facilities Controlled or Not Controlled by the Client. The Bank requires the Client, as part of its environmental and social assessment, to identify and assess the potential environmental and social risks and impacts of Associated Facilities, as follows:

•To the extent the Client controls or has influence over the Associated Facilities, the Bank requires it to take the following actions: (a) the Client is required to comply with the requirements of the ESP and ESSs with respect to such facilities, to the extent of its control or influence; and (b) if the Associated Facilities are financed by another multilateral development bank or bilateral development organization, the Bank may rely on the requirements of such other development partner in place of all or some of the requirements set out in the ESP and ESSs, provided that, in the Bank’s judgment, such requirements do not materially deviate from what would otherwise be required under the ESP and ESSs.

•If the Client does not control or have influence over the Associated Activities, it identifies in the environmental and social assessment the environmental and social risks and impacts the Associated Facilities may present to the Project.

•The Client is required to demonstrate, to the Bank’s satisfaction, the extent to which it does not exercise control or have influence over the Associated Facilities by providing details of the relevant considerations, which may include legal, regulatory and institutional factors.

(5) Involuntary Resettlement

Avoid Involuntary Resettlement wherever possible; minimize Involuntary Resettlement by exploring Project alternatives; where avoidance of Involuntary Resettlement is not feasible, to enhance, or at least restore, the livelihoods of all displaced persons in real terms relative to pre-Project levels; to improve the overall socioeconomic status of the displaced poor and other vulnerable groups; and to conceive and implement resettlement activities as sustainable development programs, providing sufficient resources to enable the persons displaced by the Project to share in Project benefits.

2.1.8 World Bank related requirements

The designated contractors and their subcontractors participating in the Yakou Shipping Hub project will follow the World Bank's corresponding environmental and social security policies, especially with reference to the following business policies/World Bank procedures.

OP/BP 4.01 Environmental Assessment

OP/BP 4.04 Natural Habitat

OP/BP 4.11 Material Cultural Resources

OP/BP 4.12 Involuntary Immigration

BP 17.50 Information Disclosure

Environmental, Health and Safety (EHS) Guidelines, International Finance Corporation (IFC) and World Bank Group

2.2 Identification of environmental impacts and Screening

The LNG receiving terminal is located within Tianjin Nangang Industrial Zone. According to the access requirements in the "Tianjin Petrochemical Industry Regulation Structure to Promote Transformation and Benefits Implementation Plan" (November 2017), the new petrochemical project must enter the Nangang Industrial Zone. The planning of environmental assessment has been carried out at the time of the establishment of the industrial zone.

The jetty of the project is located in the LNG terminal operation area of Dagang Port Area of Port of Tianjin. According to the "LNG Terminal Operation Area Planning Scheme Adjustment of Dagang Port Area of Tianjin Port", the location of the basin of the project has been determined in the planning stage of the port area.

2.2.1 Identification of environmental parameters

The major environmental impacts of the construction of the receiving terminal of this project are shown in Table 2.2-1below.

Table 2.2-1 Identification of environmental impact parameters of the receiving terminals

Evaluation phases	Environmental components	Evaluation Parameters	Enviroemntal impacts and Characterization	Sigificance
Construction	Marine ecological environment	Benthos	Port project occupation	++
		fish eggs and larvae	Port project occupation & Diffusion of Suspended Sediment Caused by offshore Construction	+
		Plankton	Port project occupation & Diffusion of Suspended Sediment Caused by offshore Construction	+
		nekton	Port project occupation & Diffusion of Suspended Sediment Caused by offshore Construction	+
	Seawater quality	SS	Diffusion of Suspended Sediment Caused by Offshore Construction	+
			Wastewater from washing sand and gravel in onshore construction site; Wastewater from the production of Prefabricated concrete parts and curling	+
		Petroleum	Oil polluted water from	+

			ships and construction machineries	
		COD, NH3-N	Human-produced sewage from Ships and Land Construction workers	+
	Hydrology	Tidal current	Engineering construction	++
	Acoustic environment	Noise	Construction machinery, equipment, vehicles, ships	+
	Atmospheric environment	TSP	Sand and stone stacking, vehicle transportation, cement unpacking, concrete mixing station	+
		Welding fume	Welding operation	+
		Volatile organic compounds	Spray painting operation	+
		NOX, CO, total non-methane hydrocarbons, etc.	Construction machinery, equipment, vehicles, ship engine exhaust emission	+
	Solid waste	Spoil and slag	Construction waste	+
		Onshore domestic waste	Onshore construction workers	+
		Waste from welding rod and slag	Welding operation	+
		Garbage from Ships	On-board life and maintenance	++
		Paint residue & Paint bucket	Spray painting operation	++
		Waste oil	Treatment of Washing Wastewater from Construction Machinery	++
		Waste engine oil	Maintenance of machinery and equipment	++
Operation	Atmospheric environment	methane & total non-methane hydrocarbon	The Unorganized Volatile Gas from the Interface of loading/unloading pipelines, Equipment and Pipeline, Flange Interface and Various Gate Valves	+
		Organized SO2, NOx, dust and so on under normal	Natural Gas Combustion of Gas-fired Boiler and Immersion Combustion Gasifier	++

		operating conditions		
		Unorganized SO2, NOx, dust	natural gas combustion from Canteen stove	+
		Oil smoke	Canteen cooking	+
		CO, NO2 and total non-methane hydrocarbons, etc.	Exhaust emission of Maritime transport and vehicles in factories	+
	Water environment	Temperature drop	Cooling water process	+ +
		Residual chlorine	Cooling water process	+ +
		COD, NH3-N	Domestic sewage of ship and staff on land	+
		Petroleum	oil polluted water from ship engine room, machinery reparation, washing water from working platform and wastewater from ground washing at the potentially polluted site	+ +
	Sound environment	Noise	Handling Pump, compressor, gasifier, etc	+
	Solid waste	Domestic garbage	Land crew	+
		Filter of Seawater intake pump house	Water intake pump house filtering	+
		Marine Domestic Waste, Marine Maintenance Waste	Ship operation and maintenance	+ +
		Sludge of comprehensive sewage treatment station	Sewage treatment of comprehensive sewage treatment station	+
		Machine oil cotton yarn	Maintenance of machinery and vehicles	+
		Waste oil sludge	Oily sewage treatment	+ +
		Waste engine oil	Vehicle and equipment maintenance	+ +
	Marine ecological environment	Entrainment	Seawater pumping	
		Temperature drop	Water cooling process	+ +
		Residual chlorine	Seawater dosing	+ +
		Oily sewage	Production and life	+

		and domestic sewage		
+ The environmental impac parameters and evaluation factors are less or less affected and need to be analyzed and predicted briefly. ++ The influence degree of the environmental impact parametesr and evaluation factors is moderate, and conventional impact analysis and prediction are needed. +++It is suggested that the environmental impact pamaters and evaluation factors are more sensitive or sensitive, and need to focus on impact analysis and impact prediction.				

2.2.2 Screening

The evaluation parameters are screened according to the contents, the identification and characterization of environmental impact parameters and the degree of the influence.

Table 2.2-2 Environmental Impact Assessment Parameters for Terminals and Receiving Terminals of Projects

Sequence number	Environmental components		Evaluation parameters	Prediction parameter
1	Terrestrial environment	Atmospheric environment	SO 2, NO 2, PM 10, PM 2.5, total non-methane hydrocarbon, methane	SO, 2, NO 2, Non-methane Total Hydrocarbon, Smoke and Smoke
		Sound environment	Laeq	Laeq
		Solid waste	General wastes, marine wastes, hazardous wastes	-
		Environmental risk	-	Methane, CO
2	Marine environment	Seawater quality	PH, DO, COD, petroleum, inorganic nitrogen, active phosphate, sulfide, copper, lead, zinc, cadmium, nickel, mercury, arsenic, chromium, volatile phenol, cyanide, benzene series, vinyl chloride, 1, 2-dichloroethane	Construction phase SS
		Marine sediment	Organic carbon, sulfide, petroleum, lead, cadmium, arsenic, copper, chromium, mercury, zinc	-
		Marine ecology	Chlorophyll a, phytoplankton, zooplankton, benthos	Ecological loss, temperature drop, residual chlorine
		marine biological quality	Zinc, chromium, copper, lead, cadmium, arsenic, mercury	-
		Solid waste	General wastes, marine wastes, hazardous wastes	-
		Environmental risk	Ship oil spill	Fuel oil
			Secondary Pollution Caused by Leakage Accident of LNG Pipeline in Receiving terminal	Methane, NO 2

2.3 Grading and scoping

According to the relevant requirements of the AIIB Environmental and Social Framework, the AIIB's Environmental and Social Policy (ESP) and Environmental and Social Standards (ESS) will apply to the project. ESS1, Environmental and Social Assessment and Management, and ESS2, involuntary resettlement apply to the project. According to AIIB's ESP, the project is classified as a category A considering the potential impact of the project's expectations on environmental and social risks. For category A projects, an environmental and social impact assessment (ESIA) is required for the project.

2.3.1 Surface water environment

(1) Grading

According to the Technical Guidelines for Environmental Impact Assessment, Surface Water Environment (HJ 2.3-2018), the receiving terminal of this project is concerned with " using seawater as the regulating temperature medium, displacement< 5000,000 m3/d, evaluation grade II " ; The terminal of this project is featured as a hydrologic impact-type, with the vertical projection area and the extension range are $A1 \leq 0.15$ km 2, and its evaluation grade is III, the disturbed bottom area is 3 km2>A2>0.5 km2, and its evaluation grade is II.

Based on above analysis, it is determined that the evaluation grading of the surface water environmental of this project is Level II.

(2) Scoping

The scope of the surface enviromental assessment is bounded by the outer edge of the jetty and the receiving terminal, eastward to the breakwater gate of the Dagang port area, south to the southern boundary of the Dagang coastal wetland marine special protection zone, north to the ocean The Gaoshaling tourism and recreation area delineated in the functional zoning, westward to the coastline, the total area of evaluation is about 389.85km2.

2.3.2 Groundwater environment

According to the requirements of "Technical Guidelines for Environmental Impact Assessment-Groundwater Environment " (HJ 610-2016), the grade of groundwater environmental impact assessment shall be determined according to the category of the construction industry and the level of Groundwater environmental sensitivity.

（1） Categorization of construction industry

According to the feasibility study, the main construction project of the project includes new LNG terminal, workboat terminal , LNG storage tank and send-out pipeline. Reference to the provisions of the Industry Categorization Table of the Subsurface Water Environmental Impact Assessment in the Technical Guidelines for Environmental Impact Assessment-Groundwater Environment (HJ 610-2016), new LNG Storage Tank for Gas Storage is categorized as “Class IV project”; Oil and gas and liquid chemical terminal is categorized as “Class II project”; Natural gas pipeline is in categorized as “Class III project”.

（2） The level of environmental sensitivity

This LNG receiving terminal project is located in the coastal intertidal zone (tidal flat), which is created from the land reclamation on the tidal flat . There are neither groundwater source protection or quasi-protection zone used to supply centralized drinking water nor decentralized drinking water source in the project area and the downstream of the groundwater flow. Therefore, according to the level of the environmental sensitivity specified in the Technical Guidelines for Environmental Impact Assessment-Groundwater Environment (HJ 610-2016), groundwater environmental sensitivity is " insensitive ".

According to " Technical Guidelines for Environmental Impact Assessment-Groundwater Environment" (HJ 610-2016), the level of environmental sensitivity of the LNG receiving terminal is " insensitive ". Therefore, the project’s component which is categorized as IV may not carry out the groundwater impact assessment but qualitative analysis of groundwater environmental impact during construction and operation phases; Wherease the project’s component is categorized as II, the evaluation grade of groundwater environmental impact is Level III.

(3) Scoping

According to the "Groundwater Guide", the Level III evaluation scope is ≤6km2, combined with the hydrogeological conditions of the project site and the distribution of sensitive points near the station site, it is finally determined that the evaluation scope of this station is for the project wall and the side to expand outward 250m .

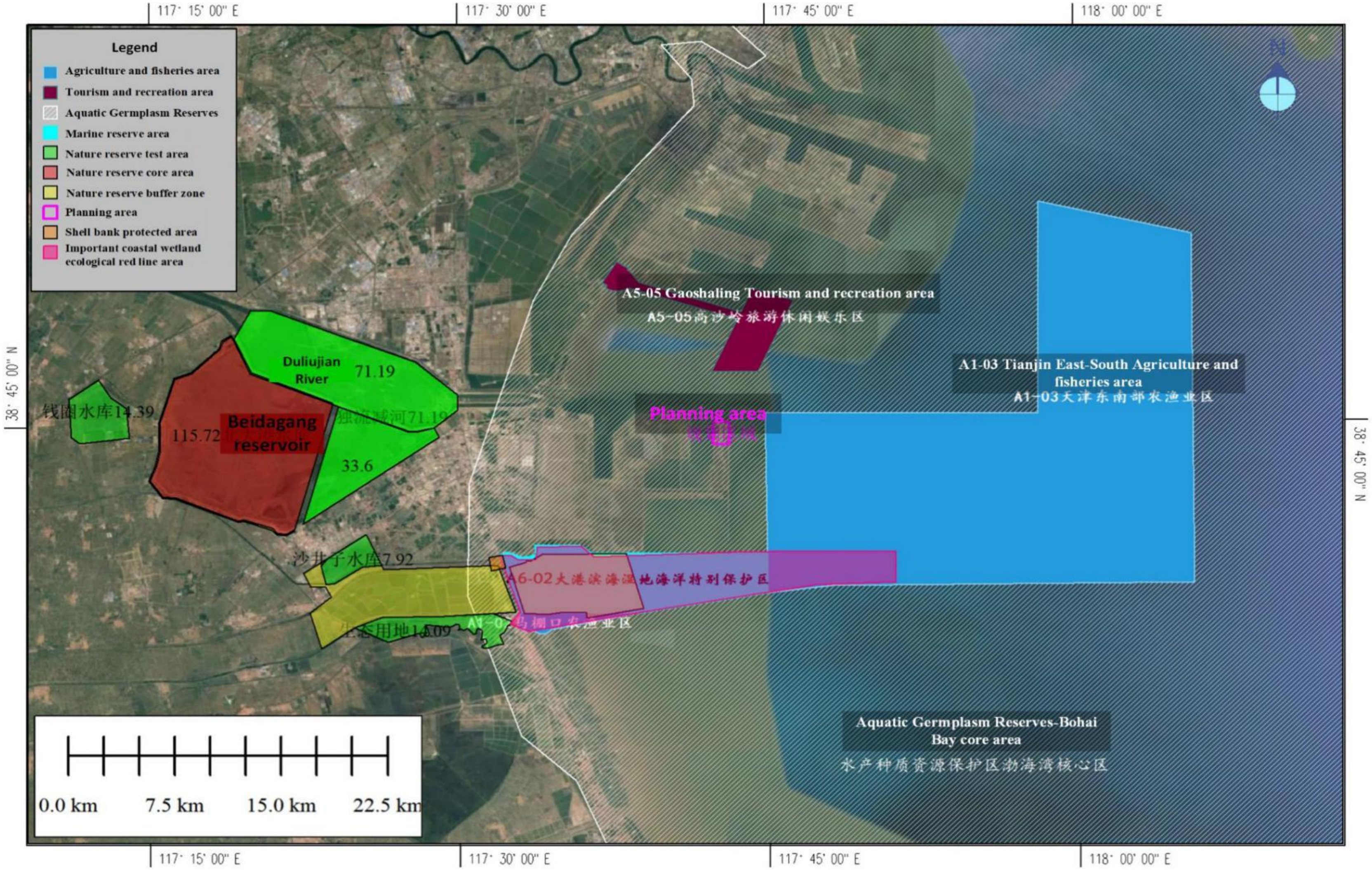


Figure 2.3-1 Scope of Marine Environmental Assessment for this Project (Sept 2018)

2.3.3 Atmospheric Environment

(1) Grading

In this project, the maximum ground concentration (Cmax) of various contaminant from various sources and its occupancy rate (Pmax), and the farthest influence distance D10% corresponding to the ground concentration of various pollutant reaching the standard limit of 10% was calculated. The calcuations are according to discrimination in the evaluation grading in Section 5.3 of "Technical Guidelines for Environmental Impact Assessment-Atmospheric Environment" (HJ2.2-2018), using the pollution source in Engineering Analysis of the Project and the recommended estimation mode (AERSCREEN) of the "Technical Guidelines for Environmental Impact Assessment - Atmospheric Environment" Appendix. According to the calculation results and the Table 2 of the evaluation grade discrimination in "Technical Guidelines for Environmental Impact Assessment - Atmospheric Environment", the evaluation grade is determined. The specific calculation results and the main parameters used are shown in the section on atmospheric environmental impact prediction during the operation period of this report. The evaluation of the evaluation work level is shown in the table below.

Table 2.3-1 Discrimintation in Atmospheric evaluation & grading

Name of pollution source	Sequence number	Contaminant	Cmax (μg/m³)	Evaluation criteria (μg/m³)	P_{MAX} (%)
Receiving terminal	SCV	SO 2	1.3913	500	0.28
		PM 2.5	1.6232	225	0.72
		NOX	11.3365	250	4.53
	Boiler	SO 2	0.814	500	0.16
		PM 2.5	0.9499	225	0.42
		NOX	6.6451	250	2.66
	Flare stacks	SO 2	0.5154	500	0.1
		PM 2.5	1.8141	225	0.81
		NOX	22.7111	250	9.08
	Unorganized emission	Non-methane total hydrocarbon	116.98	2000	5.85
		NOX	3.98	200	0.853
		PM 2.5	0.695	450	0.077

According to the calculation results in the table above, the Pmax of Nox is the largest among various contaminants from various pollution sources, reaching 9.08%<10%. Based on the evaluation grade of Technical Guidelines for Environmental Impact Assessment-Atmospheric Environment (HJ2.2-2018), the evaluation grade of the atmospheric of this project is Grade II.

(2) Scoping

According to HJ 2.2-2018, the scope of the atmospheric environmental impact assessment of the project with Grade II is 5 km. Therefore, the evaluation scope is based on the receiving terminal as the center, the length of 5 km rectangular area as the scope of the assessment of the atmospheric environment.

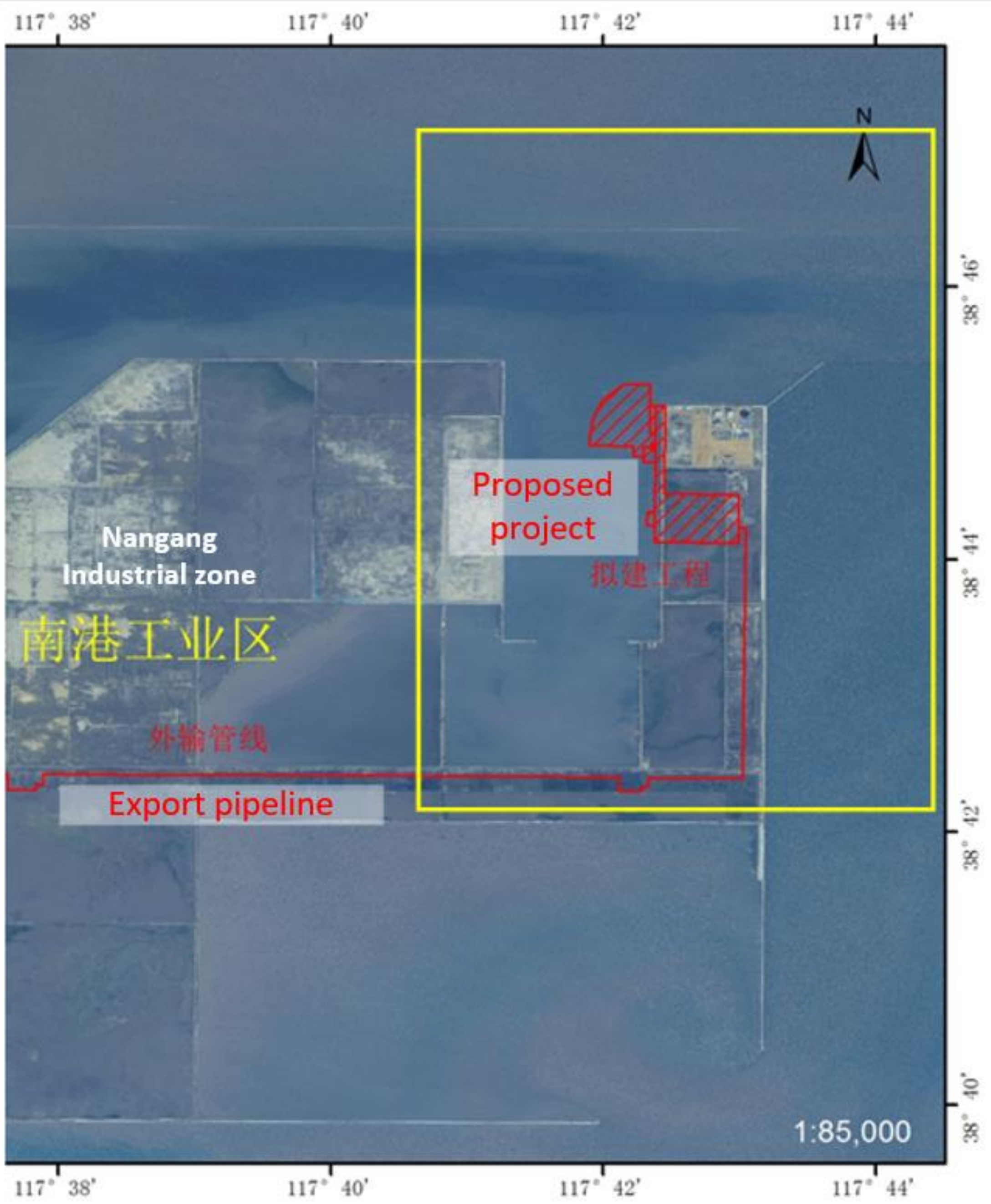


Figure 2.3-2 Schematic of Atmospheric Assessment Scope

2.3.4 Noise

(1) Grading

The grade of sound environmental impact assessment of the project is determined according to the " Technical Guidelines for Environmental Impact Assessment-Sound Environment " (HJ 2.4-2009). The specific basis of the evaluation criteria is shown in Table 2.3-2.

Table 2.3-2 Evaluation criteria for acoustic environmental assessment

Evaluation	Decision basis

grade	Functional zoning of sound environment	Noise level increment of sensitive target within the scope	Number of affected populations
Level I	Category 0 or protected areas with special noise limitations	>5 dB (A)	Manifest
Level II	Categories 1 and 2	≥3 dB (A), ≤5 dB (A)	Increase more
Level III	Categories 3 and 4	Less than 3 dB (A)	Change little

The noise of LNG receiving terminal project during construction phase comes mainly from the construction machinery; And the noise during the operation phase mainly comes from the equipment in the terminal, and the noise in the state of maintenance or accident. According to the on-site investigation, the functional zoning of the sound environment of this project is category 3. Thus, the evaluation grade of the sound environment assessment is level III.

(2) Scope of evaluation

According to the relevant provisions of the Technical Guidelines for Environmental Impact Assessment-Sound Environment (HJ 2.4-2009), the scope of evaluation grade level 2 can be appropriately reduced according to the actual conditions such as the types of sound environment functional areas and sensitive targets in the region and adjacent areas of the construction project. There is no environmental protection objects within the area close to the site boundary . According to the noise prediction results, the predicted boundary noise limits of the plant shall not exceed the category III of the requirement listed in Emisson standard for industrial enterprises noise at boundary (GB 12348-2008) after the project commissioning. It shall achieve target emissions. Therefore, the evaluation scope of the noise environmental impact assessment is defined as 200 m outside the project boundary.

2.3.5 Ecological environment

(1) Grading

①Receiving terminal project

According to the grading classification of the Technical Guidelines for Environmental Impact Assessment-Ecological Impact (HJ19-2011), the grade of ecological impact assessment is set as level III for the receiving terminal of the project , as detailed in Table 2.3-3.

Table 2.3-3 Evaluation criteria for ecological environment assessment of the receiving terminal project

Influence area Ecological sensitivity	Project footprint (including waters)			Basic information of this project	Evaluation grade
	Area ≥20 km 2 Or more than 100 km in length	Area 2 km ~20 km 2 Or 50 km to 100 km in length	Area ≤ 2 km 2 Or length ≤50 km	The project area (waters) of the LNG receiving terminal is 1,296,984 km 2	Level III
Special ecological sensitive	Level I	Level I	Level I	It occupies the key environmental sensitive area of	

area				Laizhou Bay National Aquatic Germplasm Resources Protection Area of Liaodong Bay	
Important ecological sensitive area	Level I	Level II	Level III		
General area	Level II	Level III	Level III		

(2) Scope of evaluation

Taking the outer edge of the project as the boundary, the assessment area is about 389.85 km2, from the east to the breakwater entrance of Dagang Port Area, to the south to the southern boundary of the marine special protection zone of the coastal wetland in Dagang Port, to the north to the tourism and recreation zone demarcated in the marine functional zone, and to the west to the sea area around the coastline.

2.3.6 Soil environment

According to the " Environmental Impact Assessment Technical Guidelines for Soil Environment " (pilot) (HJ 964-2018), the receiving terminal of this project belongs to the " Transportation and Storage Post Industry " in which the terminals and storage of dangerous goods storage tank areas are " Class II Project ". Take into account the LNG receiving terminal of this project is constructed on the reclamation land, the sensitivity of soil environment is " insensitive " and the evaluation grade is level III.

2.3.7 Environmental risk

2.3.7.1 Preliminary Assessment of Environmental Risk Potential

The fuel oil used in the transportation of the proposed project to transport LNG is mainly hydrocarbons. The chemical structure of the fuel oil is mainly composed of three series, namely alkanes group, cycloalkanes group and aromatic (group). There is a difference depending on the composition of the fuel oil. The physical properties of the fuel oil vary with its chemical composition, colors range from dark brown to dark green to black. Fuel oil with high sulfur content gives off a strong, pungent odor; The density of fuel oil is less than that of water. Fuel oil is insoluble in water, but soluble in organic solvents, such as benzene, flavor, ether, trichloromethane, carbon sulfide, carbon tetrachloride, etc., it can also be partially dissolved in alcohol.

Natural gas has a lower density than air, has a very low boiling point (-161.5 ° C), and is almost insoluble in water. The main component of natural gas is methane. In case of natural gas leakage and fire explosion, the fire will be extinguished only after the natural gas combustion is completed according to the actual accident of the transmission pipeline. There is no fire-fighting wastewater generated without water-extinguishing. Thus, the water environment quality and hydrological parameters are basically unaffected under normal production and accident conditions of this project.

This evaluation mainly analyzes the influence of fuel oil leakage and LNG leakage on atmospheric environment.

(1) Analysis of Risk Characteristics of Hazardous Substances and Processing Systems

In accordance with the requirement of Appendix C, the Hazardous classification of Hazardous Substances and Processing Systems (P), in Technical Guidelines for Environmental Risk Assessment of Construction Projects (HJ 169-2018), the ratio of quantity of hazardous substances to critical mass (Q) and industry and production process (M) of the project are determined.

Combined with the characteristics of the project, the processing station and the pipeline between the two nodes that can be controlled are used as a functional unit.

①Ratio of quantity of hazardous substances to critical mass (Q)

Receiving terminal: The main component of natural gas is methane . According to HJ 169-2018, the critical mass of methane is 10t . It is necessary to build 10 natural gas storage tanks of 20000 m3 for this project. Thus, the maximum total Q of hazardous substances in this project is “Q≥100”.

②Industry and production process

Receiving Station: According to Table C.1 in HJ 169-2018, the M score of the storage tank area for hazardous substances is 5/sets. There are 10 storage tanks of this project thus the M value of the industry and production process of the project is " M>20" (M1).

③Hazardous classification of Hazardous Substances and Processing Systems (P)

In accordance with the Technical Guidelines for Environmental Risk Assessment of Construction Projects (HJ 169-2018), Appendix C, Hazardous classification of Hazardous Substances and Processing Systems (P):

Receiving station: Q value belongs to " Q ≥ 100 " and M>20 belongs to M1, so hazard (P) of project hazardous substances and process system is classified as P1.

(2) **Environment sensitive characteristic analysis**

According to the Technical Guidelines for Environmental Risk Assessment of Construction Projects (HJ 169-2018), Appendix D, Classification of Environmental Sensitivity (E), the atmospheric environmental sensitivity of the LNG receiving terminal, station yard and the pipeline are low sensitivity (E3).

(3) Environmental Risk Potential Assessment

According to the harzard of hazardous substances and process systems involved in the construction project and the environmental sensitivity of the site, combined with the environmental impact pathways under the accident, the environmental risk level of the construction project is analyzed in a general way, and the environmental risk potential is determined according to the following table.

Table 2.3-4 Environmental Risk Potential Classification of Construction Projects

Environmental sensitivity (E)	Hazardous substances and process system hazards (P)			
	Extremely high hazard (P1)	High Hazard (p2)	Moderate Hazard (P3)	Minor hazard (P4)
Highly environmentally sensitive area (E1)	IV +	IV	III	III
Environmental sensitivity area (E2)	IV	III	III	II
Low environmental sensitivity area (E3)	III	III	II	I

According to the table above, the atmospheric environmental risk potential of the Receiving terminal is III.

2.3.7.2 Evaluation grading

According to the Technical Guidelines for Environmental Risk Assessment of Construction Projects (HJ 169-2018), the environmental risk potential is determined based on the hazards and environmental sensitivity of the substances and processing systems involved in the construction projects, and the evaluation level is determined according to the following table.

Table 2.3-5 Levels of evaluation work

Environmental risk potential	IV, IV +	**III**	**II**	I
Evaluation grade	**Level I**	**Level II**	**Level III**	Simple Analysis[a]
a: it is a relative detailed evaluation of the contents of the work, in the description of hazardous substances, environmental impact pathways, environmental hazard consequences, risk prevention measures and other aspects of the qualitative description. Note: The project site Q value is 0.107 . According to the Technical Guidelines for Environmental Risk Assessment of Construction Projects (HJ 169-2018), when Q<1, the environmental risk potential is I.				

Based on the above identification results: the atmospheric environmental risk assessment of this environment is Level II; In addition, the LNG unloading involves ship operations. The risk of the ship operation mainly includes the navigation, berthing and unloading. Taking into account the specialty of the industry, the evaluation of the ship operation risk is referring to the requirements of the Technical Specification for Risk Assessment of Vessel-Induced Pollution to the Marine Environment (Trial), the oil and gas and liquid chemical terminals are all Level I. The environmental risk assessment quantitatively predicts the impact of the accident, explains the scope and extent of the impact, and proposes prevention, mitigation and emergency measures.

2.3.7.3 Evaluation scope

Atmospheric Environmental Risk Assessment scope: A rectangular area 5 km from the receiving terminal boundary.

Marine environment risk assessment scope: taking the outer edge of the project as the boundary, eastward to the breakwater gate of the Dagang port area, south to the southern boundary of the Dagang coastal wetland marine special protection zone, north to the marine functional zone delineated Gaoshaling the tourism and recreation area is westward to the sea area surrounding the coastline. The total area of evaluation is about 389.85km2.

2.4 Evaluation criteria

2.4.1 Environmental quality standard

The function zoning for nearshore environment where the project is located is determined based on the “Reply on the Environmental Functional Zoning of Coastal Waters in Tianjin city” (Jin Zheng Han [2013] No. 66) and “Tianjin Marine Functional Zoning (2011-2020)” (Letter No. 159 [2012] of State Council). The functional zoning for air quality is determined according to the Ambient Air Quality Standard (GB3095-2012). The acoustic environment functional area is determined in accordance with the “‘Environmental quality standard for noise’ Applicable Area Division in Tianjin” (Letter No. 590 [2015] of Tianjin Environmental Protection Agency) (see Table 2.4-1 for details).

Table 2.4-1 List of environmental quality standards for terminals and receiving terminal

Project	Standard number	Standard Name and Classification	Level

Seawater quality	GB 3097-1997	Standard for Water Quality of Seawater	Four-class
Atmospheric environment	GB 3095-2012	Standard for Environmental Air Quality	Secondary
		Detailed Explanation of Comprehensive Emission Standard for Air Pollutants	Reference for other station characteristic pollutants in terminals and receiving terminal
	GB 3096-2008	Sound Environmental Quality Standards	Terminal and Receiving terminal to implement Class 3 of standards.
	GB 18668-2002	Marine sediment quality	Three categories
Marine organism	GB 18421-2001	Standard for the Quality of Marine Life	Three categories
Soil	GB 36600-2018	Standard for Management and Control of Soil Pollution Risk in Construction Land for Soil Environmental Quality (Trial Implementation)	Table 1 Selection of Type II Land Use Risks

2.4.2 Air pollutant emissions standard

2.4.2.1 Exhaust gas

(1) The SCV heating furnace shall comply with the requirement of new boiler air pollutant emission concentration limit in the Emission standard of air pollutants for boiler (DB12/ 151-2016).

Table 2.4-2 Emission limit of SCV heating furnace

Pollutant name	Emission limit (mg/m3)	Standard source
Smoke and dust	10	Boiler Air Pollution Emission Standards (DB12/ 151-2016)
Sulfur dioxide	20	
Nitrous oxide	80	
Smoke blackness	≤ 1	

(2) VOCs with unorganized emissions during the operating period implement the limits of the unorganized emission monitoring concentrations in the Standard for the Control of Volatile Organic Compounds Emissions from Industrial Enterprises (DB12/ 524-2014). The site boundary concentration of non-methane total hydrocarbon with unorganized characteristic pollutants shall be subject to the limits of unorganized emission monitoring concentration in Table 2 of the Detailed Standard for Integrated Emission of Atmospheric Pollutants.

Table 2.4-3 Limits for Unorganized Characteristic Pollutant Emissions at the Site boundary of the Terminal

Contaminant	Limits for Monitoring Unorganized Concentration in Plant (mg/m3)	Standard source
VOCS	2.0	Standard for Control of Volatile Organic Pollutants Emission from Industrial Enterprises (DB12/ 524-2014) Table 5
Non-methane total	2.0	Table 2 Limits for Monitoring Concentration of Unorganized Emissions

hydrocarbon		

(3) The project's own sewage treatment station implements the limits of ambient air concentrations around the odor concentration boundary in Table 2 of the Odor Emission Standard (DB12/059-2018).

Table 2.4-4 Pollutant discharge limits for sewage treatment stations

Contaminant	Units	Standard value	Standard source
Odor concentration	Dimensionless	20	Emission Standards for Odor Pollutants (DB12/059-2018)

2.4.2.2 Waste water

(1) During the heating season (December to February), the domestic sewage from the project's receiving terminal will be sent to the Nangang Industrial Zone Wastewater Treatment Plant for treatment, and the water quality will meet the receiving standard of the sewage treatment plant. The submerged combustion vaporizer (SCV) produces condensate drainage from natural gas, which is relatively clean and directly discharged into the sea.

Table 2.4-5 Standards for the implementation of the project's discharge into the wastewater treatment plant in the Nantang Industrial Zone

Execution criteria	Chemical oxygen demand	Biochemical oxygen demand in five days	Ammonia nitrogen
Reception Standards for South Port Sewage Treatment Plants, Level III Standard for Integrated Sewage Discharge Standards (DB12/ 356-2018)	≤ 500	≤ 300	≤ 45
Standard for Integrated Sewage Discharge for Condensation and Drainage of Immersion Combustion Gasifier (DB12/ 356-2018) Level I	≤ 30	≤ 6	≤ 1.5

(2) During the non-heating season (from March to November), the domestic sewage of the receiving terminal is treated by self-built sewage treatment station. After treatment, the effluent meets the requirements of the “Urban Sewage Recycling-Urban Miscellaneous Water Quality” (GB/T18920-2002). It is partly used as the Receiving terminal for greening, road spraying and ground washing. The rest is discharged into the domestic sewage collection tank and will be received by the Nangang sewage treatment plant.

Table 2.4-6 Water Pollutant Discharge Standards for Self-Built Sewage Treatment Stations

Sequence number	Project	Road sweeping and fire fighting	Urban greening
1	PH	From 6.0 to 9.0	From 6.0 to 9.0
2	Color/degree	≤ 30	≤ 30
3	Olfactory	All pleasure	All pleasure
4	Biochemical Oxygen Demand for Five Days (mg/L)	≤ 15	≤ 20
5	Total dissolved solids (mg/L)	≤ 1500	≤ 1000

Sequence number	Project	Road sweeping and fire fighting	Urban greening
6	Ammonia nitrogen (mg/L)	≤ 10	≤ 20
7	Dissolved oxygen (mg/L)	≤ 1.0	
8	Turbidity/NTU	≤ 10	≤ 10
9	Iron (mg/L)	A.	A.
10	Manganese (mg/L)	A.	A.
11	Anionic surfactant (mg/L)	≤ 1.0	≤ 1.0
12	Total coliforms	≤ 3	≤ 3
13	Total residual chlorine (mg/L)	After 3.0 min contact ≥ 1.0 , the end of pipe network ≥ 0.2	

2.4.2.3 Noise

(1) Noise during construction period

During the construction period, the emission limits of Environmental Noise Emission Standard (GB 12523-2011) shall be implemented.

Table 2.4-7 Noise Evaluation Criteria for Construction Plant Boundaries [Unit: DB (A)]

Construction stage	Main noise source	Daytime	Night
Earthwork, pile driving, structure, decoration	Bulldozers, excavators, loaders, pile drivers, concrete mixers, vibrators, chainsaws, cranes, elevators, etc.	70	55

(2) Plant noise during operation

The receiving terminal shall implement Category III standard limits of the Emisson standard for industrial enterprises noise at boundary (GB 12348-2008)

Table 2.4-16 Performance criteria for site boundary noise assessment [unit: DB (a)]

Execution Location	Standard limit		Noise control standard
	Daylight	Night	
Receiving terminal site boundary	65	55	Environmental Noise Emission Standard for Industrial Enterprises (GB 12348-2008) Category 3

2.4.2.4 Solid waste

Solid wastes are classified and treated as required in accordance with the relevant provisions of the National Hazardous Wastes List (2016 Edition) and the General Criteria for Identification of Hazardous Wastes (GB 5085.7-2007).

(1) General solid waste treatment and disposal shall implement the "General Industrial Solid Waste Storage and Disposal Site Pollution Control Standards " (GB 18599-2001).

(2) Hazardous Solid Waste Disposal shall implement the Standard for pollution control on hazardous waste storage (GB 18597-2001).

(3) Announcement on the Amendment of 3 National Pollutant Control Standards for General Industrial Solid Waste Storage and Disposal Site Pollution Control Standards (GB18599-2001) (Provision of Environmental Protection Department Announcement No. 36 of 2013)..

2.4.2.5 Marine contaminants

Table 2.4-8 Marine Water Pollutants Emission Control Standards (GB 3552-2018)

<table>
<tr><th>Pollutant species</th><th colspan="2">Emission control requirements</th><th colspan="4">Emission limit</th></tr>
<tr><td>Machinery oil sewage</td><td colspan="2">Discharge into reception facilities or on target</td><td colspan="4">≤15 mg/L (applicable to ships built before 1 January 2021 and vessels built after 1 January 2021 requiring collection or access to reception facilities)</td></tr>
<tr><td rowspan="14">Domestic sewage of ship</td><td rowspan="12">Within 3 nautical miles</td><td rowspan="12">Collect or discharge in compliance with the ship's navigation [2]</td><td rowspan="4">Ships installed (including replacement) domestic sewage treatment plants before January 1, 2012</td><td>Contaminant</td><td>Limit</td><td>monitoring location</td></tr>
<tr><td>BOD$_5$(mg/L)</td><td>50</td><td rowspan="11">Domestic sewage treatment plant outlet</td></tr>
<tr><td>SS(mg/L)</td><td>150</td></tr>
<tr><td>heat-resistant coliforms(number/L)</td><td>2500</td></tr>
<tr><td rowspan="8">Ships installed (including replacement) domestic sewage treatment plants on or after January 1, 2012</td><td>Contaminant</td><td>Limit</td></tr>
<tr><td>BOD$_5$(mg/L)</td><td>25</td></tr>
<tr><td>SS(mg/L)</td><td>35</td></tr>
<tr><td>heat-resistant coliforms (number/L)</td><td>1000</td></tr>
<tr><td>COD$_{cr}$ (mg/L)</td><td>125</td></tr>
<tr><td>pH (Dimensionless)</td><td>6～8.5</td></tr>
<tr><td>Total nitrogen (total residual chlorine) (mg/L)</td><td>＜0.5</td></tr>
<tr><td></td><td></td></tr>
<tr><td>3 nautical miles <with the nearest land distance ≤ 12 nautical miles</td><td colspan="5">The following conditions are met:
(1) Using equipment to break solids and discharge after disinfection
(2) The ship speed is not less than 4 knots, and the domestic sewage discharge rate does not exceed the maximum allowable discharge rate at the corresponding ship speed.</td></tr>
<tr><td>>12 nautical miles from the nearest land</td><td colspan="5">The ship speed is not less than 4 knots, and the domestic sewage discharge rate does not exceed the maximum allowable discharge rate at the corresponding ship speed.</td></tr>
</table>

Marine refuse	In any sea area, plastic waste, waste cooking oil, domestic waste, incinerator ash, abandoned fishing gear and electronic waste are collected and received; Food waste: received within 3 nautical miles; 3 nautical miles to 12 nautical miles after smashing ≤ 25 mm; discharge at 12 nautical miles; Residues of goods: received within 12 nautical miles; no hazardous materials for marine environment can be discharged after 12 nautical miles; Animal carcass: receiving within 12 nautical miles; 12 nautical miles outside can be discharged; Cargo tanks, decks and exterior cleaning waters are free of hazardous materials from the marine environment and other wastes are collected;

2.5 Evaluation focus and evaluation period

2.5.1 Evaluation focus

According to the nature of the project and the distribution of sensitive targets around it, the key work of this rating is as follows :

(1)Comprehensive engineering analysis, find out the pollution production link of the project, account for the strong pollution source ;

(2) Impacts of engineering construction on the marine environment (hydrodynamic, water quality, marine life) ;

(3) Impacts on the surrounding environment (atmosphere, water, noise, solid waste, ecology) during the operation of the project ;

(4) Pollution control measures and their technical and economic analysis ;

(5) Environmental risk impact assessment and emergency countermeasures.

2.5.2 Evaluation period

The environmental impact assessment period of the project mainly includes construction period and operation period.

2.6 Pollution Control and Environmental Sensitive Targets

2.6.1 Pollution control target

Control the discharge of various pollutants from the receiving terminal, and make the discharge meet the standard, so that the surrounding environmental quality is not lower than the existing environmental functions after the completion.

2.6.2 Environment sensitive target

2.6.2.1 Marine environment sensitive target

According to the "Tianjin Marine Functional Zoning (2011-2020)" and other plans and the "Tianjin Municipal People's Government's Reply on the Environmental Function Zoning of Tianjin's Coastal Waters" (Letter [2013] No. 66 of Tianjin Municipal Government), the receiving terminal is located in Class IV functional zone. There are 5 environmental protection zones in the Class II coastal waters near the sea, namely Dagang Coastal Wetland Marine Special Protection Zone (TJ003BII), Gaoshalingdong Reserve Zone (TJ005BII), Mashedkou Agriculture and Fisheries Zone (TJ007BII), Tianjin Southeastern Agricultural and Fishery Area (TJ008BII), Gaoshaling Tourism and Recreation Area (TJ011BII); one Class III nearshore water environment functional zones, Tianjin Port Nangang Shipping Area (TJ013CIII); and two Class IV of nearshore waters environmental functional zones, Gaoshaling Industrial and Urban Sea Area (TJ017DIV), Nangang Industry and Urban Sea Area (TJ018DIV). The location of the project in the environmental function zoning map of the coastal waters is shown below.

According to the " Tianjin marine ecological red line protection report " issued and implemented by Tianjin Maritime Bureau in 2014, the ecological red line area of Dagang coastal wetland marine special protected area extends to the east parallel to the provincial boundary line of Jinjinan extension (about -6 m isobath), and extends south to all provincial boundary sea area of Jinjinan line, including the Mapengkou agricultural and fishery area. The area of the protected area extends to the east about 23 km2 from the EIA stage, and the nearest position of the project remains basically unchanged. At the same time, the construction is located in the core area of the National Aquatic Germplasm Resources Protection Area of Bohai Bay-Liaodong Bay-Laizhou Bay. The environmental sensitive targets of this sea area are statistically determined as shown inFigure 2.6-1 and Table 2.6-1

Table 2.6-1 Location relationships of marine environment sensitive targets

Type	Primary Sensitive Destination Name	Orientation	Closest to planning area
Marine protected area	Dagang Binhai Wetland Marine Special Reserve Area	South side	8.1 km
Marine ecological red line	Tianjin Dagang Binhai Wetland	South side	8.1 km
Ecological red line	The Red Line of Ecological Protection in the Riparian Riparian Zone Red Line Area for Ecological Protection of Wetland Biodiversity Conservation in Tube-Beidaigang	West Side	12.5 km 18.4 km
Nature reserve	Old stable mouth area shell dike experiment area (national level)	South west side	Seventeen kilometers
	Tianjin Beidagang Wetland Nature Reserve (Provincial)	West Side	Eighteen kilometers
National Aquatic Germplasm Resources Conservation Area	Liaodong Bay Laizhou Bay National Aquatic Germplasm Resource Reserve Bohai Bay Core Area	Inside	Integral inner
Agro-fishery area	Barn mouth farming and fishing area	SW	13.7 km
	Agricultural and Fishery Area in Southeast Tianjin	East side	2.5 km
Tourist Recreation Area	Gao Sha Ling Tourism Recreation Area	North	3.8 km

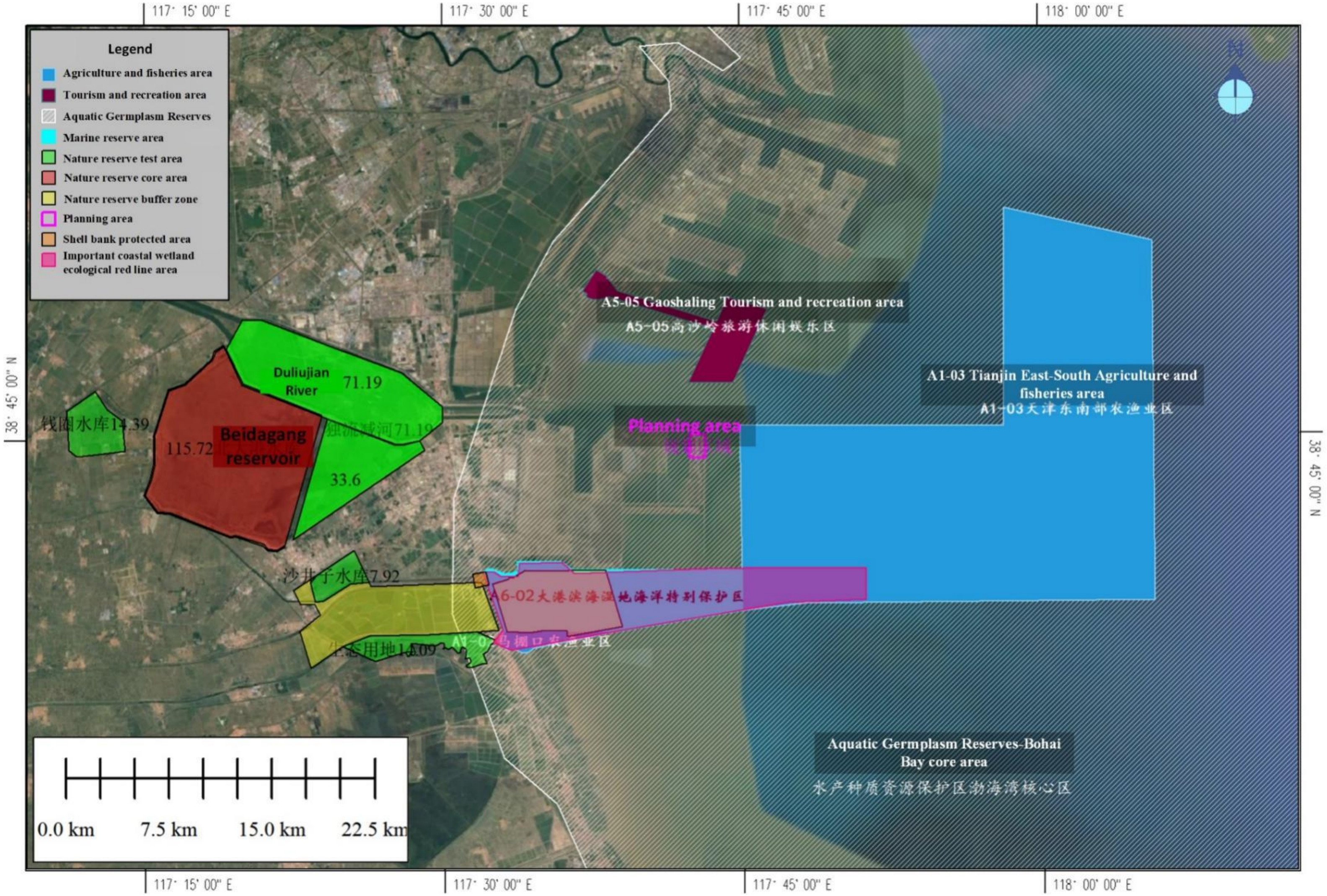


Figure 2.6-1 Distribution of marine environmental sensitive areas (September 2018)

2.6.2.2 Atmospheric environment sensitive target

The LNG receiving terminal project is located at the north end of the east jetty of the east harbour basin in the Nangang industrial zone of Tianjin Binhai New Area. There are no atmospheric environmental sensitive targets within the scope of the evaluation.Acoustic environment sensitive target

2.6.2.3 Environmental risk sensitive target

The LNG receiving terminal of this project is located at the north end of the east jetty of east harbour basin in the Nangang industrial zone of Tianjin Binhai New Area. There are no noise sensitive targets within the scope of the evaluation.

2.6.2.4 Environmental risk sensitive target

The LNG receiving terminal project is located at the north end of the east jetty of the east harbour basin in the Nangang industrial zone of Tianjin Binhai New Area. There is no residential area within 5 km around the proposed project. Thus the environmental risk sensitive target within the evaluation scope is the offshore water environment.

3 Analysis of Alternatives

3.1 With and Without Project Alternatives

(1) The existing LNG supply capacity cannot guarantee the demand of Beijing, Tianjin and Hebei province.

According to the "Implementation Plan for the Construction of LNG Storage and Transportation System in Bohai Rim Region (2019-2022)", the storage capacity of the LNG receiving terminal shall meet the demand of 5% of the gas enterprises and 3 days of emergency gas of local governments. At the moment, there are two LNG receiving terminals in the Beijing-Tianjin-Hebei region, namely Tianjin floating LNG from China National Offshore Oil Corporation (CNOOC) and Tianjin LNG from the China Petroleum and Chemical Corporation (Sinopec), with a gasification capacity of 4,300 × 104 Nm3/d. In addition, Tangshan LNG receiving terminal supplies to the Beijing-Tianjin-Hebei region with a gasification capacity of 4,200 × 104 Nm3/d. It is planned to expand the total gasification capacity for Tangshan LNG and Tianjin floating LNG from CNOOC to 27,900 × 104 Nm3/d in 2022. Considering the radiation area of the send-out pipeline, the supply to the Beijing-Tianjin-Hebei region will be about 16978 × 104 Nm3/d in 2025. In addition, considering the total supply capacity of all pipelines export to this region, it will be 32452 × 104 Nm3/d by then. However, the daily demand for high monthly average of the Beijing-Tianjin-Hebei region will be up to 36885 × 104 Nm3/d in 2025. Thus, the supply capacity is unable to guarantee the demand of the Beijing-Tianjin-Hebei region.

(2) The project is expected to largely enhance natural gas reserve and peak capacity in the Beijing-Tianjin-Hebei region.

In 2017, Beijing's natural gas consumption was about 162 × 108 Nm3, which is the largest among all cities in China and the second largest city in the world. The gas consumption in Beijing is expected to increase up to 210 × 108 Nm3 in2022, and 260 × 108 Nm3 in2030. Natural gas supply has become the core to secure Beijing’s energy supply.

At present, Beijing’s natural gas supply is facing severe challenges due to insufficient reserve capacity. Given this, heat supply shortage has become a critical issue which badly affects societal well-beings, in particular for occasions with serious malfunctions of upstream facilities and extreme weather. According to estimations, in 2017, the volume of peak demand (defined as the sum of the demand which exceeds annual average over all months) in Beijing accounts for 30% of the annual gas consumption. However, the usable capacity of gas storage in the surrounding Beijing-Tianjin-Hebei region was only about 27× 108 Nm3, which was far from meeting the peak demand in Beijing. Also most enterprise fail to meet the national requirements about keeping gas reserve capacity of at least 5%. In light of this, this project will help to largely enhance gas reserve capacity to meet peak demand in the Beijing-Tianjin-Hebei region. This is also well aligned with China’s state-level energy policies.

The total consumption in Beijing-Tianjin-Hebei region will stably increase, mainly driven by development of downstream markets. According to the market analysis, the supply gap in 2023 can reach up to 1848× 104 Nm3/d in months with high gas demand, and increase to 4063 × 104 Nm3/d in 2035.

(3) This project is seen as an important move to optimize energy consumption mix, and promote energy conservation and emission reduction in the Beijing-Tianjin-Hebei region.

China will experience radial energy transition in the next five years and beyond. Clean and low-carbon energy is the core to address air pollution and mitigate climate change. However, being subjected to various economic and technical limitations of deploying renewable and storage technologies, scalable and flexible power resources are required to balance intermittency of the system. Gas power plants are characterized by high flexibility and fast ramping up, shutting down capability. Gas power has been proven to be effective in complementing wind and solar power, which helps to reduce the renewable curtailment in China and thus improve overall energy efficiency security of the power supply.

Therefore, renewable development and gas supply should go hand in hand to facilitate China's clean energy transition.

Natural gas itself is an efficient, clean and low-carbon high-quality energy resource, rich in reserve and supply, relatively low-cost, easy to use and low in emissions. The thermal efficiency of natural gas for power generation and industrial combustion is normally 10% higher than that of coal. The efficiency of natural gas-based combined cooling, heat and power (CCHP) plant is nearly 2 times higher than that of coal-fired power generation. However, the CO2 emission from gas is merely 59% of coal and 72% of fuel oil. The sulfur dioxide emission concentration of large gas-steam combined cycle unit is almost zero. The sulfur dioxide emission of industrial boiler is 17% of coal and 25% of fuel oil. Nitrogen oxide emission from large gas-steam combined cycle unit is 73% of ultra-low emission coal power unit and 20% of coal from industrial boiler. At the same time, compared with coal and fuel oil, natural gas has no dust emissions.

3.2 Site selection analysis

3.2.1 Suitability of social conditions

(1) Location conditions

The target market of the proposed Beijing Gas-Tianjin Nangang LNG emergency reserve project is determined to be Beijing, Tianjin and Hebei Province. The natural gas wil be supplied to Beijing in priority to assure the emergency and the peak regulation. The project is an important facility for realizing "interconnectivity " between the Beijing-Tianjin-Hebei region and the national natural gas pipeline network.

Port of Tianjin is an important hub of China's comprehensive transportation system and a major coastal hub port. It is one of the main transit ports for energy and raw materials, and is the main line port for container transportationin in the north of China and an important port for the development of modern logistics. In addition, it is an important port for foreign trade in Beijing, Tianjin and North China. In accordance with the requirements of building a modern port, Port of Tianjin should gradually develop into a modern and comprehensive port with advanced facilities, complete functions, efficient management and significant benefits. It will have transportation organization, loading and unloading, transshipment and replacement, port industry, modern logistics, bonded, information and the comprehensive services and so on.

Port of Tianjin is divided into 8 parts, namely Beijiang Port Area, Dongjiang Port Area, Nanjiang Port Area, Dagukou Port Area, Gaoshaling Port Area, Dagang Port Area, Haihe Port Area and Beitang Port Area. Based on the development of Lingang industrial zone, Gaoxaling Port Area is planned and constructed. Based on the development of Nangang industrial zone, Dagang Port Area is planned and constructed. The development strategy of the port of Tianjian is as following: the central part of the port of Tianjin, e.g., Beijiang, Dongjiang, Nanjiang port areas, will be mainly focused on the optimization of the industrual structure and the enhancing the port function; The function of Beitang port area will be changed from cargo transportation mianly to tourism passenger transport in order to support the development of marine tourist area. Beijiang, Dongjiang, and Nanjiang port areas will mainly serve the transit of goods in the hinterland. In order to support the further development of Port of Tianjin and provide the space for Partial goods within the port area, TianjinDagukou, Gaoshaling, and Dagang port areas has been gradually making a transition from providing serices for Lingang industrial zone to the goods transit transportation for the hinterland.

The proposed project is located in the East Jetty of Donggang Habour basin, Nangang Industrial Zone of Tianjin. At the moment, there are only Sinopec LNG terminal and its working ship terminal. The minimum distance between the project and Sinopec terminal is 356 m, which meets the safety distance requirement.

The breakwater of Nangang Industrial Zone and the cofferdam of the harbor have been built. The shielding condition is good.

(2) External associated supports

1) Water supply

The construction of the water distribution center of The Nangang Industrial Zone has completed. It has a water supply capacity of 3000 t/d. The water plant has been expanded to a scale of 5×104 t/d. The water quality of water plant can meet the needs of both industrial and drinking water. Water quality indicators meet the Sanitary Standards for Drinking Water (GB 5749-2006).

2) Power supply

The two 220 kV substations under the jurisdiction of the State Grid Tianjin Electric Power Company in Nangang Industrial Zone are 220 kV Kilometer Bridge Power Station and 220 kV Taking-off Road Substations, respectively. The substation of 220 kV Kilometer Bridge is 15 km away from the project site ; The 220 kV Tengfei Road substation is 25 km away from the project site. The two 220 kV substations are new substations, with more surplus power supply capacity and outlet spacing, which can meet the demand of power supply for this project.

3) Communications

Wired communication in the terminal area is connected at the rear side of the terminal. The ship-shore communication required for the project in the far offshore and offshore is solved by using the existing coastal radio station in Port of Tianjing. The VHF wireless walkie-talkie is used for the production dispatch communication in the dock area and the Receiving terminal area. Communication during the construction period can be wired by the local telecommunications bureau.

4) Highway

According to the plan, Nangang industrial zone will form the " two horizontal and one vertical " road pattern of external collection and transportation. The " two horizontal" refers to the northern Jinshi Expressway in the east-west direction and the southern Nangang Expressway. The Jinshi Expressway passes through the Dagang Reservoir-North Dike and enters the port. The Nangang Expressway enters the port by the Shajingzi Sub-district. These two expressways enter the Nangang Industrial Zone from the east of the Haibin Avenue as the expressway connecting line. This realizes the direct entry of the expressway to the port. “One vertical” refers to the north-south coastal highway. The coastal road has a 4 km section in the middle of the Nangang Industrial Zone, the rest is the viaduct section, and an interchange is reserved in the middle of the 4 km landing section. At present, the Nangang Industrial Zone has completed the construction of an 8m wide road connecting to the Sinopec LNG receiving terminal. The east side of the project area has planned a 40m wide main road in the port area, and the traffic conditions outside the site are good.

5) Building Materials

Building materials supply is rich in Tianjin area. Steel, cement and other building materials can be purchased locally.

6) Hire Tugboat Services

The conditions of tugboat in the Port of Tianjin are good. According to the actual situation, the project is to be equipped with two 5000 HP Z type tugboats. Other barges are considered for hire.

7) Construction conditions

Port of Tianjin is an old port built for many years. During the years of the port construction, it has mastered a lot of detailed basic technical data, accumulated rich and mature practical experience, and has a number of port construction teams with rich experience, high technical level and excellent equipments. The Tianjin Port area has all kinds of infrastructure required for port and offshore construction, such as large component prefabrication plants and working boat docks, which provide strong technical guarantee for the implementation of the project.

8) Port and service facilities

The supporting facilities such as the port and service of Nangang Industrial Zone are under planning and construction, which can meet the needs of the project after it is completed and put into production.

In summary, the proposed project has many advantages and supporting conditions such as superior location conditions, perfect external cooperation conditions, and better construction facilities. Therefore, from the perspective of social conditions, the site selection of this project is appropriate at the northern end of east jetty of the Donggang east harbour basin in Nangang Industrial Zone.

3.2.2 Suitability of natural resources and environmental conditions

(1) Meteorological conditions

Natural factors such as waves, winds, currents, fog, thunderstorms, etc. will have an impact on the navigation safety. The main factors affecting the navigation of LNG ships in the sea area are cold wave, strong wind and ice. The adverse effects of waves and fog last for a short time. The cold wave and strong wind affect the longest continuous non-voyage days in the year is about 5 days; The maximum number of consecutive non-navigable days affected by cold wave and strong wind is about 5 days. In general years, sea ice has little effect on ship navigation. However, the number of consecutive days affecting navigation may be longer in the year of severe ice condition. However, the port of Tianjin, as a shipping hub, shall take appropriate measures to break ice. Since the consective day will affect the safe operation of the LNG ship, the number of these days shall be limited to 5 days.

(2) Water depth conditions

The representative ship type designed for this project is a 266,000 m^3 LNG vessel with a full draft of 12.2 m. According to the LNG Terminal Design Code (JTS 165-5-2016), the design depth of the harbor basin and the channel is -14.6 m.

The existing channel of Dagang Port Area is deepened and widened on the basis of the 50,000 DWT channel. It is 100,000 DWT, which meets the requirements of 100,000 DWT for one-way and 50,000 DWT for two-way traffic, and meets the requirements of 266,000 m3 LNG vessel as well.

(3) Hydrology conditions

1) Waves

The project is located on the north side of east harbour basin in Dagang Port Area. It is covered by the north breakwater, the east breakwater and the mouth gate breakwater. The project is located on the north side of East basin in Dagang Port Area. It is sheltered by the northern breakwater, the east breakwater and the entrance breakwater. The impact of the offshore waves on the terminal is minimal.

2) Current

According to the measured data in June 2011, the tidal current in this area is reciprocating flow. and the velocity of the tidal current is obviously larger than that of small tidal current. The flow rate of the measured spring tide is significantly larger than the neap tide, and the flow rate of the open sea is greater than that of the nearshore. Affected by terrain, the maximum flow point is located inside the entrance of the breakwater. According to the distribution of the cross flow at the fluctuation time, the cross flow in the terminal area is less than 0.10 m/s, and the maximum cross flow in the channel is located near the breakwater entrance, but the maximum cross flow is less than 0.25 m/s, and the berthing condition is better.

3) Water temperature

The water temperature in the project sea area in winter is so low that LNG can't be gasified. Thus seawater is no longer used as a gasification heat source (IFV gasifier), but submerged combustion vaporizer (SCV) in winter. So the project does not need to take or discharge seawater in winter. The operation of the receiving terminal is not affected by sea ice.

4) Sediment conditions

The project is located in the western part of Bohai Bay, and its north side is the Duliujian River estuary. The characteristics of the coast and the sediment movement characteristics are similar to those of Port of Tianjin. The coast is still a silty coast. Water near the shore is shallow, the slope of the underwater terrain is slow, and the sediment movement is active. Wave is dominated in this area. Sediment initiation under waves and the sediment transport under tidal current are the main driving forces for shaping underwater terrain.

The rivers that enter the sea along the Tianjin Port mainly include Haihe River, Yongding New River (Ji Canal), Weihe River and Duliujian River. Among them, the sediment from the Haihe River to the sea has a significant impact on the erosion and accretion of the shore. After the construction of the tidal gate in Haihe River in 1958, the sediment from the Haihe River fell to about 200,000 m3 from 6 million to 8 million m3 before the construction of the gate. Especially since the 1970s, the sediment into the sea was almost zero. In the same period, the sediments into the sea from the Yongding New River, the Weihe River and the Duliujian River were also minimal. Therefore, for this project, there are limit sands coming from rivers, and the sediment mainly comes from the sediment transport under the action of wave currents.

The natural water depth at the head of the breakwater dike is about-5m, which is basically outside the wave-breaking zone. At the same time, with the development of the port area, the area of the surrounding shoals is greatly reduced. So the sediment concentration in the water area of this project is low, and sediment accretion is not a limiting factor of the construction of this project.

5) Engineering geological conditions

According to the engineering geological survey report of the Tianjin LNG Project, which is adjacent to the east side of the project, the geological structure of the project sea area is in a relatively stable area with a deep cover. The terrain is flat and open, and there is no significant adverse geological development that affects the stability of the site, such as landslides and collapses. Although the construction site belongs to the earthquake-resistant unfavorable section of the sea area, the soft site soil, the Class IV construction site, and the silt with slight liquefaction characteristics, it can be treated by certain engineering measures. There is no unfavorable geological development which is too difficult to be treated. Based on the comprehensive analysis and judgment, the site is stable and it is a construction site that can be used for general engineering construction, and is suitable for the construction of this project.

The surface layer of the project site is fluvial silt and mucky silty clay. The middle layer is a dense fine sand layer, and the lower layer is silty clay, and the clay interacts with the sand layer. Based on the analysis of the distribution characteristics and engineering properties of the site, there are no geotechnical conditions for the terminal platforms, mooring piers and approach bridges using natural foundation. Pile foundation should be adopted. By properly selecting the structure and bearing layer of the hydraulic structure, appropriate protective measures and supporting works are taken, and the geological conditions can meet the needs of LNG terminal and land construction.

Based on the above analysis, the natural conditions of the location area can fully meet the requirements for the construction and operation of the project.

3.2.3 Suitability of ecosystems

The sensitive area of the ecosystem near the project area is the Bohai Bay Aquatic Germplasm Resources Conservation Area and the planned Dagang Coastal Wetland Marine Special Protection

Area. The project is located in the Bohai Bay Aquatic Germplasm Resources Protection Area . The project is located in the Bohai Bay Aquatic Germplasm Resources Protection Zone. The project will have certain impact on the aquatic germplasm resources in the protected area during the construction and operation period. There is no development and construction plan for the planned Dagang Coastal Wetland Marine Special Protection Area. At present, some fishermen are engaged in open farming, fishing by using fixed and mobile fishing gear, mainly protecting the ecological environment of marine wetland and the ecological biodiversity gene pool in the shallow sea, and carrying out important economic fish and shellfish proliferation. The marine fishery resources are restored by means of artificial reefs and artificial release. The site selection of this project is far away from the protected area (the nearest distance is 9.7km), and the project construction and operation will not adversely affect it.

According to the historical data of the marine ecological environment of the project sea area and the monitoring data of the current situation, there is no typical marine ecosystem in the selected area, the concentrated distribution area of non-major economic fish, the migratory route of non-important economic fish, the feeding ground, and the spawning ground or a nursery place.

The phytoplankton and zooplankton in the project area is lack in number. The diversity index is general, the density of benthic organisms, intertidal organisms and swimming organisms is low, and the biodiversity index is relatively simple. The suspended sediment in the construction period of the project will have certain adverse effects on phytoplankton, zooplankton and benthic organisms in the sea. The impact is temporary and will disappear with the completion of construction. The impact of the land reclamation and construction of hydraulic structures on the marine ecological environment is permanent, which will result in the loss of a large number of benthic organisms and fishery resources. The impact of project construction on the marine ecological environment must be alleviated through ecological compensation.

Therefore, the construction of this project will have certain adverse impacts on the ecological environment of the selected sea area . The loss of marine life is a common species and which will not cause the deterioration of the marine ecological environment of the sea area. The ecological environment of the selected sea area can adapt to the sea used in this project.

3.2.4 Adaptability to surrounding development activities

According to the current urban plan of Nangang Industrial Zone, there are no residential areas, schools, rivers, military restricted zones and military administrative zones within 1.5 km of the receiving terminal. Lakes, scenic spots, nature reserves, basic farmland protection areas, animal husbandry areas, fishery waters and production bases for seed, breeding stock and aquatic fingerlings; stations, terminals (except those authorized by the State for handling hazardous chemicals), airports and highways, railways, waterways, metro ventilation pavilion, metro entrances and exits; Water supply sources, water plants and water source protection areas; public facilities such as hospitals, theaters, stadiums and so on; areas such as commercial centers, parks and other densely populated areas that are protected by laws and administrative regulations, meet the requirements of relevant laws and regulations.

In order to reduce the impact of leakage of LNG to form a flammable gas cloud on the terminal and tank area, the fire-fighting area is prohibited within 500m from the loading port. The project site is located in the planned port area and the side of the approach channel entrance. There are no factories and mines and residential areas around the project. It is far away from other terminals, which is beneficial to the LNG ship entering and leaving the port and unberthing in an emergency. The port area has good independence, large environmental capacity, and good environmental conditions and safety.

The interests of the project and the surrounding development and utilization activities are clear and can be solved in a coordinated manner.

The site selection of this project takes fully into account the characteristics and nature of the proposed project, and is far from the densely populated villages, towns and other industrial and mining enterprises.

Based on the above analysis results, from the perspective of social conditions, natural resources and environmental conditions, regional ecosystems, and other sea activities around the site, the site selection of this project is reasonable.

3.2.5 Uniqueness of location scheme

Port of Tianjin has a total of eight port areas. According to the access requirements in the "Tianjin Petrochemical Industry Structure Adjustment and Transformation Benefits Implementation Plan" (November 2017), "the new petrochemical project must enter the Nangang Industrial Zone". According to this, the LNG terminal is planned to be located in Tianjin Nangang Industry. District construction; according to the "Tianjin Port Dagang Port Area LNG Terminal Operation Area Planning Scheme Adjustment", the location of the project terminal harbour basin has been determined in the planning stage. Therefore, the project site selection is unique.

3.3 Comparative Analysis of ProcessingTechnology

At present, the treatment of BOG by natural gas liquefaction stations and LNG receiving terminal in the world mainly includes the following four methods: BOG direct pressurization and transportation, recondensing process, BOG reliquefaction and BOG discharge to flare combustion.

3.3.1 Scheme overview

(1) BOG direct pressurized external transmission

The direct pressurized external heat transfer process of the vaporized gas is to directly transfer the vaporized gas to the gas transmission pipe network after being compressed to the external pressure, and consumes a large amount of compression work.

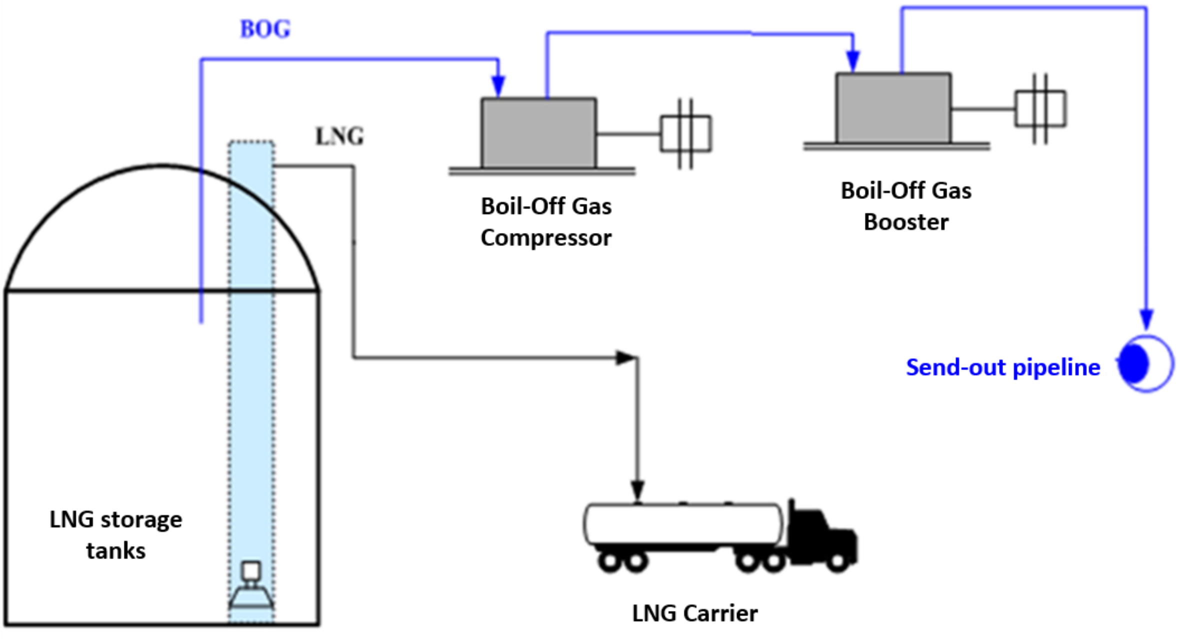


Figure 3.3-1 Schematics of BOG Direct pressurization and transportation

(2) Recondensation process

The evaporating gas recondensing process compresses the evaporating gas to an intermediate pressure, and then mixes with the LNG outputted from the low-pressure pump in the tank in the recondenser. Since the LNG is supercooled, the evaporating gas can be recondensed. The condensed LNG is pressurized by a high pressure output pump and then externally transferred. Therefore, the recondensing process can utilize the cooling capacity of LNG to reduce the energy consumption of evaporation of the evaporating gas, thereby saving energy, which is more reasonable than the direct output process and the reliquefaction process. This process is generally suitable for large LNG receiving terminal with large scale and sustainable external gas supply.

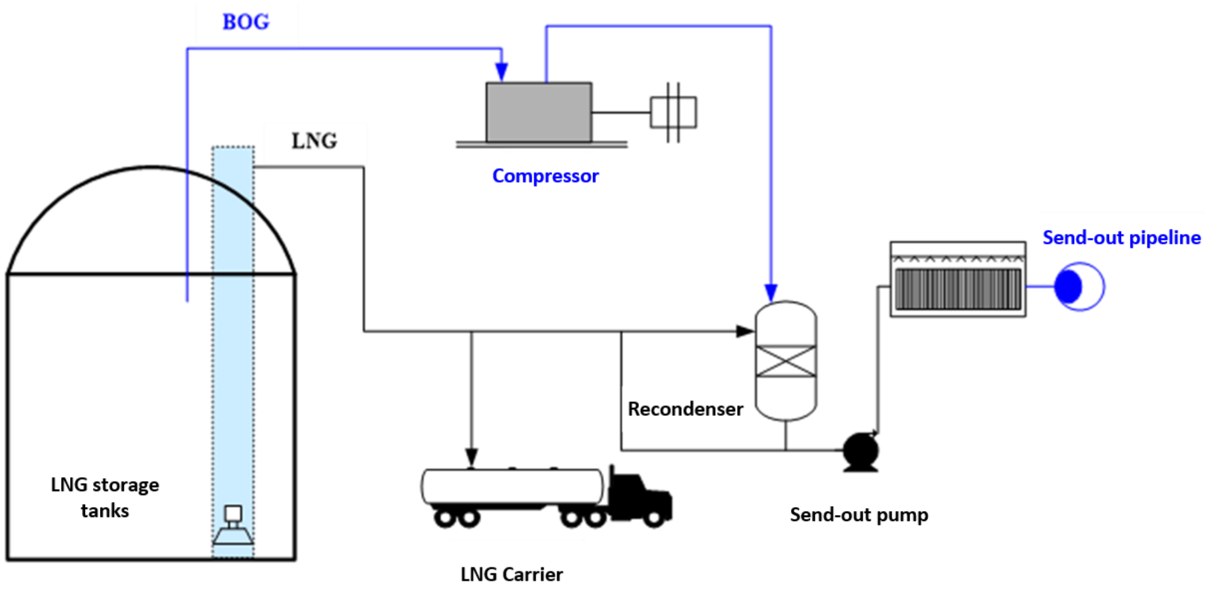


Figure 3.3-2 schematic diagram of recondensation process

(3) Reliquefaction of BOG

The evaporating gas reliquefaction process sends the evaporating gas to the reliquefaction device, and re-liquefies the evaporating gas into LNG through the refrigeration cycle of the reliquefaction device and returns to the storage tank. The reliquefaction device needs to be equipped with BOG booster compressor, refrigerant compressor, cold box, throttle valve and other equipments. The process is complicated, the number of equipment is large, the operation and maintenance volume is large, the operation energy consumption is very high, and it is usually used for the Receiving terminal. Natural gas pipelines, LNG receiving terminal that do not have external transport conditions.

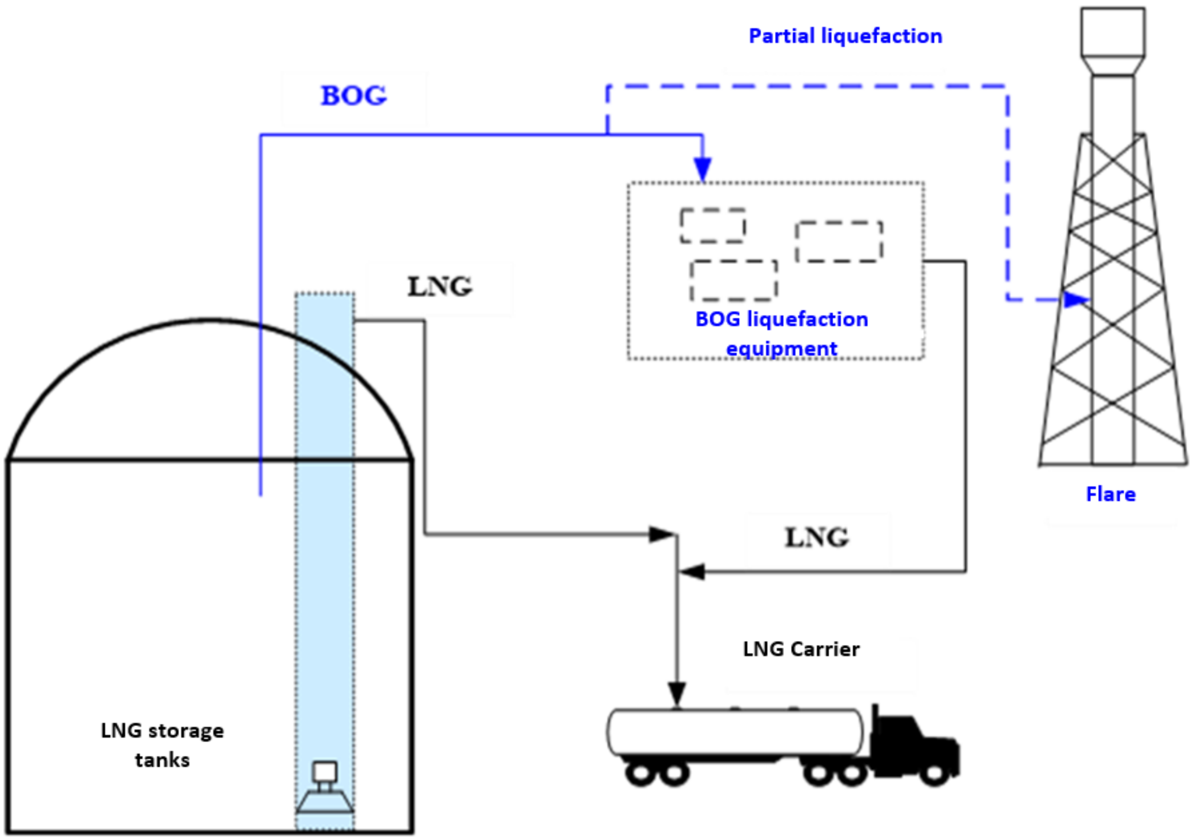


Figure 3.3-3 schematic diagram of BOG reliquefaction

3.3.2 Scheme comparison

The project has an external natural gas pipeline with a certain amount of natural gas transmission conditions, so can directly eliminate the Scheme 3 " re-liquefaction process" Therefore, this project will only compare and select the two schemes of evaporative gas treatment: scheme 1 "BOG direct pressurization and transportation process " and scheme 2 "recondensation process".

The construction progress plan of the project is as follows :

Table 3.3-1 Implementation Plan of Construction Progress

Date	Progress
November 2022	Completion and commissioning of terminal, 4 storage tanks and supporting projects
November 2023	Construction of 4 Storage Tanks in Mid-term
November 2024	Construction and production of 10 storage tanks

Table 3.3-2 Planned Gas Delivery by the Works

Year	Off-base gas transmission (Daily average)	Peak regulation external gas transmission (Daily output of high monthly average)	Emergency safety external gas transmission (Day of emergency output)	LNG Liquid Outgoing (Average Daily Output)
	$10^4 Nm^3/d$	$10^4 Nm^3/d$	$10^4 Nm^3/d$	$10^4 Nm^3/d$
2022	150	557	6000	411
2023	150	1848	6000	822
2024	150	2493	6000	1370
2025	150	2815	6000	1507

2026	150	3138	6000	1644
2027	150	3299	6000	1918
2028	219	3445	6000	1918
2029	274	3500	6000	2055
2030	329	3555	6000	2740
After 2035	658	4000	6000	4576

According to the preliminary planning of the construction of this project (Table 3.3-1) and the planned gas transmission (Table 3.3-2), if the BOG evaporative gas treatment scheme is adopted by the recondensation process, the LNG Receiving terminal shall have the limit of minimizing the external gas transmission. According to the preliminary planning of the construction of the project, the minimum gas transmission capacity of the recondensation process is shown in Table 3.3-3.

Table 3.3-3 Minimum External Gas Transmitting Capacity of Recondensation Process (0.8 MPa)

Working condition				**Minimum gas delivery**	
Disembark	**Is it loaded**	**Component**	**Number of cans**	**10^4 nm 3/h**	**10^4 nm ^{3}/d**
Non-unloading	Non-loading	Liquid-rich	4	13.26	318
	Non-loading	Lean liquid	4	15.1	362
	Loading	Liquid-rich	4	14.86	357
	Loading	Lean liquid	4	16.67	400
	Non-loading	Liquid-rich	8	21.23	510
	Non-loading	Lean liquid	8	24.03	577
	Loading	Liquid-rich	8	22.79	547
	Loading	Lean liquid	8	25.72	617
	Non-loading	Liquid-rich	10	25.23	606
	Non-loading	Lean liquid	10	28.44	683
	Loading	Liquid-rich	10	26.73	642
	Loading	Lean liquid	10	30.11	723

Table 3.3-4 Minimum external gas transmission capacity of recondensation process under unloading conditions (0.8 MPa)

Working condition				**Treatment of Evaporation Capacity by BOG Compressor**	**Minimum external gas delivery**
Disembark	**Is it loaded**	**Component**	**Number of cans**	**104 nm 3/d**	**104 nm 3/d**
Unloading	Loading	Liquid-rich	4	76	585
		Liquid-lean	4	82	641
		Liquid-rich	8	108	746
		Liquid-lean	8	118	820
		Liquid-rich	10	108	824
		Lean liquid	10	118	913

The operating pressure of the recondensers is usually 0.6-0.9 MPa, and the operation pressure of the recondensers can be increased to reduce the minimum requirements of the recondensers. However, increasing the operating pressure of the recondenser will increase the energy consumption of the BOG compressor. The operation pressure of the recondenser in this project is 0.8 MPa after considering the actual conditions of the base load and the operation pressure of the recondenser in the existing Receiving terminal in China. The operation pressure value of the recondenser of the LNG Receiving terminal of this project needs to be proved in detail in the preliminary design stage.

In 2022, when four LNG tanks were put into operation first, the planned off-base gas delivery was much less than the minimum required for the recondensation process . Under the off-base conditions, the direct pressurized external transmission process of the evaporative gas was adopted, and the difference of the planned off-base gas delivery was supplemented by the direct gasification of the LNG under pressure. If the downstream user market develops rapidly, when the base load market can reach the scale of 400 × 10^4 m^3/d in 2022, the recondensation process can be used in the base load external transport condition (non-unloading ship) ; When the base load market capacity reaches 641 × 10^4 m^3/d in 2022, the recondensation process can be used for the off-loading conditions (including ship unloading).

In 2023, 8 LNG storage tanks were put into operation, and the planned off-base gas flow was less than the minimum external gas flow requirements of the recondensation process . Under the off-base conditions, the direct pressurized external transmission process of the evaporative gas was adopted. If the downstream user market develops rapidly, when the base load market can reach the scale of 617 × 10^4 m3/d in 2023, the recondensation process can be used in the off-loading condition (non-unloading ship). When the base load market capacity reaches 820 × 10^4 m3/d in 2023, the recondensation process can be used for the off-loading condition (including ship unloading).

In 2024, 10 LNG storage tanks were put into operation, and the planned off-base gas delivery did not meet the minimum requirements of the recondensation process. Under the condition of external transportation under base load, the direct pressure transfer process of evaporative gas is adopted. A. If the downstream user market develops rapidly, when the base load market can reach the scale of 723 × 10^4 m^3/d in 2024, the recondensation process can be used in the off-loading condition (non-unloading ship) ; When the base load market capacity reaches 913 × 10^4 m^3/d in 2024, the recondensation process can be used in the base load external transport (including ship unloading).

According to the simulation results, it is found that the minimum external gas transmission volume of the recondensation process is larger than that of the non-loader, so it is suggested that the owner adopt the pressure loading in the later operation to reduce the return of the evaporative gas to the tank during the loading process.

Under the peak regulation or emergency safety condition, the planned gas transmission is larger than the minimum gas transmission in the evaporative gas recondensation process scheme, which meets the requirements of the minimum gas transmission in the evaporative gas recondensation process scheme. In order to save energy and reduce consumption, the evaporative gas recondensation process can be used under peak regulation or emergency security conditions.

3.3.3 Summary

In summary, the BOG direct pressurized external transport process is adopted under non-peak regulation or non-emergency security conditions. Peak regulation or emergency security season, using Scheme 2 "re-condensation process".

4 Project overview

4.1 Introduction

Construction site: The project is located in Nangang Industrial Zone, Tianjin. The Receiving terminal site is located on the east side of Donggangchi in Nangang District, and the south side of Sinopec LNG Receiving terminal. The west boundary of the site is 319m away from the West Fanglang, and the east boundary of the site is east. Breakwater 264m. The terminal is located at the northern end of the east bank of the East Port of Donggang Industrial Park in Nangang Industrial Zone. The project location is shown in Figure 4.1-1

Construction scale: one construction Receiving terminal, construction scale of 500×104t/a, construction of 10 20×104m3 LNG storage tanks and supporting process equipment, and auxiliary public works facilities. Two 20×104m3 LNG storage tanks will be reserved in the future; construction One for each of the intake and outlet ports; one for the construction of a reliable berth of 1 to 266,000 square LNG ships and one for the workboats. After the project is completed, the LNG loading capacity is 170×104t/a, and the maximum gasification external transmission capacity is 6000×104Nm3/d.

The total investment of the project is 203.349 million yuan, and the construction period is about 44 months (including construction preparation period)

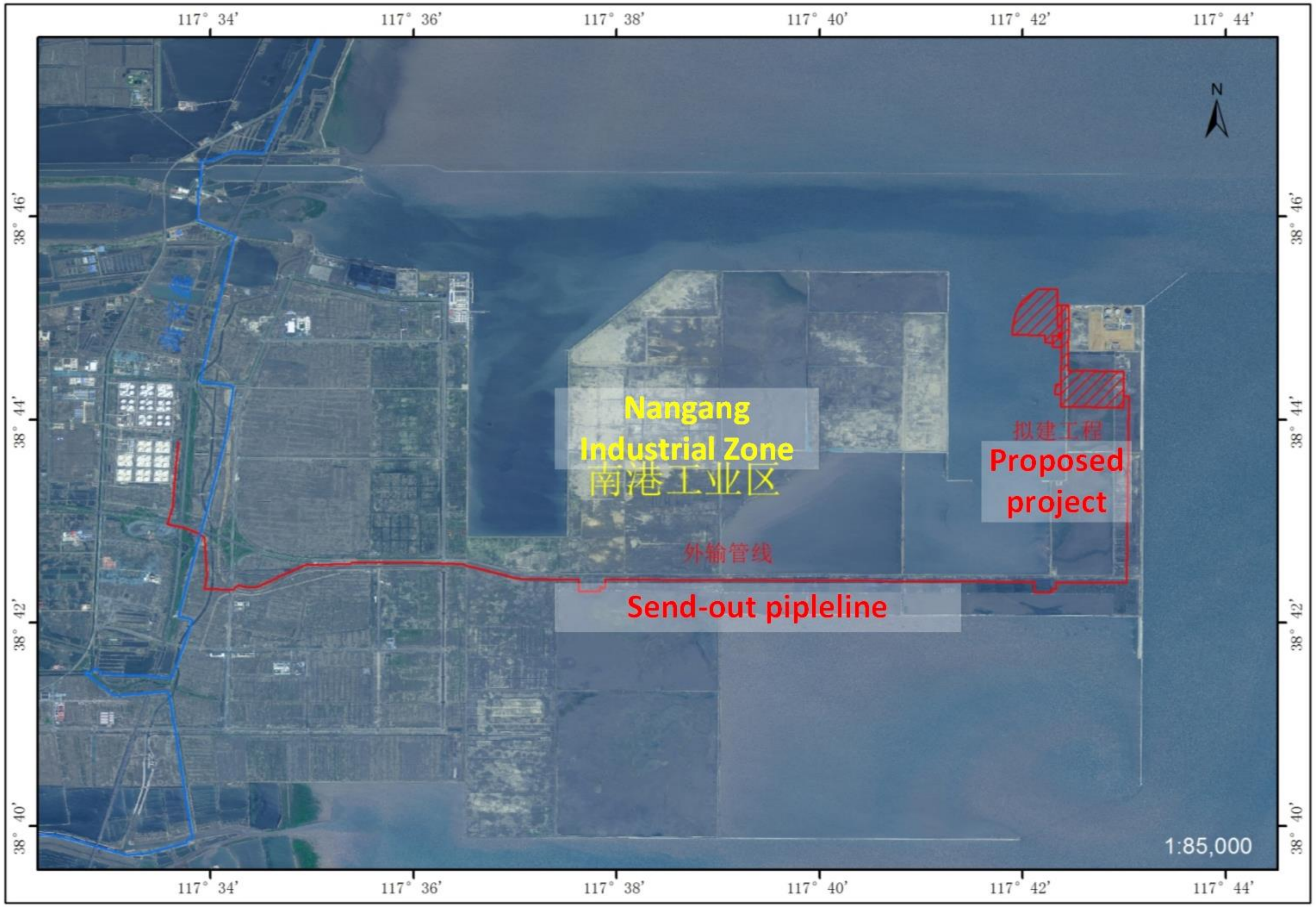


Figure 4.1-1 Project location

4.2 Layout of piers and receiving terminal and structure and dimensions of hydraulic structures

4.2.1 Layout of LNG receiving terminal

The north boundary of the receiving terminal of this project is 391 m from the south wall of Sinopec LNG Project, 40 m from the west boundary axis of Donggangchi dike and 264 m from the east boundary. The site is divided into LNG storage tank area, process area, auxiliary production area, administrative office area, tanker loading area, flare area, fire station.

Table 4.2-1 Main construction contents and scale of LNG receiving station

Sequence number	Project Name	Footprint (M2)
A	**Storage tank area**	**234253**
1	Twelve storage tanks	79764
2	Shower Valve Room One	81
3	Rain valve room two	81
4	Shower Valve Room No.3	81
5	Four collection tanks	121.5
6	Tank area road	20478.2543
7	Outdoor operation area and safe distance area	114299
8	Pipe gallery	19347
Two	**Process area**	**70516**
1	BOG compressor shed	1702
2	Shower Valve Room Four	31
3	Recondensation zone	320
4	High-pressure pump area	1100
5	IFV carburetor	400
6	SCV Carburetor	1800
7	External transport process equipment area	4000
8	Outdoor operation area and safe distance area	57163
9	Pipe gallery	4000
Three	**Loading area**	**52835**
1	Loading control room	280
2	Loading shed	4616
3	Rain valve room	81
4	Liquid collecting pool	20.25
6	Outdoor operation area and safe distance area	46877.9
7	Pipe gallery	960
Four	**Common device area**	**11021**
1	**Seawater intake area**	
1.1	Seawater pump house	2500
1.2	Chlorine room and chemical warehouse	594
1.3	Boiler House and Softening Water Station	315
1.4	Regional substation	663
1.5	Sea water intake area road	519
1.6	Seawater intake area greening	5370
1.7	Sea Water Intake Corridor	1060
2	**Public works area**	
2.1	Substation	1843
2.2	Generator house	275
2.3	Air pressed nitrogen station	301
2.4	Maintenance shop and warehouse	1093
2.5	Comprehensive warehouse	1093

2.6	Central control room	1287
2.7	Laboratory	580
2.8	Fresh water pump house	375
2.9	Water jug, 100 m3	20
2.10	Fire hydrant, 1200 m3	145
2.11	Public works area road	591
2.12	Roads and Greening in the Area	19688
Five	**Fire station area**	**5517**
1	Fire fighting complex	960
2	Training tower	24
3	Training ground	1600
4	A road	1450
5	Afforest	1483
Six	Administrative office area	**17157**
1	Complex building	2778
2	Inspection office building	0
3	Main guard	97
4	Domestic sewage treatment area	162
5	Sports field	3500
6	Fire escape and safe distance	8120
7	Afforest	2500
Seven	**Flare region**	**12135**
1	Flare	3519
2	Sewage treatment area	800
3	Field enclosure	468
4	Afforest	7348

Figure 4.2-1 The general plane position chart

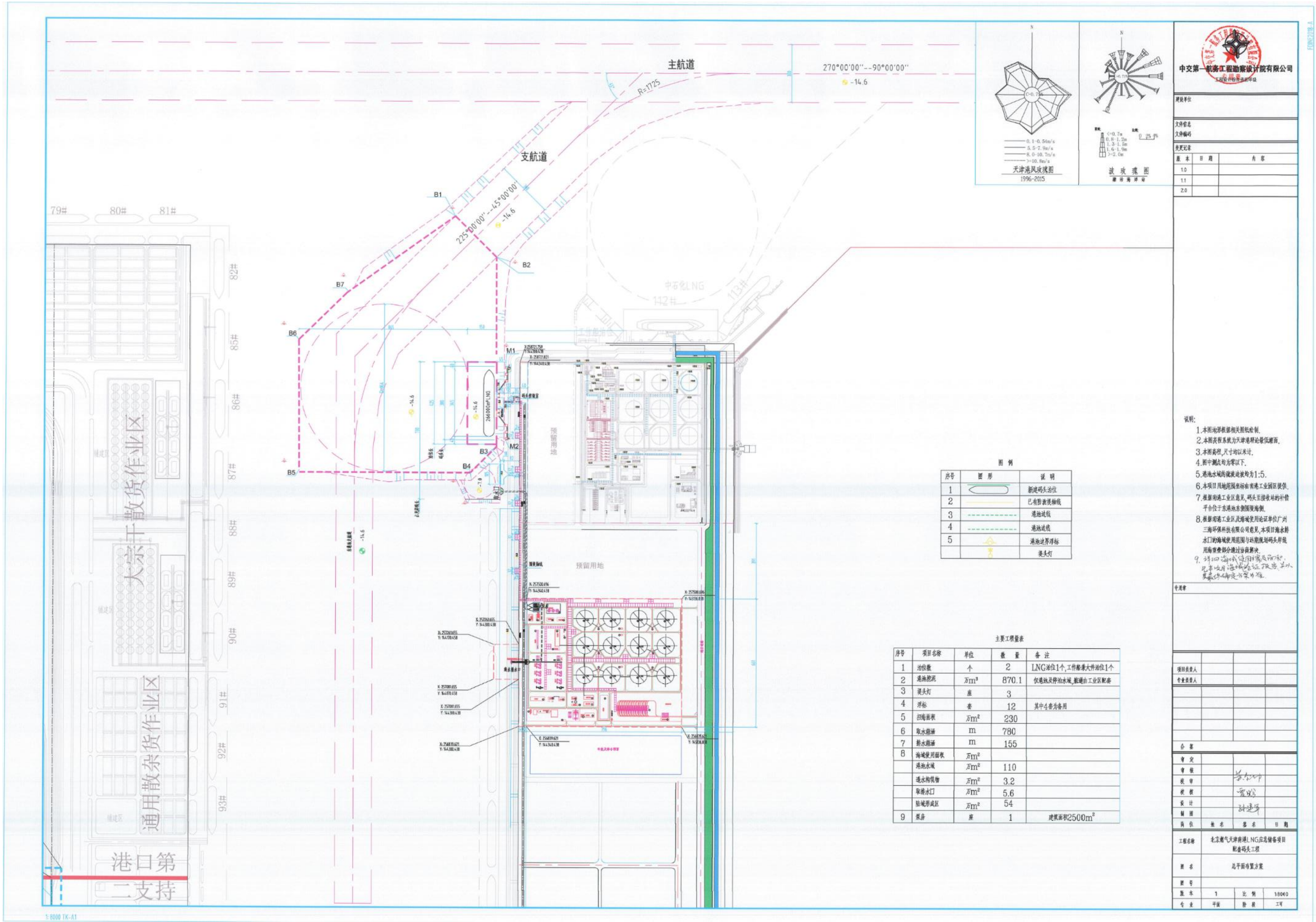


Figure 4.2-2 The general layout of the project (a)

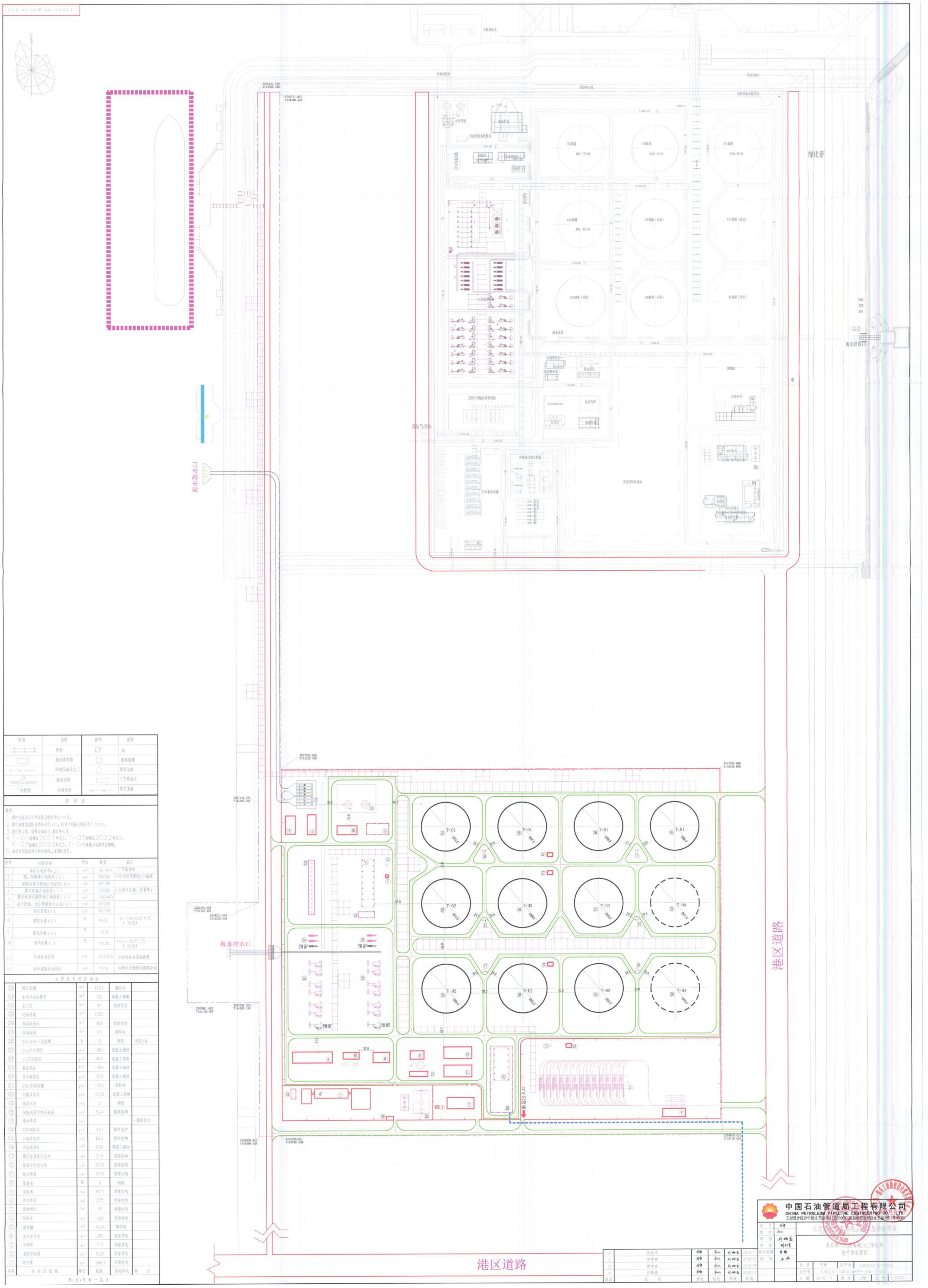


Figure 4.2-3 The general layout of the project (b)Figure 4.2-4 Receiving station floor plan (partial enlargement)

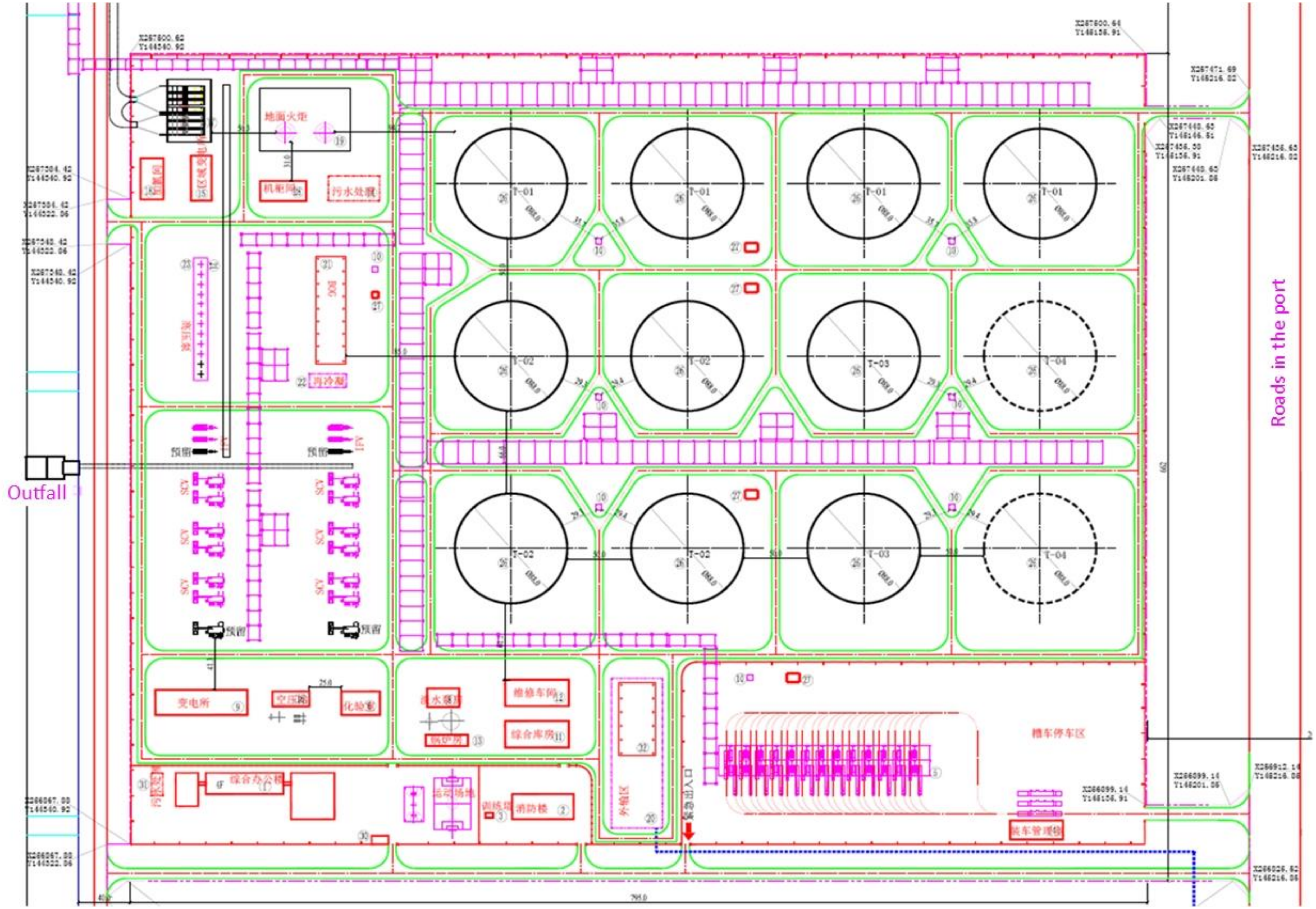


Figure 4.2-5 Receiving station floor plan (partial enlargement)

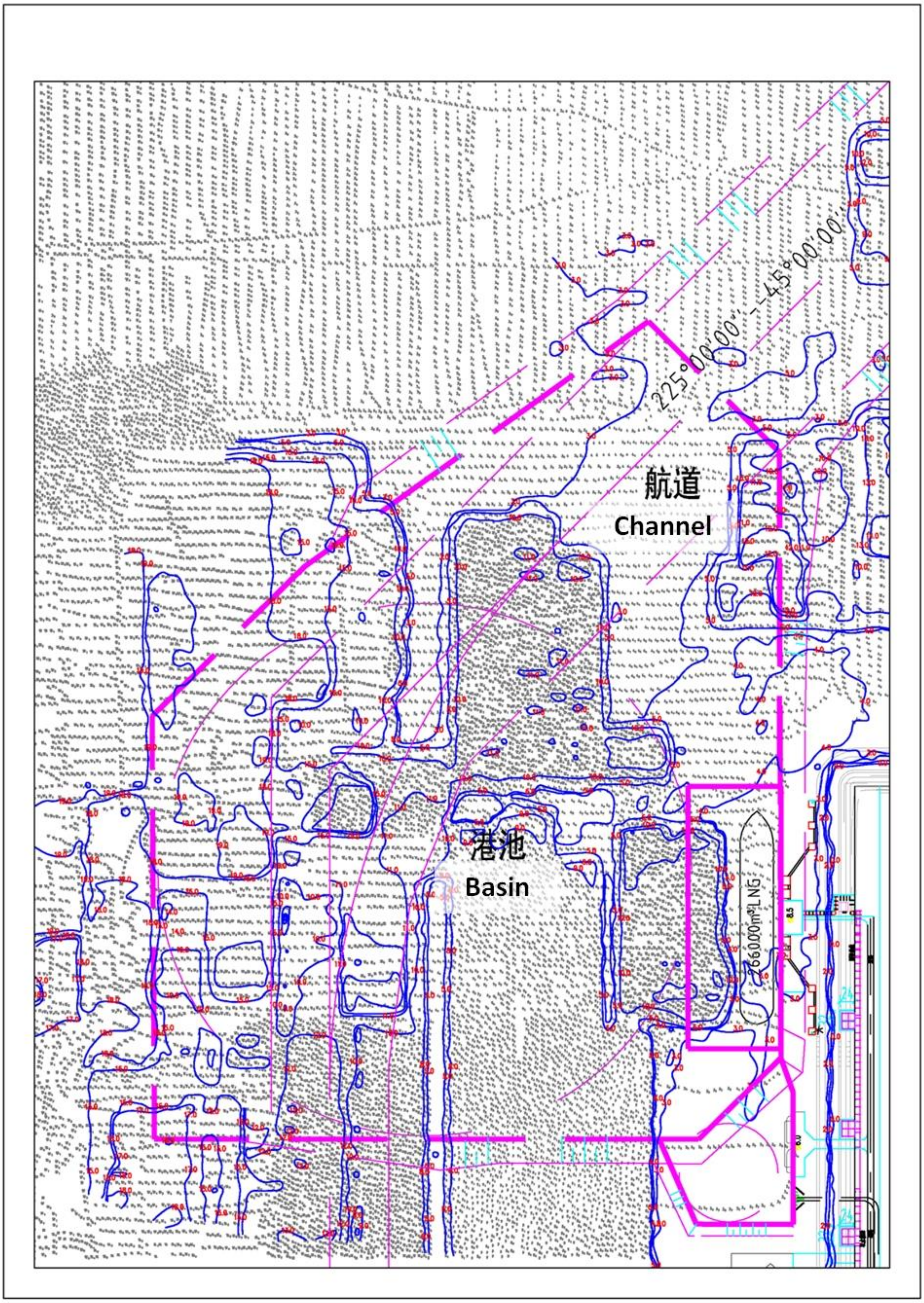


Figure 4.2-6 Schematic diagram of water depth topography near LNG terminal

4.2.2 Terminal and intake and outfall layout

(1) LNG ship terminal

The LNG terminal is located on the north bank of the east side of the East basin. It is arranged in a butterfly style with a length of 380m. The work boat dock is located in the southwest of LNG Terminal. The berth is 105m long and 18m wide.

(2) Intake, outfall and π-bend base piers

A water intake is arranged on the south side of the LNG berth, adjacent to the south side of the workboat berth. The water culvert is buried along the planned public passage on the east side of the East basin and adjacent to the LNG pipe corridor. The seawater drain is arranged on the east side of the east breakwater, about 870m from the water intake, and is discharged to the outer sea through the east tide levee. The displacement is 58800m3/h (16.33m3/s) and the diffusion coefficient is 5m2/s. The drainage water temperature is always lower than the water intake 5 °C.

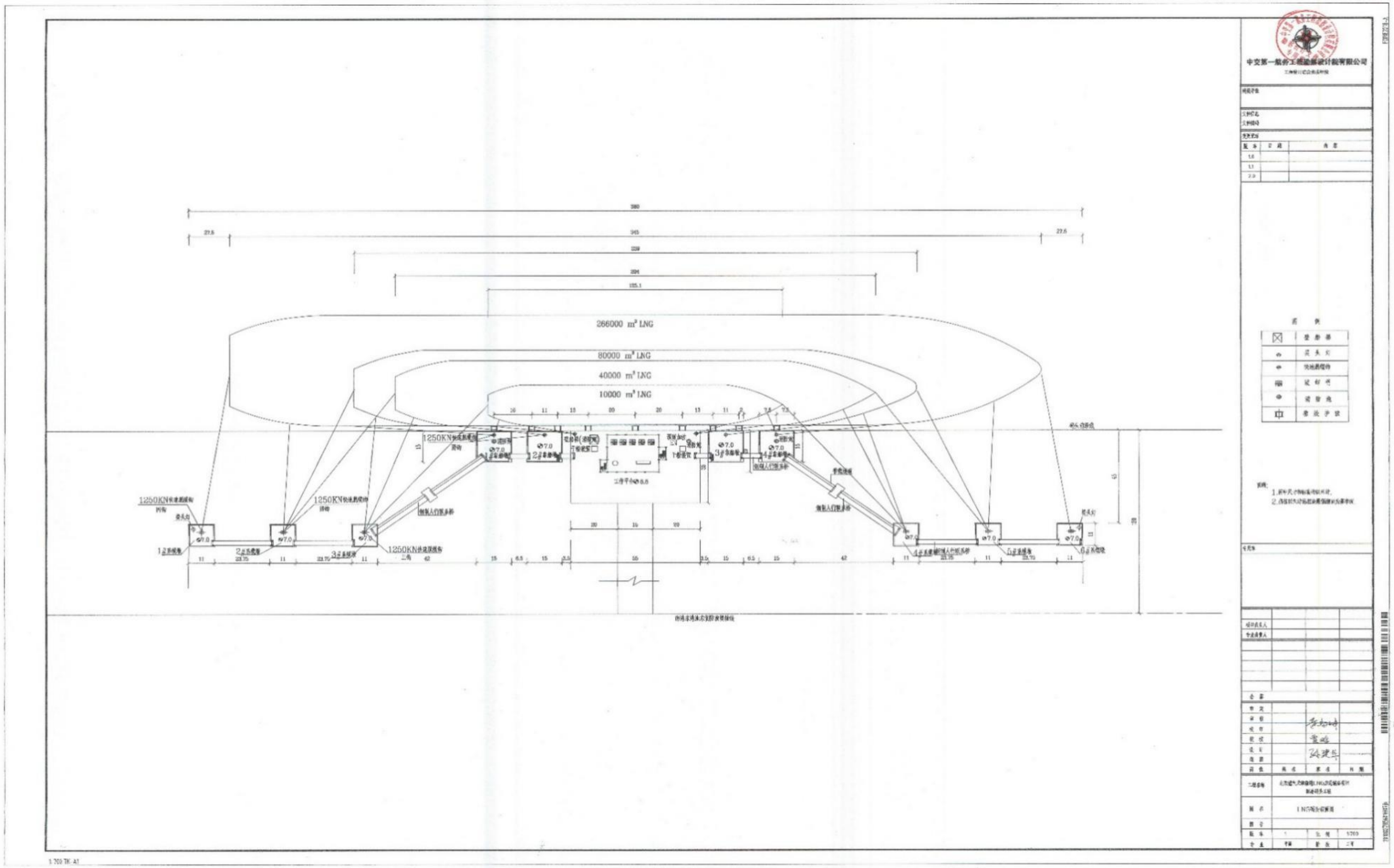


Figure 4.2-7 LNG terminal floor plan

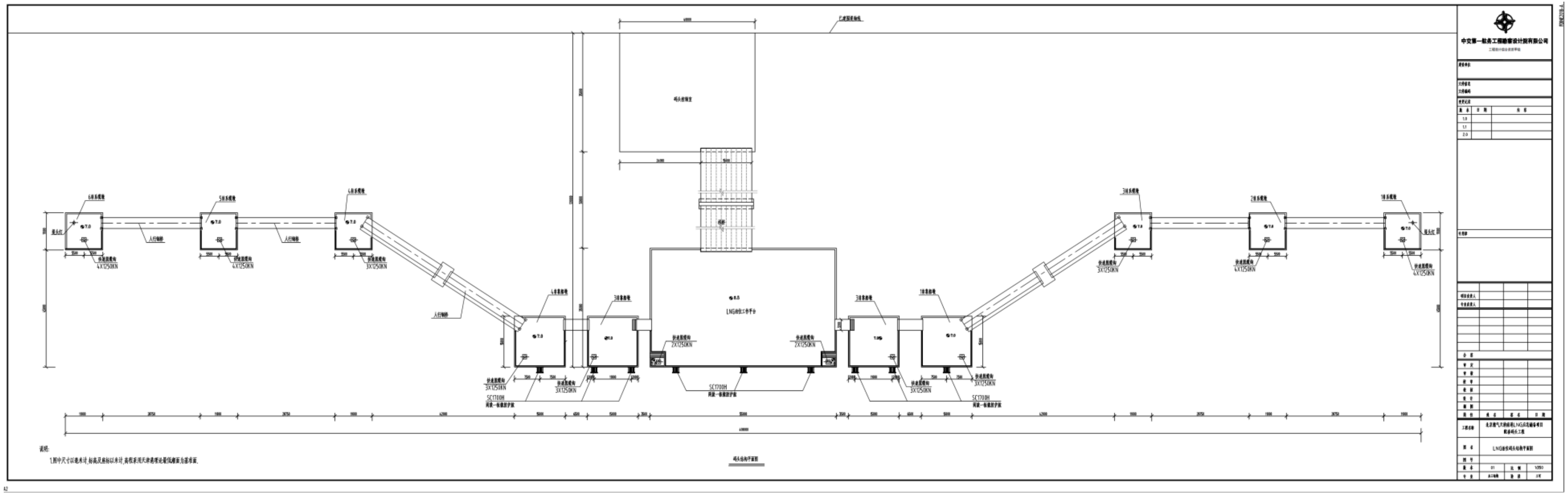


Figure 4.2-8 LNG terminal structure general plan

4.3 Utilities

4.3.1 Water supply and drainage for the LNG terminal

4.3.1.1 Volume and quality of water supply

See Table 4.3-1 for the requirement in the volume and quality of water supply for Receiving terminal and LNG vessel-unloading dock.

Table 4.3-1 Statistics of Water Consumption

S.N.	Type of Water Supply	Water Consumption (m3/d)	Water Quality Standard	Remark
1	Domestic water	24 m^3/d	Meeting GB5749-2006	Continuous
2	Water for LNG vaporization	58800m^3/h		Continuous
3	Water for flushing equipment and site of Receiving terminal	88 m^3/d		Intermittent
4	Water for landscaping	61 m^3/d		Intermittent
5	Make-up water for production water tank	25m^3/h		Intermittent
6	Unforeseen water consumption	17.3 m^3/d		Intermittent
7	Production water of process system	3.5 m^3/h		Continuous
8	Water for vessels	495 m^3/d	Meeting GB5749-2006	Intermittent

4.3.1.2 Water source

(1) Fresh water

The fresh water source is based on the city water supply network near the Receiving terminal, with water quality meeting the requirement of Standards for Drinking Water Quality (GB5749-2006). The fresh water is mainly used for the production, life, pressure stability test of fire water network, pipeline flushing after firefighting, and other purposes in the Receiving terminal (including terminal).

After up-to-standard treatment, the domestic sewage and production wastewater can be used as the water source for landscaping and flushing of equipment and site in the Receiving terminal.

(2) Seawater

The Receiving terminal is constructed near the sea, therefore it's considered to pump seawater from the sea area in the vicinity as the water for heat-exchanging of LNG vaporizer, as well as for the fire water of terminal and Receiving terminal.

4.3.1.3 Plan of water supply

The water supply system of the project is divided into four main systems, i.e. domestic water system, production water system, fire water system, and seawater system etc.

(1) Domestic water system and production water system

This system is used for supplying domestic water, production water, water for eye-washers, and water for showering.

The production water supply system is composed by production water tank and production water pumps. In the Receiving terminal, it is arranged with 1 set of production water tank with effective volume of 1200m3 (in which 100m3 is used for pressure stability of fire water network and flushing of pipe network) and 2 sets of production water pumps (1 in use and 1 standby, Q= 35m3/h, H= 60m, sharing 1 set of frequency converter). The fresh water from the city water network first enters into the production water tank through pipeline, and is then transferred to various water-using points after pressurized by the production water pump.

The domestic water supply system is composed by domestic water tank, domestic water pumps, and chlorine dioxide generators. In the Receiving terminal, it is arranged with 1 set of domestic water tank with effective volume of 100m3 (in which 100m3 is used for pressure stability of fire water network and flushing of pipe network) and 2 sets of domestic water pumps (1 in use and 1 standby, Q= 35m^3/h, H= 60m, sharing 1 set of frequency converter). The fresh water from the city water network first enters into the domestic water tank through pipeline, and is then transferred to various water-using points after pressurized by the domestic water pump. In order to ensure the quality of domestic water, 2 sets of chlorine dioxide generators are arranged (1 in use and 1 standby) to charge chlorine dioxide into domestic water tank. See Figure 4.3-1 for detailed process of water supply.

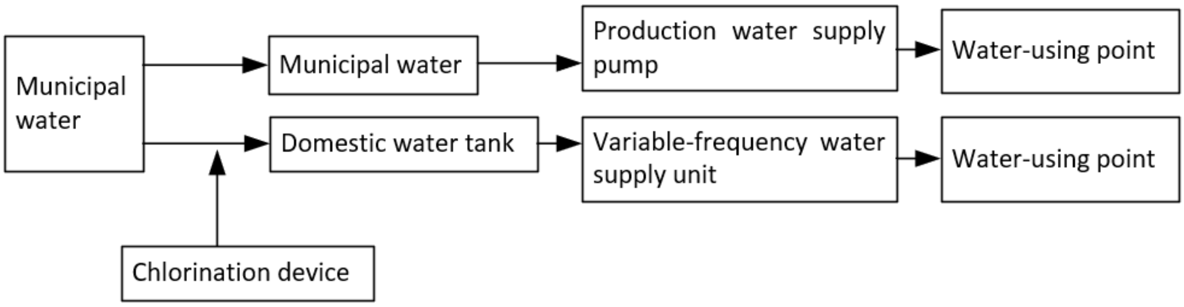


Figure 4.3-1 Flow Chart of Domestic & Production Supply Water

The outdoor production and domestic water pipelines in the Receiving terminal are laid underground, and the pipelines adopt HDPE plastic water supply pipes.

(2) Fire water system

The high-pressure fire water system is used for supplying fire water for process units & auxiliary production units in the Receiving terminal and the terminal . The fire water of this project adopts sea water, and fresh water is adopted for pressure-holding of the firefighting system under non-fire conditions, and the fresh water for pressure-holding is supplied by the pressure-holding system.

(3) Seawater system

The seawater is mainly used for the heating-up of LNG vaporization. Main structures and equipment include underwater seawater intake head, gravity intake pipelines, seawater intake (including filtering pond, front pond of pump station, and suction sump), seawater (fire-fighting) pump room, electric gate valves, electric grid cleaning machine, rotary filter screen, seawater pumps, electric single-girder crane, and seawater chlorination device etc. See Figure 4.3-2 for detailed process of seawater supply.

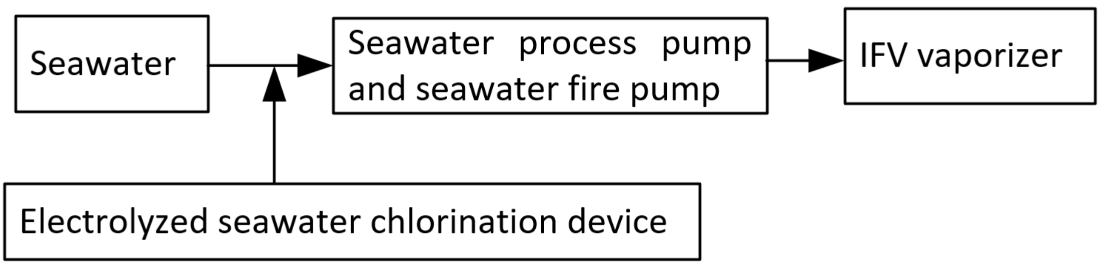


Figure 4.3-2 Flowchart of Seawater Supply

The designed flowrate of seawater pump is determined by the maximum temperature drop of 5℃ for the seawater used for LNG vaporization. In the project, 4 sets of vertical long-arm seawater pumps are arranged, meanwhile, the position for future expansion of 3 sets of seawater pumps is reserved.

In order to effectively prevent the breeding of bacterium and algae, the sodium hypochlorite generator is arranged as the seawater chlorination device, with the capacity of Q=120kg/h (effective chlorine). The effective chlorine charging points include the filtering pond (before the electric grid cleaner) of water intake and the water inlet of pump (seawater pump and seawater fire-fighting pump). At the filtering pond of water intake, the effective chlorine charging mode is continuous charging, with the charging amount of reaching 1.0~1.5ppm; and the charging mode is charging by impact, with charging amount reaching 3ppm, at the frequency of 30 minutes at a time and twice per day.

After heat-exchanging with intermediate fluid vaporizer (IFV), the cold water is discharged into the sea floor far away from the seawater intake through the seawater discharge pipeline. 2 pieces of DN2400 seawater supply pipelines (for the consideration of future seawater consumption amount) are laid underground in the Receiving terminal for the purpose of transferring seawater to the vaporizer. The pipelines adopt GRV pipes of socket connection.

4.3.1.4 Main equipment and work quantity of water supply system

See Table 4.3-2 for the main equipment and work quantity of water supply system.

Table 4.3-2 Main Equipment and Work Quantity of Water Supply System

S.N.	Name	Spec. and Parameters	Unit	Quantity
1	Seawater process pump	(See the sub-report of terminal for detail)	set	4
2	Sodium hypochlorite generator	120kg/h	set	1
3	Variable-frequency domestic water supply unit	25m3/h H= 60m, including 3 sets of water supply pumps (with the specification of 25m3/h H= 60m each), 1 set of variable-frequency controller and relevant accessories.	set	1
4	Chemicals dosing device of domestic water	50g/h	set	2
5	Residual chlorine detection device		set	1
6	Production water supply pump	Q=35m^3/h，H=60m	set	2

4.3.1.5 Drainage volume

There is no discharge of production and domestic sewage at the LNG vessel-discharging terminal . See Table 4.3-3 for the drainage volume in the Receiving terminal

Table 4.3-3 Statistics of Drainage Volume

S.N.	Name of Drainage	Drainage Volume	Frequency of Drainage	Remark
1	Domestic drainage of Receiving terminal	21.6 m^3/d	Continuous	BOD_5，COD，SS
2	Waste water discharge of LNG vaporization	61776m^3/h (future)	Continuous	Seawater
3	Waste water after flushing of the equipment and site of Receiving terminal	88 m^3/d	Intermittent	Small amount of oil stains and impurities

4.3.1.6 Drainage Plan

This project is arranged with four drainage systems, i.e. domestic sewage, oil-containing sewage, seawater drainage, and stormwater.

(1) Domestic sewage drainage system

This system is mainly used for collecting and discharging the domestic sewage of toilets, showering, and other facilities in the buildings of various working areas. After pretreatment by the septic tank, the domestic sewage discharged from various buildings are discharged into the main pipe of domestic sewage by gravity flow and transferred into the regulating pond of domestic sewage treatment unit, and then lifted by the domestic sewage lifting pump to the integrated treatment unit of domestic sewage for treatment, with treatment capacity of Q=5m m3/h. After treatment by the unit, the quality of domestic sewage shall reach the water-using standard of city landscaping of Code for Design of Wastewater Reclamation and Reuse and The Reuse of Urban Recycling Water—Water Quality Standard for Urban Miscellaneous Water Consumption. After up-to-standard treatment of domestic sewage, some of it will be used as the water for landscaping of Receiving terminal, road spraying, and ground flushing, and the other of it will be discharged into the domestic sewage collection sump and will be treated by the sewage treatment plant of the port area. The indoor domestic sewage adopts UPVC plastic drainage pipes connected by adhesion; and the outdoor underground domestic sewage network adopts HDPE double-wall corrugated pipes of socket connection.

(2) Oil-containing sewage drainage system

The oil-containing sewage mainly comes from various installations or units which may or actually discharge oil-containing sewage. After flowing into the oil-containing sewage collection sump through the gravity pipelines, the oil-containing sewage discharged from various installations areas will be lifted by the oil-containing sewage lifting pump to the oil-containing sewage treatment unit, with designed treatment capacity of Q= 5m3/h. The oil-water separation unit includes the working sections of oil-separation with inclined plate and filtering treatment, so as to ensure that the discharged water quality of oil-containing sewage meets the standard of recycling; and separated waste oil will be stored in the slop tank and periodically transported out. After treatment of oil-containing wastewater, the sewage will be transferred into the domestic sewage treatment unit for biochemical treatment together with domestic sewage. After up-to-grade treatment, it can be used as the water for landscaping of Receiving terminal, road spraying, and ground flushing; and the sludge will be transported out regularly. HDPE plastic drainage pipes are adopted for the drainage of oil-containing sewage.

(3) Seawater drainage system

Such drainage is the seawater after heat-exchanging through intermediate fluid vaporizer. In this project, 4 sets of intermediate fluid vaporizers are arranged, and additional 2 sets will be added in future. After heat-exchanging, the seawater will be collected by the drainage open-ditch and then will be discharged into nearby sea area through the connected off-station drainage buried-culvert. During Phase-I construction, future seawater drainage volume needs to be considered in the designing of seawater drainage open-ditch.

4.3.1.7 Main equipment and work quantity of drainage system

See the following table for the main equipment and work quantity of drainage system.

Table 4.3-4 Main Equipment and Work Quantity of Drainage System

S.N.	Name	Spec. and Parameters	Unit	Quantity
1	Oil-containing sewage treatment unit	$5m^3/h$	set	1
2	Domestic sewage treatment unit	$5m^3/h$	set	1
3	Drainage pump	$Q=10m^3/h$, H=20m	set	16
4	Drainage pump	$Q=10m^3/h$, H=60m	set	4

4.3.2 Heat supply

The heat-supply pipe network of the industrial zone is unbuilt. In order to meet the needs of heating for processes and buildings in the station, 1 set of hot-water boiler room is separately arranged in the Receiving terminal which adopts atmospheric-pressure hot water boiler as the heat source. The hot water circulation system adopts open-type circulation system and skid-mounted equipment.

4.3.3 Compressed Air and Nitrogen System

4.3.3.1 Compressed air system

The instrument air and plant air system in the Receiving terminal mainly supply the compressed air for air-operated valves, SCV, flare, tanker loading system, nitrogen generation system, and utility station etc.

According to the consumption amount of instrument air and plant air in the Receiving terminal, the air compressor room and 1 set of storage tank is arranged in the station, and the output rate of compressed air from the air compressor is 2000Nm3/h.

See Table 4.3-5 for the consumption amount of compressed air for the main facilities in the Receiving terminal

Table 4.3-5 Compressed Air Consumption

S.N.	Name of Unit or Facility	Volume of Purified Air (m3/h)		Volume of Unpurified Air (m3/h)	
		0.6 MPa		0.6 MPa	
		Continuous	Intermittent	Continuous	Intermittent
1	Air-operated valves	550	550		
2	Flare	4	120		
3	SCV	385	440		
4	Tanker loading system	7	7		
5	Consumption for nitrogen generation	880	880		
6	Maintenance purging			30	200
	Total	1826	1997	30	200

The instrument air and plant air system are mainly composed by air compressors, drying & purification skids, and air storage tanks etc. After drying and purification, the compressed air shall meet the following specification, Water dew point ≤-30℃@0.6MPag; Granularity ≤0.1μm, and filtering precsion of 99.9%.

4.3.3.2 Nitrogen system

It's composed by nitrogen-supply BOG compressor, utility station, low-pressure delivery pump, flare, LNG storage tank, high-pressure delivery pump, vessel-unloading system, and tanking loading system etc.

According to the consumption amount of nitrogen in the Receiving terminal, 2 sets of PSA nitrogen generation systems are arranged in the Receiving terminal to supply continuous nitrogen for internal use of the Receiving terminal, and 1 set of liquid nitrogen system to supply intermittent nitrogen. The volume unit of nitrogen system, m3,means the volume of nitrogen under the condition of 0 ℃, 101.3 kPa, similarly hereinafter for the description of volume unit of nitrogen system.

The consumptions of nitrogen in the Receiving terminal mainly include two types, i.e. continuous nitrogen consumption and intermittent purging nitrogen. See Table 3.5-6 for demanded volume by different characteristics of using, and the nitrogen-using pressures are all ≥0.6MPa.

Table 4.3-6 Nitrogen Consumption

S.N.	Name of Unit or Facility	Consumption (m^3/h)		Pressure (MPa)
		Normal	Max.	

1	BOG compressor	106	156	0.6
2	BOG booster	53	50	0.6
3	Maintenance purging	0	120	0.6
4	Low-pressure delivery pump	0	20	0.6
5	LNG storage tank	0	100	0.6
6	High-pressure delivery pump	0	20	0.6
7	Vessel-unloading system	5	505	0.6
8	Tanker loading system	26	26	0.6
9	Flare system	30	500	0.6
	Total	220	1497	

The nitrogen system is mainly composed by PSA nitrogen-generation skid and liquid nitrogen system. Among them, the PSA nitrogen-generation skid is mainly composed by nitrogen filtering skid, nitrogen generator and buffer tank; the liquid nitrogen system is composed by liquid nitrogen storage tank, air-temperature vaporizer and electric auxiliary heater. The PSA nitrogen-generation skid supplies continuous nitrogen for the internal use of the Receiving terminal, and the pressure of nitrogen at the outlet of nitrogen-generation skid shall be ≥0.8MPa. The liquid nitrogen system is arranged outside the air-compressor room, adopting outdoor arrangement. The liquid nitrogen system is composed by 2 sets of liquid nitrogen storage tanks (1 in use and 1 standby), as well as autoboosting system, liquid nitrogen air-temperature vaprizer, liquid nitorgen electric auxiliary heater, and outlet pressure-regulating pipeline. The liquid nitrogen unit supplies intermittent nitrogen for internal use of the Receiving terminal, meanwhile serves as standby nitrogen source for PSA nitrogen-generation. The liquid nitrogen is outsourced, which is transported by tanker to the Receiving terminal and unloaded into the storage tank.

4.3.3.3 Main equipment and main work quantity

The air compressor and filtering & purification skid are arranged in the air-compression nitrogen generator room, 3 sets of oil-free screw-type air compressors (2 in use and 1 standby) are arranged, with single-set capacity of 1000Nm3/h and discharge pressure of 1.05MPa; there are two sets of drying & purification skids (1 in use and 1 standby), with single-set capacity of 2000Nm3/h, including gentle-heating regeneration drying unit, filtering unit, and compressed-air buffer tank etc. The volume of the air storage tank shall be able to meet continuous using of compressed air for 15 minutes in the Receiving terminal, with the volume of 120m3 and designed pressure of 1.6MPa.

The PSA nitrogen-generation skid is arranged in the air-compression nitrogen generator room, and 2 sets of PSA nitrogen-generation skids are arranged, with single-set processing capacity of 250Nm3/h and purity ≥99.0;And there are 2 sets of filtering skids, with single-set processing capacity of 250Nm3/h, and the filtering precision needs to meet the needs of nitrogen-generation skids and nitrogen in the plant. The nitrogen-generation skids adopt double-column or multi-column adsorption process.

The liquid nitrogen system is arranged with 2 sets of vertical liquid-nitrogen storage tanks, with single-set volume of 30m3; there are 2 sets of air-temperature vaporizers and 1 set of electric heaters as well as corresponding control system, with single-set designed capacity of 1600m3/h, for the purpose of meeting peak and intermittent nitrogen consumption. When 1 set of air-temperature vaporizer is defrosting, the other set will be running, and electric heater will be started when nitrogen temperature is lower than 0℃.

See Table 3.5-7 and Table 3.5-8 for the main equipment and work quantity of air-compression system and nitrogen system.

Table 4.3-7 Main Equipment and Work Quantity for Air-Compression System

S.N.	Equipment Name	Spec.	Quantity
1	Oil-free screw-type air compressors	Q=1000 Nm^3/h， 1.05MPa	3 sets
2	Drying & purification skids	Q=2000 Nm^3/h	2 sets
3	Compressed-air storage tank	V=120m^3， 1.6MPa	1 set

Table 4.3-8 Main Equipment and Work Quantity for Nitrogen System

S.N.	Equipment Name	Spec.	Quantity
1	PSA nitrogen-generation skid, supported with drying & purification skid	Q=250 Nm^3/h， purity ≥99%	2 sets
2	Liquid nitrogen storage tank	V=30 m^3	2 sets
3	Air-temperature vaporizer	Q=1600 Nm^3/h，	2 sets
4	Electric auxiliary heater	Q=1600 Nm^3/h，	1 set
5	Pressure-regulating device	Q=1600 Nm^3/h，	1 set
6	Nitrogen storage tank	V=20 m^3	1 set

4.3.4 HVAC

4.3.4.1 Heating System

GHP (gas-engine heat pump) heating is adopted for the comprehensive administration building, shift dormitory, multi-functional building and comprehensive fire-fighting building.

Air-conditioning heating is mainly adopted in the main guard room, substation, central control room & main control room, lab, terminal control room, tanker-loading management room, on-site rack room, and regional substation; and heating with electrical heater is adopted for rooms without air-conditioner.

Hot-water heating is adopted for sodium hypochlorite generation room, chlorine-generation room & chemicals warehouse, seawater (fire-fighting) pump room, air-compression nitrogen generation room, maintenance workshop & warehouse, fresh water pump room, boiler room & demineralized water room, and comprehensive

4.3.4.2 Air-conditioning system

(1) Central control room

Constant-temperature-humidity all-air conditioning system is adopted for the rack room, control room, and engineer room, 2 in use and 1 standby. Blast-resistant valves are all arranged at the fresh-air inlet and exhaust outlet of the air-conditioning system for terminal control room, so that the air inlet & outlet of the air-conditioner can be timely closed.

(2) Terminal control room and on-site rack room

Air-cooled cool-air air-conditioner is adopted for each room, meanwhile, air purifier is arranged for treatment of fresh air entering into the instrument room and control room. Blast-resistant valves are all arranged at the fresh-air inlet and exhaust outlet of the air-conditioning system for terminal control room, so that the air inlet & outlet of the air-conditioner can be timely closed.

(3) Main guard room and tanker-loading management room

Split-type heat-pump air-conditioner is arranged in each functional room according to demand.

(4) Office building, comprehensive fire-fighting room, and canteen

GHP air-conditioning system is adopted, and fresh-air system is considered for some tall-and-big space, as well as for other rooms with requirement of fresh air but without openable external windows. Split-type heat-pump air-conditioner is separately arranged for single electricity transformation & distribution room.

(5) Chlorine-generation room & chemicals warehouse, and air-compression nitrogen generation station

Air-conditioned cooling is arranged for the electricity-distribution control room or rack room, adopting split-type heat-pump air-conditioners.

(6) Substation and regional substation

Special air-conditioner for electricity-distribution room is adopted, and the load of air-conditioner is considered according to the equipment's heat-dissipating capacity, without consideration of fresh-air load.

(7) Lab

Air-cooled cool-air air-conditioner is adopted, without consideration of exhaust load.

4.3.4.3 Ventilation system

(1) BOG compressor shed and tanker-loading shed

In order to prevent the accumulation of combustible gas at the top of shed, ventilation with unpowered roof fan is arranged on top of the shed, at the frequency of 6 times/hour (only considering the space with exterior envelope).

(2) Central control room, terminal control room and on-site rack room

Mechanical ventilation system is arranged in the toilet, adopting diagonal-flow fan and make-up air from adjacent room by means of negative pressure, with ventilation rate of 10 times/hour. After-fire exhaust is arranged for rooms with gaseous media fire-extinguishing system, and the after-fire ventilation rate is calculated as 5 times/hour, and fire-fighting smoke-exhaust fan is adopted. Mechanical air intake-and-exhaust system is arranged in the electricity-distribution room and UPS room, adopting in-line fan for air intake and diagonal-flow fan for air exhaust.

Blast-resistant valve is arranged for each air inlet and air exhaust, air-tight valve is arranged at the air inlet and electric valve is arranged at the air exhaust to interlock with the fan.

(3) Chlorine-generation room and chemicals warehouse

Mechanical exhaust system is arranged for the purpose of removing indoor residual heat and dilute harmful gas. The exhaust rate is calculated by the residual heat removal and harmful gas, which shall be no lower than 12 times/hour. Axial-flow fan is adopted for exhaust from the top and bottom of room, and shutter is adopted for air makeup at the intermediate level. 2/3 of total exhaust amount is exhausted from the bottom area, and 1/3 of total exhaust amount is exhausted from the top area.

(4) Substation and regional substation

Exhaust with axial-flow fan and natural air-intake is adopted, and the ventilation rate is considered as 6 times/hour.

(5) Air-compression nitrogen-generation station and fresh-water pump room

The ventilation rate of fresh-water pump room is considered as 6 times/hour, and the ventilation rate of air-compression nitrogen-generation room is considered as 10 times/hour, both of them adopts exhaust with roof-mounted fans and natural air-intake.

(6) Lab

The fume hood adopts mechanical exhaust with variable-frequency fan, and the ventilation rate is adjusted according to the opening area of hood door; the exhaust system is shared by universal exhaust hood, adopting mechanical exhaust with diagonal-flow fan, and check valve is arranged at the outlet of each fan. All exhaust is lead to the roof through the air duct, which is exhausted out through the conical cowl connected to the fan and air duct. Because the ventilation hood and exhaust cowl adopt intermittent operation, their continuous operation time shall not exceed 2 hours, and natural air make-up is adopted.

(7) Comprehensive office building, main guard room, tanker-loading management room, and comprehensive fire-fighting building

Mechanical ventilation system is arranged in the toilet, adopting ceiling-suspended toilet ventilator for air exhaust, with ventilation rate of 10 times/hour. For ventilation and residual heat removal for electricity distribution room in winter and transition season, lover ventilating fan is adopted, with ventilation rate of 6 times/hour.

4.3.5 Maintenance workshop

The maintenance workshop is arranged with mechanical-maintenance team, electrical-maintenance team, and instrument-maintenance team. It's responsible for daily maintenance and minor repair of mechanical equipment, electrical equipment and instruments of the Receiving terminal. Overhaul and intermediate maintenance are contracted to other professional companies of maintenance and installation, and the maintenance & emergency-repair of the Receiving terminal rely on the pipeline maintenance & emergency-repair team. It's responsible for eliminating the faults occurred during normal production, emergency-repair of mechanical equipment, and elimination of punch-list items; responsible for daily maintenance for equipment and pipelines of the Receiving terminal, such as periodic lubrication, cleaning, and changing-lubricant, as well as changing pipe flanges and valve gaskets; and responsible for fabrication of some small, simple and urgent parts, as well as the re-processing of outsourced spare parts.

4.3.6 Fire Protection

4.3.6.1 Collaborative firefighting forces of the project

There is special-service fire brigade of the port area in the vicinity of the Receiving terminal, as follows,

Table 4.3-9 Condition of Special-Service Fire Brigade of the Port Area

Firefighting Organization	Types of main fire engines	Tonnage of Fire Engine	Distance to Receiving Station (km)	Time Needed to Arrive at Receiving Station (min)
Special-Service Fire Brigade of Tianjin Nangang	Turbo-jet fire engines 4 sets Foam-powder fire engines 2 sets Ladder trucks 1 set Foam fire engine 1 set	4t water/2t foam 5t water/4t foam/2t powder 21m，400kg 8t water/ 10t foam	25km	40

4.3.6.2 Fire Protection Plan

During the fire protection design of the project, 1 time of fire occurrence is considered at the same time in the terminal and Receiving terminal, the fire life in LNG tank farm is considered as 6h, and the fire life in process unit area and LNG tanker loading/unloading area is considered as 3 hours; and the fire life of the terminal is considered as 6h.

According to the characteristics of LNG, this project is arranged with various firefighting facilities including fire water system, high-expansion foam firefighting system, dry-powder firefighting system, gaseous firefighting system, fixed-type water-spray system, fixed-type water-curtain system, and mobile fire-extinguishers, and the firefighting facilities arranged in various areas are as follows,

(1) Terminal

Elevated remote-control firefighting water monitor & built-in water-curtain system, outdoor fire hydrant, fixed-type water-spray system, fixed-type water-curtain system (terminal apron), high-expansion foam fire-extinguishing system (liquid-collection sump of the terminal), dry-powder fire-extinguishing device, gaseous fire-extinguishing system (terminal control room), and mobile fire-extinguisher.

(2) LNG tank fram

Outdoor fire hydrant, fixed-type water-spray system (steel-structure platform on top of LNG storage tank), high-expansion foam fire-extinguishing system (liquid-collection sump of the terminal), dry-powder fire-extinguishing device (safety valve on top of LNG storage tank), and mobile fire-extinguisher.

(3) Process production area

Fixed-type firefighting water monitor, outdoor fire hydrant, high-expansion foam fire-extinguishing system (liquid collection sump of the terminal), fixed-type water-spray system (BOG compressor and BOG booster), and mobile fire-extinguisher.

(4) Tanker-loading area

Fixed-type firefighting water monitor, outdoor fire hydrant, high-expansion foam fire-extinguishing system (liquid collection sump of the terminal), mobile fire-extinguishers, and dry-powder fire-extinguishing devices.

(5) Auxiliary production area

Outdoor fire hydrants, mobile-type foam fire-extinguishing device, gaseous fire-extinguishing system (equipment room), and mobile-type fire extinguishers.

(6) Administrative office area

Gaseous fire-extinguishing system (central control room), outdoor fire hydrant, indoor fire hydrant, and mobile fire-extinguisher.

4.3.6.3 Fire water supply system

The high-pressure fire water system is used for supplying fire water for process units & auxiliary production units in the Receiving terminal and the terminal . The fire water of this project adopts sea water, and fresh water is adopted for pressure-holding of the firefighting system under non-fire conditions, and the fresh water for pressure-holding is supplied by the pressure-holding system. The fire water system is composed by seawater fire water pump station, fresh-water pressure-holding system, and fire water network etc.

In order to reduce the corrosion of pipelines by seawater, it's necessary to drain the seawater out of the pipeline everytime after firefighting and adequately flush the pipelines with fresh water.

In this project, 1 set of seawater (firefighting) pump room is arranged, where 4 sets of seawater firefighting pumps are arranged inside the pump room, including 2 sets of electric pumps and 2 sets of diesel pumps (2 in use and 2 standby), adopting the type of vertical long-shaft pumps. In the fresh-water pump room, 2 sets of fresh-water pressure-stabilizing pumps are arranged (1 in use and 1 standby. Single pump: Q=54m3/h, H=120m), as well as 2 sets of fresh-water pressure-testing pumps (1 in use and 1 standby. Single pump: Q=1200m3/h, H=120m).

Under nonfire conditions, the firefighting press-stabilizing pump maintains the system pressure of firefighting pipe network. In case of fire, start the fire pump for fire extinguishing. After fire-extinguishing is finished, start the fresh-water firefighting pump to flush the firefighting pipe network.

The Receiving terminal adopts DN500 firefighting main pipeline, which is laid underground in a ranged manner, and GRE pipes are planned to be adopted for the selection of pipe material. Pressure-relief device is arranged at the connection between the water outlet main pipe of seawater firefighting pump and the firefighting main pipe of Receiving terminal. Galvanized steel pipes are adopted for the water-spray system.

4.3.6.4 Fire-fighting and extinguishing system

(1) Outdoor fire hydrants

The high-pressure fire water system network directly supplies water to the outdoor fire hydrants, and aboveground pressure-regulating fire hydrants are selected. Each fire hydrant has 2 DN80 connectors and 1 DN150 fire engine connector, and the flow rate of fire hydrant shall be no less than 15L/s. Each fire hydrant is arranged along the road, with its large-caliber water outlet facing the road.

The fire hydrant shall be 1~5m to the pavement edge, no less than 5m to the building's outer wall, and no less than 15m to protected equipment. The distance between fire hydrants arranged at the process area, tank farm, tanker-loading area, and terminal trestle shall be no more than 60m, and the distance between fire hydrants in other areas shall be no longer than 120m.

(2) Firefighting water monitor

In this project, 3 types of firefighting water cannons are arranged, including fixed-type remote-control firefighting water monitor, fixed-type manual firefighting water monitor, and mobile firefighting water monitor.

① Fixed-type remote-control firefighting water monitor

In the terminal area of the project, the fixed-type remote-control firefighting water monitor is arranged on the firefighting monitor tower of the terminal platform, ensuring that the effective designed horizontal range can cover the process facilities on LNG vessels and the process loading/unloading facilities on the terminal .

The horizontal & vertical range of the remote-control firefighting water monitor shall be able to cover the targeted protection area. The rotation and water-inlet control valve are electrically controlled, which are remotely operated in the terminal control room, and able to be remotely controlled and manually operated. The remote-control firefighting monitor is of explosion-proof type.

② Fixed-type manual firefighting water monitor

The fixed-type firefighting water monitors are arranged in the process area and tanker-loading area, so as to protect process facilities such as vaporizer, compressor, high-pressure pump and tanker-loading system etc. There shall be at least 15 meters of safety distance between the manual fixed-type firefighting water monitor to the protected equipment. If there is any difficulty in arrangement beyond 15 meters of safety distance, alternative protection shall be considered.

The rated flow rate of manual firefighting monitor is 50L/s, and rated working pressure of water monitor is 0.8MPa. When spraying water at straight flow in still air, the minimum horizontal range shall be 60m. The form of outlet water can be straight-flow water spray or fog spray.

The rotation range of firefighting monitor: Horizontal movement angle of 360° and vertical movement angle of -50° to 70°.

③ Mobile firefighting water monitor

In this project, 2 sets of mobile firefighting water monitors are arranged near the high-pressure pump, as the supplement for fixed-type firefighting system in case of accident.

The outlet pressure of mobile firefighting water monitor is 0.8MPa, with minimum flow rate of 50L/s and effective range of no less than 50 meters. The form of outlet water can be straight-flow water spray or water fog. Under the condition of straight-flow water spray, the range of horizontal rotation angle shall be 90°, with 45° respectively from the center to either side; and the range of vertical rotation angle shall be 60° above the horizontal surface.

(3) Indoor fire hydrant

Indoor fire hydrants are arranged in buildings, such as the comprehensive building of the Receiving terminal, maintenance workshop and warehouse, and BOG compressor room etc., and the water source is connected from the fire water system pipe network. The indoor fire hydrants are pressure-relief and pressure-stabilizing indoor fire hydrants, with specification of DN65 and outlet pressure of no more than 0.5 MPa.

(4) Fixed-type water-spray firefighting system

Fixed-type water-spray systems are arranged at the following equipment or areas: Pump platform on top of LNG storage tank, BOG compressor shed, BOG booster shed, and the emergency evacuation route of the terminal .

The fixed-type water-spray system is composed by components such as pipes, deluge valves unit, filter and spray nozzles etc., which are used for providing cooling protection for protected objects. The system adopts the control mode of remote control in the control room or mechanical emergency manual control. The water source of the water-spray system comes from the fire water system pipe network.

The water-supply spray intensity of the maintenance channel on the top of each tank is 10.2L/min•m2, and the water-supply intensity of tank-top pump outlet, instruments, valves, and safety-valve platform is 20.4L/min·m2, with water-supply duration considered as 6 hours.

The water-supply spray intensity of BOG compressor shed and BOG booster shed are 9L/min·m2, with water-supply duration considered as 3 hours.

The water-supply spray intensity of the terminal 's emergency evacuation & escape route is 10.2L/min·m2, with water-supply duration of no less than 6 hours.

(5) Fixed-type water-curtain firefighting system

1 set of water-curtain system is arranged at the terminal apron, which is composed by pipes, deluge valves unit, filter, water-curtain spray-nozzles and other components, adopting the control mode of automatic control, remote-control, or mechanical emergency manual control. The water-supply spray intensity of water-curtain is 2.0L/s·m, with water-supply duration of no less than 6 hours.

The self-contained water-curtain system on the monitor tower of the terminal 's remote-control firefighting water monitor provides cooling protection for the monitor tower. The valve of the cooling water-curtain system for the monitor tower is normal-open; once the electric valve of the firefighting water monitor is opened, a small branch of water flowing to the water monitor will go to the water-curtain system, meanwhile providing cooling protection for the monitor tower.

(6) High-expansion foam fire-extinguishing system

High-expansion foam fire-extinguishing system is arranged at each LNG accident collection sump. The purpose for the arrangement of high-expansion foam fire-extinguishing system is to control the volatile of LNG into the LNG collection sump. Designed supply intensity of foam mixture is 7.2L/min·m2, with supply duration of foam mixture of 40min. The original solution of foam adopts 3% high-expansion foam original-solution. The high-expansion foam generator with foam expansion of 500 times is selected.

Automatic control mode is adopted for the high-expansion foam fire-extinguishing system. At least 3 low-temperature detectors are arranged in each LNG accident collection sump. After 2 low-temperature detectors detect leakage of LNG into the collection sump, the fire alarm control panel will start the electric valve by interlock, thus the high-expansion foam fire-extinguishing system will be activated, spraying foam into the collection sump.

All the foam solutions prepared shall be seawater-resistant, heat-resistant and smoke-resistant, and shall meet the requirement of environmental protection.

(7) Gaseous fire-extinguishing system

Fixed-type gaseous fire-extinguishing system is arranged in the central control room of the Receiving terminal, equipment room, and terminal control room, and Heptafluoropropane is selected as the fire-extinguishing agent. After the two routes of fire detectors of the protection area give out alarm, the system can be automatically started by interlock, which can also be started by remote-control or manually.

(8) Dry-powder fire-extinguishing system

Fixed-type dry-powder fire-extinguishing system is arranged at the relief valve on top of each LNG tank, for the purpose of extinguishing the fire at the outlet of relief valve. The storage amount of dry powder for each unit shall be no less than 1000kg, with reserve level of 100%. The system adopts automatic control mode, automatically interlocking with the signals of flame detector. This system can also be started by remote-control or manually.

2 sets of dry-powder monitor fire-extinguishing devices are arranged at the LNG terminal , and the storage amount of dry powder for each set of device shall be no less than 3000kg. Each set of device is arranged with 1 dry-powder monitor and 2 dry-powder reels. The system adopts the control mode of remote control or manual control.

4.3.6.5 Mobile fire-extinguishing devices

Dry-powder, CO2 portable and trolley-type fire extinguishers are arranged in the terminal , LNG tank farm, process unit area, tanker-loading area and various buildings, to facilitate extinguishing incipient fire. 1 set of mobile powder trolley-type fire-extinguisher is arranged at the diesel generator unit, to facilitate timely putting off the fire of liquid diesel. The maximum protection distance for fire-extinguishers of process area of Receiving terminal, tank farm, terminal area and tanker area shall not exceed 9m, and the maximum protection distance in Class-B and Class-C facilities and buildings shall not exceed 12m.

4.3.6.6 Fire station

A fire station will be newly built in the Receiving terminal, equipped with corresponding quantity and types of fire engines.

4.3.6.7 Main equipment and main work quantity

See Table 4.3-10for the main equipment and work quantity of fire protection system.

Table 4.3-10 Main Equipment and Work Quantity

S.N.	Equipment Name	Spec. and Parameters	Unit	Quantity
1	Electric-driven fire pump		pc	2
2	Diesel-driven fire pump		pc	2
3	Firefighting testing pump	$Q=1200m^3/h$， H=120m	pc	2
4	Pressure-stabilizing pump	$Q=54m^3/h$， H=120m	pc	2
5	High-expansion foam skid	3%， 8L/s， foam concentrate liquid 1.0m3	set	8
6	High-expansion foam generator	3%， foam expansion 1:500， 4L/s	set	16
7	Dry-powder fire-	Discharge rate of 2kg/s, charging amount of	set	10

	extinguishing device (safety valve on top of LNG storage tank)	dry-powder tank at 1000kg, and reserve level of 100%		
8	Dry-powder monitor system	Discharge rate of 25kg/s, and charging amount of dry-powder tank at 3000kg	set	3
9	FM-200 gaseous fire-extinguishing system	For terminal control room	set	1
10	FM-200 gaseous fire-extinguishing system	For the central control room of Receiving terminal, and electricity distribution room	set	2
11	Fixed-type manual firefighting water monitor	50L/s, range of 60m	pc	45
12	Mobile manual firefighting water monitor	50L/s, range of 60m	pc	2
13	Outdoor fire hydrant	aboveground pressure-regulating type, 2 DN80 connectors and 1 DN150 connector	pc	128
14	Box of fire-control equipment		set	128
15	Indoor pressure-relief and pressure-stabilizing fire hydrant	KN65	pc	70
16	Fire hydrant box		set	70
17	Fire extinguisher	MF/ABC5	pc	190
		MF/ABC8	pc	50
		MFT/ABC50	pc	21
		MT7	pc	70
		MPT40	pc	2
18	Production water tank	1200m^3	set	1

4.3.7 Anti-Corrosion

(1) Aboveground equipment, pipeline, and outer surface of storage tank

Table 4.3-11 Outer surface of aboveground-mounted steel pipelines, equipment, storage tank & auxiliary steel structures

Material	Type of thermal (cold) insulation	Coating plan
Carbon steel and low-alloy steel	Without thermal (cold) insulation	Epoxy zinc rich primer/Epoxy micaceous iron oxide intermediate coating/polyurethane finish
	With thermal (cold) insulation	Epoxy zinc rich primer/Epoxy micaceous iron oxide intermediate coating
Stainless steel (except for full-containment tanks)	Without thermal (cold) insulation	Novolac epoxy resin primer/Epoxy micaceous iron oxide intermediate coating/polyurethane finish
	With thermal (cold) insulation	Novolac epoxy resin primer

(2) Outer surface of buried carbon-steel equipment and pipelines

The system of solvent-free liquid epoxy coating (600μm) +polypropylene reinforced-fiber adhesive tapes (overlapped 50~55% by winding) is adopted for anti-corrosion and protection of the carbon-steel pipelines and equipment installed in a buried manner for the project.

(3) Concrete structure

Elastic polyurea coating system shall be applied for the concrete structure at the outer layer of full-containment tanks for water-proof protection.

4.3.8 Automatic control

The supervisory control and data acquisition (SCADA) system, with computer as the core, shall be adopted for the automatic control system of send-out pipeline project. The production & operation parameters of the pipelines will be transferred to "Beijing Fuel Gas Dispatching and Control Center" through the data communication system, and the dispatching and control center will conduct centralized monitoring, control and management for the production and operation condition of various sites of the gas line, and receive important parameters related to the gas lines. The dispatching and control center respectively monitors the stations and valve rooms by establishing the computerized control system. Only under the condition of being authorized by the dispatching and control center can the station control system and monitoring valve room RTU can control and operate the process equipment of the station. The operation control of the dispatching and control center for the station shall at least include: ESD command of station, normal startup of station, and normal shutdown of station etc.

The whole-line-monitoring valve room of pipelines transmits data to upstream and downstream stations, and such data is uploaded to the dispatching and control center via the communication router of upstream and downstream stations.

4.3.9 Communication

The main communication mode of this project is optical communication, and the communication rate of optical communication system is STM-4. 1 set of 622mbt/s optical communication equipment is respectively arranged at Nangang Distributing Station, Daqiuzhuang Distributing Station, Jinghai Liaison Station, Yongqing Liaison Station, Anci Distributing Station, and Chengnan Terminal Station. The SCADA data is transferred to Chengnan Terminal Station via the optical communication system; and at Chengnan Terminal Station, the SCADA data of various stations is transferred to Beijing Operation and Dispatching Center via the rented special-line digital circuit.

The standby SCADA data transfer mode of various process stations shall be kept consistent with the standby communication mode of LNG Receiving terminal, i.e. transferring data to Beijing Dispatching Room via rented special-line digital circuit.

4.3.10 Power Supply and Distribution

An 110kV main substation will be newly built at the LNG Receiving terminal; power utilization for the first station of outward transportation will rely on the 110kV main substation, and one route of low-voltage power supply will be connected from the main substation to the distribution boxes on site.

Respectively at each distributing station and Chengnan Terminal Station, the power supply system of using 1 route of 10kV system external power supply and standby emergency power-generator unit, and the standby emergency power generator is used to power the load of secondary class and above, as well as some life load when external power supply encounters power failure.

Uninterrupted power supply (UPS) is arranged for the automatic control, communication system, and emergency lighting etc. in the station, with backup time of 1.5 hours.

Class-A monitoring valve room is connected to 1 route of 10kV power supply nearby, and equipped with uninterrupted power supply (UPS) as the backup power, with backup time of 24 hours. The power supply of Class-B monitoring valve room is considered by instrument RTU system.

4.3.11 Manpower Quota

Base on this project, Beijing Gas Group will establish three main branch companies, i.e. LNG Sales Branch Company, LNG Receiving terminal Branch Company, and Pipeline Branch Company, with total manpower quota of 247 persons, in which,

Natural Gas Sales Branch Company: Established with Operation Department, Sales Department, and Metrological Verification Center etc., with total staffing of 40 persons;

LNG Receiving terminal: Established with Operation Department, Technical Department, Engineering Department, Marine Affairs Department and Commodity Inspection Department etc., with total staffing of 150 persons. Among them, there are administrative personnel of 30 person-times, production operation personnel for Receiving terminal of 110 person-times, and maintenance & inspection personnel of 10 person-times. The operation shifts adopt the system of three shifts by four teams. Main operation management and production are taken charge by the Production Dispatching Department, and various departments and organizations of the Receiving terminal are arranged inside the Receiving terminal.

Pipeline Branch Company: Established with Engineering Department, Technical Department, Operation and Maintenance Department, and Safety & Environment Protection Department etc., 84 persons in total. Among them, there are 15 persons of quota for the company's headquarter, 5 persons of initial quota for the Receiving terminal, 10 persons of quota for Jinghai Liaison Station, 10 persons of quota for Yongqing Liaison Station, and 44 persons of quota for Chengnan Terminal Station (including 34 persons of maintenance & emergency-repair). The operation shifts adopt the system of three shifts by four teams, and main operation management and production are taken charge by the Production and Maintenance Department.

All of the Natural Gas Sales Branch Company, LNG Receiving terminal Branch Company (persons other than operation/maintenance personnel), Pipeline Branch Company (persons other than operation/maintenance personnel) will rent buildings for office and accommodation in the MSD of economic development zone. In the Receiving terminal, 90 persons will be on duty for day shift and 10 persons for night shift (Maximum additional 30 persons of contractors are considered for office work).

4.4 Supporting project

4.4.1 Navigation channel

The existing channel class of Dagang Port is 100,000 DWT, which meets the requirements of 100,000 DWT for one-way and 50,000 DWT for two-way traffic, and meets the requirements of 266,000 m3 LNG vessel as well.

The design LNG navigation channel elevation for this project is -14.6m. The existing Dagang 100,000 DWT navigation channel has been completed, and its class is 100,000 DWT for one-way traffic (meets the requirements of 266,000 m3 vessel's navigation), and the design channel bottom elevation is -14.6/-15.0 m (partial sections need dredging). Meet the requirements for the whole project.

4.4.2 Anchorage

The existing LNG emergency anchorage is located at the northeast corner of the 8# anchorage with a scale of 2400×1250m. According to the schedule of the project, it is proposed to share the existing LNG emergency anchorage in the early stage.

4.5 Process Plan of Receiving Station

4.5.1 Characteristics of Material Storage and Transportation

See Table 3.7-1 for the main characteristics of material storage and transportation of LNG

Table 3.7-1 Table of Main Characteristics of Material Storage and Transportation of Materials

Type	Boiling Point ℃	Liquid Density kg/m3	Relative Density
LNG	-162	430～460	0.6～0.7

4.5.2 Process flow

The main process flow of the project is receiving, storage and vaporization of LNG, and supplying gas to the gas transmission trunk line. See Figure 4.5-1 for the process flow chart of the Receiving terminal.

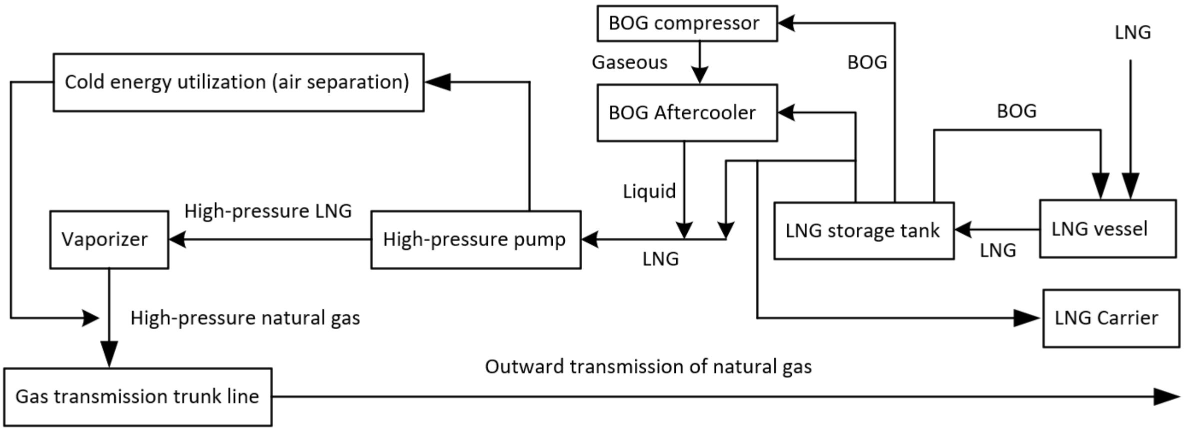


Figure 4.5-1 Process Flow Chart of the Receiving Station

4.5.2.1 At-Dock Vessel-Loading/Unloading System

(1) Berthing/connecting unloading arm for transport vessel

The dock is arranged with process and safety facilities needed for loading/unloading of LNG. When the LNG vessel is arriving, the port operator, pilot, tugboat and vessel berthing monitoring system control the berthing and mooring of the transport vessel.

Only after the transport vessel has safely moored and established communication with onshore can the LNG unloading arm and gaseous-phase return arm be connected. Afterwards, it's necessary to test the emergency cut-off system, and use nitrogen to displace the air in the unloading arm up-to-grade, then use the LNG on board to cool the transmission pipelines and LNG unloading arm of the transport vessel, and then perform the vessel loading/unloading operation.

(2) Unloading of LNG transport vessel

After the LNG transport vessel arrives at the vessel-unloading dock, LNG is first pressurized by the unloading pump on board of the transport vessel, then LNG passes through the LNG unloading arm and is transmitted into the LNG storage tank through the vessel-unloading pipeline. In order to balance the pressure in the cargo hold, some vapor in the LNG storage tank return to LNG vessel hold through the gaseous-return pipelines and gaseous-phase return arm.

During the unloading operation, it's necessary to identify the actual vessel-unloading rate and number of LNG storage tanks for simultaneously-receiving the unloaded LNG according to the level of LNG storage tank and type of LNG vessel. Level indicator is arranged in each LNG storage tank for monitoring the level in the tank. The vessel-unloading pipeline are arranged with fixed-type sampling & analysis system, which can conduct online analysis for LNG in pipeline. The sampling system is arranged with 1 set of sampling device divided into three groups. The first group uses gas chromatography for analysis, so as to confirm the compositions of LNG in the waybill; the second group will be kept by Buyer for 30 days and will be used when Seller needs to conduct analysis; the third group will be sealed up with signatures of both Buyer and Seller, to be used when dispute occurs. When unloading LNG, sampling and analysis of LNG can also be conducted in the lab by manual sampling. Compositions of LNG on the waybill can be confirmed by analyzing the LNG unloaded. When unloading the vessel, it's possible to reasonably charge the LNG into the storage tank through the feed valve on the top or at the bottom of the storage tank according to the LNG composition on the waybill provided by Seller, avoiding stratification of LNG, thus reducing the possibility of liquid surging in the storage tank.

After vessel-unloading is finished, before the LNG transport vessel is disconnected, use nitrogen to purge from the top of the unloading arm, press the LNG in the unloading arm respectively to the drain tanks of LNG transport vessel and LNG dock and disconnect the connector between the unloading arm and vessel. During the maintenance for drain tanks on the dock, it's also possible to directly discharge the LNG from the discharging arm and vessel-unloading pipeline into the LNG vessel-unloading pipeline through bypass.

During non-vessel-loading operations, some LNG in low-pressure output main pipe will perform cold-holding circulation of vessel-unloading pipeline through 1 piece of 10” pipeline, so as to keep the LNG vessel-unloading pipeline under cold-state standby condition. The majority of circulating LNG will return to the LNG low-pressure output main pipe connected to the recondenser, and the other of circulating LNG will pass through the bypass of feeding valves at the top and bottom of LNG vessel-unloading pipeline, and return to various LNG storage tanks.

(3) LNG vessel-loading

In this project, the function of LNG vessel-loading is arranged.

When the LNG transport vessel is arriving, the port operator, pilot, tugboat and vessel berthing monitoring system control the berthing and mooring of the transport vessel. Only after the transport vessel has safely moored and established communication with onshore can the LNG unloading arm be connected. After testing the emergency cut-off system and using nitrogen to displace the air in the unloading arm up to the requirement of oxygen content, use the LNG outputted from the storage tank to cool the transmission pipelines and LNG unloading arm of the transport vessel, and then perform the vessel-loading operation.

LNG is boosted by the vessel-loading pump in the storage tank, and the vessel-loading operation for on-dock LNG is performed through the low-pressure outward transmission main pipeline, vessel-loading crossover pipeline, vessel-unloading pipeline, circulation cold-holding pipeline and unloading arm. In order to balance the pressure in LNG hold, some vapor of the hold return to LNG vessel storage tank through the gaseous-return arm and gaseous-phase return pipeline. During the loading operation, it's necessary to identify the actual vessel-loading rate and number of LNG storage tanks for simultaneous outward transmission of the unloaded LNG according to the level of LNG storage tank and type of LNG vessel. Level indicator is arranged in each LNG storage tank for monitoring the level in the tank. The same set of analysis system is used for the sampling of vessel-loading and vessel-unloading.

After vessel-loading is finished, before the LNG transport vessel is disconnected, use nitrogen to purge from the top of the unloading arm, press the LNG in the unloading arm respectively to the drain tanks of LNG transport vessel and LNG dock and disconnect the connector between the unloading arm and vessel. During the maintenance for drain tanks on the dock, it's also possible to directly discharge the LNG from the discharging arm and vessel-unloading pipeline into the LNG vessel-unloading pipeline through bypass.

4.5.2.2 LNG storage system

In this project, the storage tanks are full-containment concrete-top storage tanks, the inner tanks adopt 9% Ni steel, and the outer tanks are constructed with prestressed concrete material. The designed pressure of storage tanks is -0.5kPaG～29kPaG. Thermal insulation layers are arranged in the annular clearance and ceiling plate of storage tanks, so as to ensure the daily maximum evaporation amount of storage tank not exceeding 0.05% of tank capacity under designed environment.

Table 3.7-2 Pressure Setting of LNG Storage Tanks

Device/Parameter	Setpoint (kPaG)	Action
Design pressure	29	
Pressure setpoint of pressure safety valve	29	Open the safety valve

High high pressure interlock	27.5	Close the automatic cut-off valve for feeding of LNG storage tank. The vessel-unloading operation signal is under unauthorized condition.
High pressure alarm	26.5	
Open the pressure control valve (PV)	25.5	Inform operators that the pressure control valve is opened. Excessive vapor will be discharged through the vapor manifold to the flare system for burning, so as to maintain the pressure of vapor manifold at setpoint.
Maximum operation pressure	25	
Normal operation pressure	23/10	
Minimum operation pressure	7	
Low pressure alarm	6	Shutdown the BOG compressor and fan by DCS
Open the gas makeup valve	4.5	Inform operators that the gas makeup valve is opened, allowing gas coming from the outward transmission pipeline to makeup the vapor main pipeline.
Low low pressure interlock	3	The low-pressure transfer pump stops, and the return-gas fan of BOG compressor stops.
Pressure setpoint of vacuum safety valve	-0.25	After the vacuum safety valve is opened, wait for the valve manufacturer to confirm.
Pressure of fully-opening vacuum safety valve	≥-0.5	
Designed vacuum pressure	-0.5	

(1) Control of storage tank

In order to prevent the leakage of LNG, all the fluid inlet/outlet pipelines and all the connection pipelines of instruments inside the tank are connected from the top of the tank. Each storage tank is arranged with 2 pieces of material-charging pipes, thus it's possible to charge from the top, or from the bottom by inserting vertical charging-pipes in the tank. The charging mode depends on the density difference between the LNG to be unloaded from LNG transport vessel and existing LNG in the storage tank. If the LNG carried in the vessel has higher density than the LNG in the storage tank, the LNG carried in the vessel shall be charged from the top of storage tank; vice-versa, the LNG carried in the vessel shall be charged from the bottom of storage tank. And it can effectively prevent the phenomenon of stratification and surging of LNG in storage tank. Operators can adjust the proportion between top charging and bottom charging of LNG by controlling the top/bottom charging valves. Cut-off valve is arranged on the charging main pipe, which can isolate the LNG storage tank and the charging pipeline under emergency.

LNG storage tank is connected to the vapor main pipeline through a piece of gaseous-phase pipeline, for the purpose of transferring the vapor generated in the storage tank and displaced gas during vessel-unloading to BOG compressor and flare system.

Each LNG storage tank is arranged with continuous monitoring instruments of in-tank level, temperature and humidity, so as to prevent stratification and overflow of LNG in tank. The pressure of storage tank is controlled by compressing and recovering the vapor generated from inside of the storage tank. If encountering conditions like quicker dropping of atmospheric pressure etc. and the compressor cannot timely process large amount of vapor, the storage tank can be protected by discharging to flare system to prevent system overpressure. The primary overpressure protection of the storage tank is discharging excessive vapor to flare system: When the pressure of LNG storage tank reaches 25.5kPag, the pressure control valve will open and vapor will be directly discharged to the main pipeline of flare. Each storage tank is also equipped with several safety valves, as the secondary overpressure protection of storage tank; the pressure setpoint of safety valve is the design pressure of storage tank, and overpressure gas is directly discharged into atmosphere through the safety valve installed on top of tank.

If the pressure of storage tank (gauge pressure) is lower because of quick increasing of atmospheric pressure, the vacuum-breaking gas from outward transmission natural gas main pipe is transferred to the vapor main pipeline, so as to maintain stabilized pressure in the storage tank; if the makeup vacuum-breaking gas is not enough to maintain the pressure of storage tank within operation range, air will enter into the tank through the vacuum safety valve installed on the storage tank to maintain normal pressure of the storage tank and ensure the safety of storage tank.

Circulation and mixing of LNG in single tank is permitted in the setting of low-pressure transfer pump and pipeline. The nitrogen injected into the internal space and annular space of the storage tank can be used to dry, purge and inert the storage tank. Annular nozzles are arranged on top inside the storage tank, connected to the vessel-unloading pipeline. These annular nozzles can pre-cool the storage tank with small amount of LNG before LNG is charged into the storage tank, so as to avoid causing higher stress and large-amount evaporation and vaporization of LNG due to sharp changing of temperature during charging of storage tank.

(2) Process flow of tank transfer

The operation of tank transfer needs to be started under non-vessel-unloading condition.

After boosted by low-pressure transfer pump, the LNG transferred out of the out-transferring tank will enter into the LNG mixing main pipe and then return to the vessel-unloading main pipe or enter into the low-pressure transmission main pipeline, then return to the vessel-unloading main pipeline through the crossover pipeline of on-dock cold-holding circulating pipeline, and then LNG will flow into the receiving tank.

4.5.2.3 Vapor treatment system

(1) BOG compressor

Vapor is mainly caused by the input of external energy, such as pump running, inward transferring of external heat, changing of atmospheric pressure, environmental influence, as well as changing of vapor's volume caused by the charging of LNG into the storage tank. The purpose of vapor treatment system is to economically and effectively recover the vapor generated from LNG Receiving terminal.

The amount of vapor generated during the vessel-unloading operation at the LNG Receiving terminal is far higher than that of non-vessel-unloading operations. Large amount of vapor is generated during vessel-unloading, some of the vapor will pass through the gaseous return line and return into the LNG hold through the gaseous return arm, to maintain pressure balance of the vessel-unloading system.

If the flowrate of vapor exceeds the processing capacity of the compressor or recondenser, the pressure of the storage tank and vapor header line will increase; when the pressure exceeds the setpoint of pressure control valve, excessive vapor will be discharged to the flare for burning.

Under the condition of non-vessel-unloading and normal output, BOG compressor is enough for the treatment of vapor generated; during vessel-unloading, under the minimum outward transmission condition, 4 compressors are needed to work simultaneously. Once 1 set of BOG compressor encounters fault, standby BOG compressor can be started; or in order to ensure effective treatment of the vapor generated during vessel-unloading, the vessel-unloading rate can be adequately reduced to avoid or reduce the discharging of vapor to flare for burning.

If the outlet pressure of the compressor needs to reach the operation pressure of recondenser, the temperature of inlet gas needs to be lower than -15℃. When none of the compressors are running, before starting the first compressor, e.g. gas temperature at compressor inlet is higher than -15℃, the high-temperature inlet gas needs to be discharged to the flare through the manual valve at compressor outlet, until the gas temperature at compressor inlet is lower than -15℃, and only then can the compressor outlet gas be discharged to recondenser. When starting other compressor, the small amount of high-temperature gas (higher than -15℃) at compressor outlet can be discharged to the front of compressor outlet buffer tank through the compressor's temperature-regulating valve; After mixing with large amount of cold BOG gas, pre-cooling can be conducted for compressor inlet.

A buffer tank is arranged at the inlet of BOG compressor, so as to prevent the carry-over of liquid drops by vapor into the compressor. Once the level of compressor's inlet buffer tank is higher, the valve can be manually opened to let the liquid flow into the low-pressure drain tank by gravity, and then use nitrogen pressurization to make the liquid return from low-pressure drain tank to LNG storage tank through the drain main pipeline.

(2) BOG booster

In the process plan of direct pressurization and outward transmission of vapor, after compressed by BOG compressor, the vapor will directly enter into the buffer tank of BOG booster; after buffering, the vapor will be pressurized by BOG booster to 9.2 MPa which is the pressure needed by the outward-transmission pipeline, and then the vapor will directly transferred to outside.

The total processing capacity of BOG booster is considered according to the total amount of vapor under the vessel-unloading condition after the 12 tanks are completed in future, without consideration of standby. Under the condition of outward transmission at base load, the number of running BOG boosters shall be selected according to the flowrate of BOG needing processing.

(3) Recondenser

The vapor pressurized from the BOG compressor and the supercooled LNG transferred from the low-pressure transfer tank of storage tank are mixed in the recondenser, where the vapor are condensed into liquid.

The process capacity of recondenser shall be considered according to designed scale, without consideration of standby. During the maintenance of recondenser or under emergency, the vapor will be discharged to BOG booster for processing. After boosting, the vapor will be directly transferred to the outward transmission pipeline; and LNG will enter into the high-pressure sendout pump through the bypass of recondenser.

Stainless-steel Raschig-ring packed bed is on top of the recondenser. The vapor enters from the top of recondenser and LNG enters from the side wall of recondenser, both of them will be mixed and heat-exchanged in the packed bed, and then vapor will be condensed. Another part of LNG will pass through the bypass of recondenser and mix with the liquid at the outlet of recondenser, and then together transferred to the high-pressure sendout pump.

The outlet pressure of recondenser is maintained as basically-constant by using the outlet pressure transmitter to control the recondenser's bypass regulating valve, so as to ensure stabilized pressure at the inlet of high-pressure pump. The flow rate proportion of LNG/BOG entering into the recondenser is regulated according to the recondenser outlet pressure and the flow rate of BOG coming from the compressor, so as to ensure the condensation of vapor into liquid.

If the operation level of recondenser is too high, the system will introduce natural gas from outward transmission pipeline, which will be depressurized to make up the gaseous-phase space of the recondenser, so as to maintain the normal operation level. If the pressure of recondenser is too high, gas will be discharged to BOG main pipeline through the pressure relief valve of recondenser, so as to maintain the normal operation pressure of the system.

4.5.2.4 LNG/NG outward transmission system

(1) LNG vaporization outward-transmission system

The LNG in the LNG storage tank enters into the recondenser through the low-pressure transfer pump. After mixing and condensing with the compressed vapor in the BOG compressor, the LNG will mix with the low-pressure LNG of recondenser bypass and then enter into the high-pressure transfer pump. After reaching necessary flow rate and pressure of transferring, it will be vaporized by the vaporizer and then transferred outward to the gas transmission trunk line.

(2) Low-pressure transfer pump

The low-pressure transfer pump is vertical submerged pump, installed in the pump well of storage tank. The setting of low-pressure transfer pump shall be able to meet maximum outward transmission amount during emergency security.

The specification of low-pressure transmission main pipe between LNG storage tank and recondenser shall be confirmed according to the maximum gas transmission amount of the Receiving terminal.

All the low-pressure transfer pumps run at constant speed, and their operation flow rate is confirmed by the outward transmission amount and cold-holding circulation amount etc. of natural gas. The outlet pipeline of each low-pressure transfer pump is arranged with minimum-flowrate regulating valve to protect the safe operation of pump. In-tank self-circulation pipeline is arranged on the low-pressure LNG main pipeline to prevent phenomenon of LNG stratification and surging in tank.

Emergency cut-off valve is arranged at the low-pressure outlet main pipeline of each storage tank, which can be used for isolating the low-pressure transfer pump from the LNG low-pressure outward transmission main pipeline, as well as for isolating the storage tank from the low-pressure LNG outward transmission main pipeline under emergency, meanwhile, it can be used for the maintenance operation of low-pressure transfer pump or low-pressure outward transmission pipeline.

(3) High-pressure pump

The high-pressure pump adopts vertical and electric centrifugal pump of constant rotational speed, installed in the special vertical pump tank.

The output flowrate of high-pressure transfer pump is controlled by the flowrate regulating valve installed at the inlet pipeline of vaporizer. The output main pipeline of high-pressure pump shall be designed according to the maximum gas transmission rate.

Cut-off valves are installed at the inlet and outlet pipelines of each pump, so as to facilitate the switching of pump and cut-off & isolation under emergency. Minimum-flowrate control valve is installed at the outlet of high-pressure sendout pump to ensure the safe operation of pump, LNG can return to the recondenser, and LNG can return to the LNG storage tank through the high-pressure drain main pipe during the maintenance of recondenser.

Special pipeline is arranged in the high-pressure sendout pump tank, which can vent the vapor generated to the recondenser. During the maintenance of recondenser, vented gas can be discharged to BOG main pipe through the vertical pipe by level control.

(4) Vaporizer

In this project, 2 types of vaporizers are arranged, i.e. intermediate fluid vaporizer (IFV) and submerged combustion vaporizer (SCV). The working principle of IFV is using the seawater or hot water of plants nearby as the heat source, and such heat source is used to heat up the intermediate fluid (propane) and make it vaporized, and then the propane vapor will be used to vaporize LNG. This vaporizer is composed by three parts: a. Seawater (or other heat-source fluid) and propane for heat-exchanging; heat-exchanging between propane and LNG; superheating of LNG, i.e. using seawater to heat up the natural gas obtained from vaporization of LNG. IFV solves the influence of possible icing caused by direct vaporization of LNG with seawater. IFV has lower requirement of seawater quality, and titanium-alloy material is adopted for the portion contacting seawater. Titanium-alloy materials have good anti-corrosion performance, which can be used when the seawater quality is relatively poor, with good low-temperature performance. SCV is in the category is heating-type vaporizer, which uses the fume generated from fuel burning as the heat source. Because the fume directly contacts the water, the water will be intensively stirred in the meantime of being heated up. The hot water then conducts heat-exchanging with the LNG in pipeline, largely enhancing the heat-transfer efficiency. The thermal efficiency of SCV is around 98%, which can quickly startup and respond to the sudden changing of load, and is suitable for gas utilization under emergency or peakload adjustment.

In consideration of the geological location of this Receiving terminal, IFV vaporizer cannot reach design load when operating with seawater under low-temperature in winter, while the gas demand of users at this time is under peakload condition, therefore SCV vaporizer is adopted for peakload adjustment season in order to ensure the reliability and safety of gas supply. SCV is installed with electric heater to prevent icing of water bath.

Flowrate regulating valve is arranged at the inlet of vaporizer, for the purpose of regulating the output rate of outward-transmission natural gas from the Receiving terminal, as well as controlling the temperature pressure of natural gas output main pipeline. The number of operating vaporizers and flowrate of operation is determined by the gas using rate of downstream users.

When the outlet temperature of outward-transmission gas is too low, the inlet LNG flowrate can be reduced by controlling the temperature of vaporizer's outward-transmission system. A cut-off valve is respectively installed at LNG inlet pipeline and natural gas outlet pipeline, therefore each vaporizer can be cut-off under emergency condition or during maintenance. Each vaporizer is also installed with safety valve, thus excessive gas can be discharged to safety location when overpressure.

(5) Metrological analysis system

In this project, 1 set of metrological unit is arranged for measurement of the gas-transmission trunk line. The metrological station is arranged with online gas chorography analyzer, which can continuously monitor the heat value and compositions etc. of outward-transmission natural gas. Meanwhile, manual sampling point is arranged for verification and backup for online analysis.

The pressure of natural gas transferred to downstream pipeline is 9.2MPaG, and the temperature of natural gas is 0~20℃.

(6) LNG tanker-loading system

The process technical plan of tanker-loading system is cold-state atmospheric-pressure vessel-loading plan. After pumped out by the low-pressure transfer pump in the LNG storage tank of the Receiving terminal, the low-temperature liquid LNG will enter into LNG low-pressure transfer main pipeline. Part of LNG will go to recondenser and vaporizer for vaporization and then will be transferred to the pipeline transmission system; the other part of LNG will be transferred to the tanker-loading station through the low-temperature pipeline, and will be loaded into LNG tanker through the loading arm; meanwhile, the gas in the tanker will return through the gaseous-phase arm, and will be transferred into the vapor main pipeline after accumulation. Apart from vessel-loading arm and gaseous-phase return arm, each tanker parking-space is arranged with nitrogen purging system. In order to maintain the low-pressure status of vessel-loading main pipeline, LNG cold-circulation cold-holding is conducted for tanker-loading main pipeline.

(7) LNG charging system for tanker/vessel

In this project, reserved connector for charging LNG to vessel is arranged. Before charging LNG to vessel, it's necessary to pre-cool the pipeline of the charger, and pre-cooling shall be finished when the charger's pipeline is full of LNG liquid and the liquid temperature & density reach requirement at the same time. Then connect the charging gun with the liquid inlet of tanker-mounted LNG cylinder and connect the return-gas gun with the return-gas port of tanker-mounted LNG cylinder, and the BOG in the tanker-mounted LNG cylinder will return to the storage tank. When the gas pressure of tanker-mounted LNG is reduced to adequate range, charge LNG into the cylinder with LNG charging gun. After charging is finished, disconnect the gas-return gun and charging-gun in sequence, and the charging process will be finished after corresponding purging is completed.

4.5.2.5 Flare system

The flare system is used for collecting the overpressure vent of BOG main pipeline, discharged gas from inlet cooling when fault occurs at BOG compressor, and excessive vapor discharged discharged from the pressure control valve of recondenser; besides, the pressure-relief gas during the maintenance of natural gas outward-transmission main pipeline will also directly enter into the flare system.

In this project, 2 sets of aboveground flares are arranged for discharging the relief gas. Flare knock-out drum and heater of flare knock-out drum are respectively arranged at upstream low-elevation points of aboveground flare, with the purpose of fully separation and vaporization of the liquid possibly carried-over by the vapor discharged to the knock-out drum.

In order to prevent the entrance of air into the flare system, low-flowrate nitrogen is continuously charged at the tailend of flare main pipeline and end of branch main pipeline, so as to maintain the slight positive press of flare system.

4.5.2.6 Fuel gas system

The fuel gas system of the Receiving terminal provides fuel for users such as submerged combustion vaporizer (SCV), flare igniter, and pilot etc.

The fuel gas mainly comes from the compressed vapor provided by BOG compressor. When BOG compressed vapor cannot meet needs, depressurized outward-transmission natural gas can be used as fuel gas. The fuel gas supplied to SCV needs to be supplied after heating-up with electric heater. The fuel gas supplied to the pilot is provided from vapor heated by electric heat-tracing pipeline or from depressurized outward-transmission natural gas. The fuel gas system is arranged with temperature monitoring, alarm, and interlock etc.

Systems such as monitoring, alarm and interlock of temperature, as well as alarm and interlock of pressure etc. are provided for the fuel gas system.

4.5.3 Main Process Equipment

Table 3.7-3 Main Process Equipment

S.N.	Equipment Name	Spec.	Unit	Quantity	Remark
I.	**Storage system**				
1	LNG storage tank	200000 m^3	Set	10	Full-containment tank of 9% nickel steel with concrete tank top
2	Low-pressure transfer pump	$Q=460m^3/h$	pc	30	3 pieces of domestic pumps 27 pieces of imported pumps
II.	**Transfer system**				
1	High-pressure sendout pump	$Q=450m^3/h$	pc	9	Imported
	High-pressure sendout pump	$Q=170m^3/h$	pc	1	Imported
2	Intermediate fluid vaporizer (IFV)	Q=180t/h	pc	4	1 piece of domestic IFV 3 pieces of imported IFVs
3	Submerged combustion vaporizer (SCV)	Q=200t/h	pc	11	3 pieces of domestic SCVs 8 pieces of imported SCVs
4	Outward-transmission metrological system		set	1	domestic
5	Tanker-loading skid	$Q=60m^3/h$	pc	26	domestic
III.	**Vapor treatment**				
1	BOG compressor	$Q=5300m^3/h$	pc	5	Imported
2	BOG booster	$Q=20000Nm^3/h$	pc	3	1 piece of domestic BOG booster 2 pieces of

					imported BOG boosters
3	Recondenser	Q=50t/h	pc	1	Inner parts are imported
IV.	**LNG receiving/unloading system**				
1	LNG unloading arm	16”，Q=3500m^3/h	pc	3	Imported
2	LNG gaseous/liquid phase return arm	16”,Q=3500m3/14000m^3/h	pc	1	Imported
3	LNG gaseous phase return arm	16”，Q=14000m^3/h	pc	1	Imported
V.	**Flare system**				
1	Aboveground flare	130t/h	Set	2	Domestic

4.6 Comprehensive of Cold Energy

According to the Assessment Opinions of Expert Group for Project Application Report (July, 2019) issued by CIECC (China International Engineering Consulting Corporation) entrusted by NDRC (National Development and Reform Commission), "Because this project is emergency reservation project with low base load and long continuation time, the baseload vaporization outward-transmission amount is hard to meet the minimum cold capacity requirement during relatively long period since the initial stage of completion and operation. At current stage, there is no condition of implementing the utilization of cold energy, and it is recommended to implement utilization of cold energy in future according to market condition.

4.7 Main construction scheme and schedule

4.7.1 BoQ and main construction equipment

Table 4.7-1 Major engineering projects and quantity tables

Sequence number	Project Name	Units	Quantities	Remarks
A	Bank slope			
1	Basin dredging works	10,000m^3	870.1	
2	Bank slope dredging works	10,000m^3	8.06	
B	LNG Terminal works	m	400	
1	Work platform 55mx35m	Item	1	
2	Mooring bollard 11mx11m	Item	6	
3	Breasting dolphin 15mx15m	Item	4	
4	Compensator pier 35mx40m	Item	1	
5	Terminal associate facility	Item	1	
6	Pipeline bridge	Item	1	60.8 m
7	Footbridge	Item	4	30 m, 34t/Item
8	Footbridge	Item	2	60m , 78 t/Item
C	Work boat terminal	m	120	
1	Front platform B = 18m	m	120	
2	Approach bridge B=15m	Item	1	
D	Ground improvement works			
1	Ground improvement area	10,000m^2	42.8	
2	Backfill area	10,000m^2	15.2	
E	Water intake	Item	1	
F	Outfall	Item	1	
G	Seawater pump house	Item	1	
H	Other auxiliary project	Item	1	

Table 4.7-2 The main construction ship, mechanical equipment quantity table

Sequence number	Equipment	Specification	Quantity
1	Pile driving boat	534 kw	1
2	Crane barge	60~ 80 t	3
3	Crane barge	500 t	1
4	Tugboat	3000 horsepower	2
5	Pile carrier	2000~3000 t	3
6	Anchor boat		3
7	Positioning barge		3
8	Transport carrier	100 t	4
9	Barge	500 t	4
10	Circulating drill	155 kw	4
11	Mud separator	250 m^3/h	4
12	Barge	1000 t	2
13	Mud truck	5t	4
14	Air compressor	20 m^3/min	5
15	Concrete mixing barge	50m^3/h	1
16	Excavator	1m^3	5
17	Self-unloading vehicle	5t	4
18	Self-unloading vehicle	10 t	8
19	Wheel loader	3 m^3	4
20	Crawler crane	30t	2
21	Plate beating machine		15

4.7.2 Construction condition

The construction area is in the West basin area of the Nangang Industrial Zone, which is still under construction. And the North Breakwater and the East Breakwater works almost completed. The offshore wind and waves have limited impact on the construction. In addition, the Nangang Industrial Zone is undergoing large-scale development and construction. The ship and various types of pipelines will probably have a certain impact on the construction.

The water area for the project site are wide open, the roads backyard along the shoreline are basically unblocked, and the marine and land transportation conditions are good. The various materials, components and equipment required for the project could be transported to the site by water and land. Tianjin Port has built a well-established hydraulic concrete component prefabrication base and offshore construction supply base to provide necessary services for the construction of the project.

There are many specialized offshore engineering construction teams in Tianjin area. These teams have decades of construction experience and relatively complete construction equipment. They are quite familiar with the construction environment and conditions and could provide a reliable guarantee for the construction of the project.

Pipeline construction could be generally divided into line construction and station construction. Pipeline construction is divided into several sections to be constructed separately. The section is divided according to administrative division and landscape type. Generally, it could be divided into several sections by every 70km～80km. The section crossing the large river and tunnel could be treated as an independent tender. The construction will be completed by a professional construction team with high-end equipment.

4.7.3 Construction scheme

4.7.3.1 Ground improvement

(1) Ground improvement standard

Ground improvement standard (handing over standard) for this stage is as follows.

①Elevation of ground improvement work: 7.8 m.

②Tank bottom area: The hard-shell layer with a thickness of no less than 6m (including the top 2m thick grade sandstone) is required within the range of 100m in the bottom of the tank. The compacting factor of the solid shell should be not less than 0.96. The characteristic value of the foundation bearing capacity should be not less than 150kPa. The characteristic value of the foundation bearing capacity for the sludge layer should be not less than 80 kPa after the treatment, and degree of consolidation should be not less than 0.90.

③Non-Tank bottom area: The thickness of the hard-shell layer in the upper part should be no less than 3m. The hard-shell layer is composed of backfilled gravel soil (or mountain soil) and pile foundation soil for the backfilled storage tank. The compacting factor of the solid shell should be not less than 0.94. The characteristic value of the foundation bearing capacity should be not less than 120kPa. The characteristic value of the foundation bearing capacity for the sludge layer should be not less than 80 kPa after the treatment, and degree of consolidation should be not less than 0.90.

④The residual settlement after construction should not be greater than 30 cm.

(2) Ground improvement division

According to the current conditions and the difference in functions, the ground improvement is divided into five areas. There are Area A (tank area), Area B (non-tank area), Area C (tank area), Area D (non-tank area), and Area E (non-tank area).

Area A (tank area) is the sum of the ground improvement ranges of the nine tanks on the west side, and the ground improvement range for each tank is a circular area of 100 m in diameter. The current elevation of the region is 6.0m. The area is about 70,700 m2, and it has not been subjected to any ground improvement activities in the past. The ground improvement scheme includes shallow solidification treatment, vacuum preloading combined with piling preloading, dynamic compaction, backfilling layered compaction graded gravel.

Area B (non-tank area) is the area around the Area A of the west side. The current elevation is about 6.0m. The area is about 152,700m2, and it has not been subjected to any ground improvement activities in the past. The ground improvement scheme includes shallow solidification treatment, vacuum preloading combined with piling preloading, backfilling about 1.6m thick mountain soil, dynamic compaction.

Area C (tank area) is the sum of the ground improvement ranges of the three tanks on the east side, and the ground improvement range for each tank is a circular area of 100 m in diameter. The current elevation of the area is 4.5m. The area is about 23,600 m2, and a vacuum preloading process has been carried out in this area. The ground improvement scheme includes draining the accumulated water, site excavation, vacuum preloading combined with piling preloading, dynamic compaction, backfilling layered compaction graded gravel.

Area D (non-tank area) includes the area around the east side of Area C, the current elevation of the area is 4.5m. The area is about 67,100 m2, and a vacuum preloading process has been carried out in this area. The ground improvement scheme includes draining the accumulated water, vacuum preloading combined with piling preloading, backfilling about 1.6m thick mountain soil, dynamic compaction.

Area E (non-tank area) includes other areas except the Area A and Area B on the west side of the site. The current elevation is about 6.0m. The area is about 213,400m2, and it has not been subjected to any ground improvement activities in the past. The ground improvement scheme includes draining the accumulated water, vacuum preloading combined with piling preloading, site mountain soil compaction, continuously excavating the pile foundation soil into the area, pile foundation soil solidification, dynamic compaction, layered rolling.

4.7.3.2 Dredging works for harbour and bank slopes

The dredging volume of the harbor is about 8,701,000 m3 (as shown in Figure 4.7-1). The dredging volume of the bank slope is about 80,600 m3. The total volume is 8,781,600 m3. The dredging mud is divided into two parts, as follows:

(1) About 500.4438 hectares pond in the east of Dagang Dongfeng Bridge in Tianjin Binhai New Area can be used as the disposal area for the project. The land use right of the pond has already obtained (Tianjin (2019) Binhai New Area Dagang Real Property No. 1015093). The main body of the rights is the management office of the Haihe River Water Resources Management Committee of the Ministry of Water Resources. The pond is mainly the temporary mud storage pit of the dredging mud in Tianjin Nangang Industrial Zone. The maximum mud storage capacity is about 6 million m3, while 3 million m3 capacity is occupied. The remaining capacity, about 3 million m3 can be used for the dredging mud of the project. The land use right certificate and dredging mud receiving agreement are respectively attached.

(2) According to the list of 2019 nationally available dumping areas published by the Ministry of Ecology and Environment, there are three dumping areas that can be used continuously around the project area. Tianjin Dredging Marine Dumping Area, which is 39.73km away from the project, has 3 million m3 maximum annual dumping quota. Huanghua Port Temporary Marine Dumping Area, which is 35.87km away from the project, has 24 million m3 maximum annual dumping quota. It is recommended that the remaining 5,761,800 m3 of dredging mud in the project could dump in these areas in batches, following the maximum annual control volume, and combined with the construction schedule and plan.

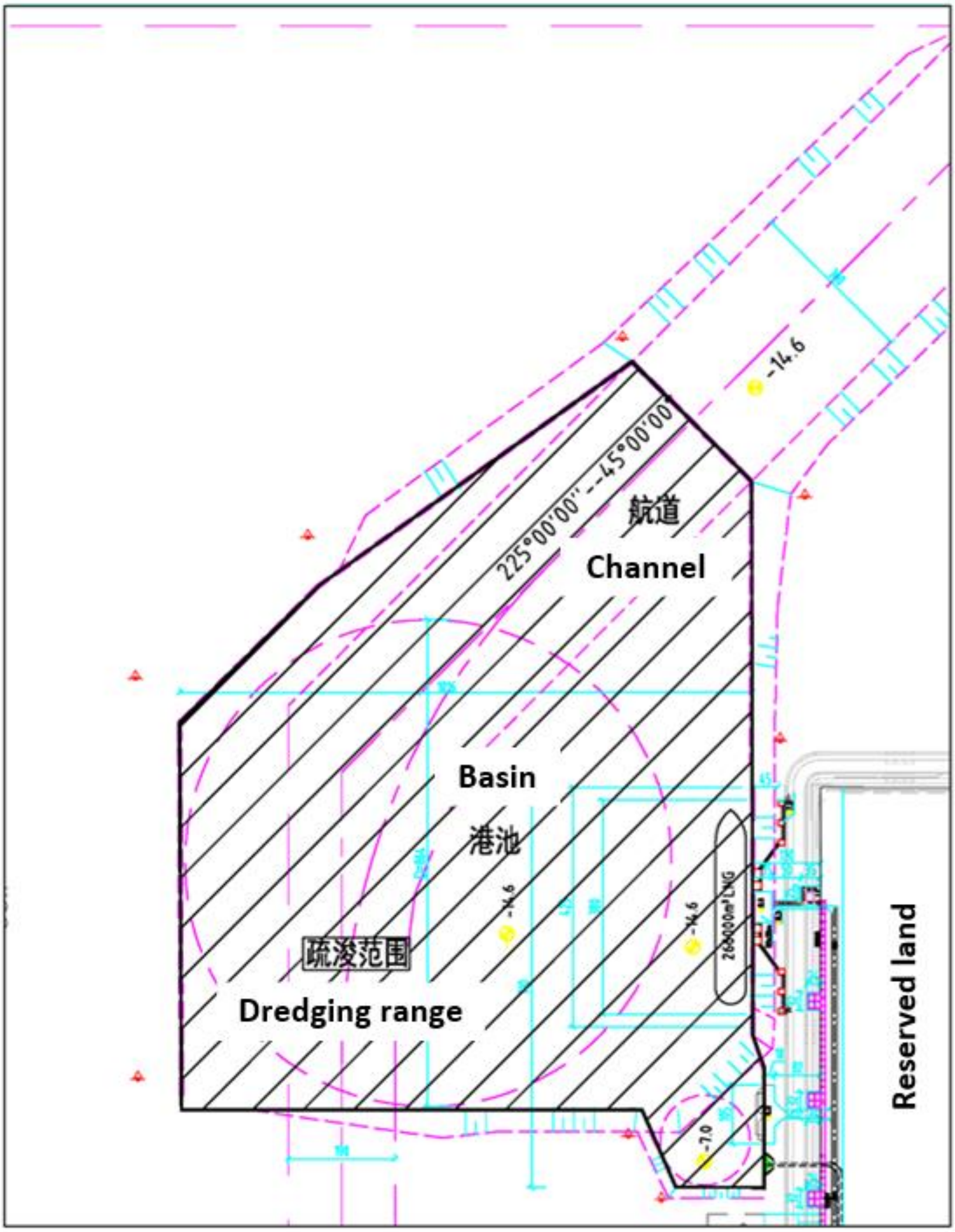


Figure 4.7-1 Dredging map

4.7.3.3 Terminal main works

According to the design, high-pile pier structure is adopted in the LNG terminal, and high-pile beam-slab structure is adopted in work boat terminal. The foundation of the terminal mainly adopts steel pipe piles, hollow square piles and reinforced concrete hollow square piles. The steel pipe piles are processed and spliced in professional processing plants, and then are transported to the vicinity of the construction site by barges. The hollow square piles are prefabricated in the existing component prefabrication yard of Tianjin Nanjiang Port Area, and then are transported to the construction site by barges, and are piling by pile driving boat. According to the lifting and installation requirements of the upper beam and slab component, the piling construction adopts the stepped and assembly line propulsion method.

For reinforced concrete bored piles, the piling construction needs to be carried out by using floating pontoons and installation casing. The bored pile needs to be carried out by diving drill machine, circulating mud retaining wall, hoisting steel cage by crane barge, and a vertical pipe method for pouring concrete. The concrete can be supplied by concrete mixing barge.

The top of the pier is a cast-in-place reinforced concrete pile cap. After pile driving, the piles of the foundation piles are fixed in time, and the bottom plate is laid, and the molded cast pile cap or pier reinforced concrete. The concrete is supplied by concrete mixing barge. The reinforced concrete longitudinal beam at the upper part of the terminal and the mooring components are installed by the crane barge after the pile cap is completed. Concrete mixing barges are used to cast joint concrete. The reinforced concrete panels are also installed by crane barges, and concrete mixing barges are used to cast joints and terminal surface.

4.7.3.4 Material source and earthwork balance

The dredging volume of the port of the project is 8.701 million m3, and the total amount of dredging on the bank slope is about 80,600 m3, totaling 8,878,600 m3. Dredging mud is divided into two parts, as follows:

(1) Part I

About 500.4438 hectares of potholes ponds in the east of Dagang Dongfeng Bridge in Tianjin Binhai New Area can be used for the disposal of dredged mud. The potholes have obtained land use rights (Tianjin (2019) Binhai New Area Dagang Unmovable Property Rights No. 1015093), the right subject is the management department of the Haihe River Downstream Administration of the Haihe River Water Resources Management Committee of the Ministry of Water Resources, which is mainly the temporary mud storage pit of the dredging mud in Tianjin Nangang Industrial Zone. The maximum mud storage capacity is about 6 million m3. , has accepted 3 million m3 of dredged mud, the remaining capacity can accept 3 million m3 of dredged mud of the project. The Haihe River Water Resources Management Committee of the Ministry of Water Resources, Haihe River Water Resources Management Bureau, has issued a consent to receive the dredging mud letter (Haihe River downstream Defense Office [2019] No. 13).

(2) Part II

According to the list of 2019 nationally available dumping areas published by the Ministry of Ecology and Environment, there are three dumping areas that can be used continuously around the project, namely the Tianjin Dredging Marine Dumping Area (39.73km away from the project), the dumping The annual maximum control dumping capacity of the district is 3 million m3, and the temporary marine dumping area of dredged materials in Huanghua Port Area (35.87km away from the project). The maximum annual dumping amount of the dumping area is 24 million m3. It is recommended that the remaining surplus of this project is 5,761,800 m3. The dredged mud is thrown to the above two dumping areas in batches according to the construction time and construction plan of the project according to the maximum annual dumping amount of the dumping area.

4.7.4 Material source and earthwork balance

The dredging volume of the basin of the project is 8.701 million m^3, and the total amount of dredging on the bank slope is about 80,600 m3, totaling 8,878,600 m3. Dredging mud is divided into two parts, as follows:

(1) About 500.4438 hectares of potholes ponds in the east of Dagang Dongfeng Bridge in Tianjin Binhai New Area can be used for the disposal of dredged mud. The potholes have obtained land use rights (Tianjin (2019) Binhai New Area Dagang Unmovable Property Rights No. 1015093), the right subject is the management department of the Haihe River Downstream Administration of the Haihe River Water Resources Management Committee of the Ministry of Water Resources, which is mainly the temporary mud storage pit of the dredging mud in Tianjin Nangang Industrial Zone. The maximum mud storage capacity is about 6 million m3. , has accepted 3 million m3 of dredged mud, the remaining capacity can accept 3 million m3 of dredged mud of the project. The Haihe River Water

Resources Management Committee of the Ministry of Water Resources, Haihe River Water Resources Management Bureau, has issued a consent to receive the dredging mud (Letter No.13 [2019] of Haihe River downstream Defense Office).

(2) According to the list of 2019 nationally available dumping areas published by the Ministry of Ecology and Environment, there are three dumping areas that can be used continuously around the project, namely the Tianjin Dredging Marine Dumping Area (39.73km away from the project), the dumping The annual maximum control dumping capacity is 3 million m3, and the temporary marine dumping area of dredged materials in Huanghua Port Area (35.87km away from the project). The maximum annual dumping amount of the dumping area is 24 million m3. It is recommended that the remaining surplus of this project is 5,761,800 m3. The dredged mud is thrown to the above two dumping areas in batches according to the construction time and construction plan of the project according to the maximum annual dumping amount of the dumping area.

4.7.5 Construction schedule

According to the engineering scale, content, construction characteristics, project quantity, site conditions and other factors of the project, the construction period of the project will take about 44 months (including the construction preparation period).

Figure 4.7-2 Scheduling of the dumping area to be used around the project

5 Engineering analysis

5.1 Analysis of Environmental Factors

5.1.1 Analysis of Environmental Factors during Construction Period

During the construction period, the main influence of water environment occurs in the operation of port engineering and dredging engineering, which results in the suspension of sediment, which results in the decrease of water turbidity and water quality, and affects the seawater quality and marine life. The construction of working platform, boat pier and mooring pier will directly affect the destruction of benthic habitat and burying benthic habitat. The main pollution factor of marine environment during construction period is SS.

The main pollutants discharged to the environment during the project construction are domestic sewage and domestic garbage produced by the construction personnel, construction waste water, working dust, mechanical soot and construction noise.

Overall, the main components of pollutants during construction are: port engineering, dredging engineering and drainage construction ; Construction of superstructure of terminal ; Working dust, mechanical exhaust, painting waste gas, construction noise and solid waste. But this kind of pollution impact is only temporary, will disappear with the end of the project construction, generally will not produce permanent pollution effect.

5.1.1.1 Offshore construction

(1) Analysis of Air Pollution Factors

The main influence of atmospheric environment during the offshore construction is the exhaust gas produced by construction ship.

(2) Analysis of water quality environmental pollution factors

①The main pollutant from the suspended sediment produced by port engineering and dredging engineering is SS.

②The main pollutants are COD, NH3-N and petroleum

(3) Analysis of Pollution Factors of Sound Environment

The noise produced by the construction ship is the main influence link to the sound environment during construction period.

(4) Analysis of solid waste pollution factors

The solid waste generated during construction period is mainly marine garbage.

(5) Analysis on Pollution Factors of Environmental Risk Accidents

Due to human or natural factors such as operation error and ship collision, the fuel oil leakage of the construction ship resulted in sudden pollution accident. The main pollutants are petroleum.

5.1.1.2 Onshore construction

(1) Analysis of Air Pollution Factors

During the construction period, the main factors affecting the atmospheric environment are mechanical excavation, filling, material transportation, loading and unloading, mixing of building materials, etc. The main influencing factors of atmospheric environment during construction are: dust from civil construction and material transportation ; Smoke and dust generated during welding ; Spray painting waste gas produced in the process of painting ; Exhaust gas from construction vehicles, etc.

(2) Analysis of water quality environmental pollution factors

Construction wastewater includes sand and gravel washing wastewater, oil pollution water of construction machinery repair, and the main pollutants are SS, COD, NH_3-N and petroleum.

Domestic sewage is the domestic sewage of the construction workers in the land area, and the main pollutants are COD and NH_3-N.

(3) Analysis of Pollution Factors of Sound Environment

The influence of construction period on the sound environment is mainly caused by the noise of construction machinery and material transportation on land.

(4) Analysis of solid waste pollution factors

The solid waste generated during the construction period is mainly domestic garbage, construction waste, scrap welding rod, welding slag, paint residue, paint bucket; machine oil cotton yarn, waste oil, waste engine oil, etc

5.1.2 Analysis of Environmental Factors in Operation Period

5.1.2.1 Waste gas

The types of waste gas pollution sources in the proposed project are divided into two categories: organized and non-organized, which are analyzed according to normal and abnormal working conditions.

(1) Organized emissions

①Discharge under normal operating conditions

Under normal operating conditions, the exhaust source of organized waste gas is the immersed combustion gasifier of the Receiving terminal and the smoke emitted by the flare stacks lamp . The main pollutants discharged after the combustion are SO_2, NO_x and soot, which are respectively discharged into the atmosphere through the chimney.

②Discharge under abnormal working conditions

The sources of organized waste gas under abnormal conditions are combustion exhaust gas from flare stacks combustion, overpressure safe vent gas from LNG tank and overpressure safe vent gas from gasifier.

(2) Unorganized emissions

The main sources of unorganized emission are total hydrocarbon (mainly methane) from the Receiving terminal and vehicle exhaust from ships and factories in the port.

5.1.2.2 Wastewater

(1) The LNG berth project will produce domestic sewage of workers, domestic sewage of ships, sewage of engine room oil of ships, sewage of machinery repair oil and washing waste water of working platform during operation.

(2) The wastewater from the Receiving terminal project is mainly production wastewater and domestic sewage. Production wastewater is mainly gasification process cold drainage, machinery repair oil sewage, possibly contaminated ground washing wastewater.

(3) The process cold drainage is only used for heat exchange, the temperature decreases after heat exchange, the water quality is not polluted, and the water is discharged directly from the water outlet. The oil pollution water in the engine room of the ship is entrusted to qualified units for receiving treatment, but not discharging ; The domestic sewage and production waste water produced by the project shall be collected and treated and discharged to the port sewage pipeline at the target level, but shall not be discharged.

5.1.2.3 Noise

(1) Under normal operating conditions, the noise source mainly includes the equipment such as loader pump, compressor, gasifier, etc. The noise value is about 80-95 dB (A).

(2) The noise sources under abnormal working conditions mainly include strong instantaneous noise generated by flare stacks and vent riser, and the instantaneous noise value is about 90-100 dB (A).

5.1.2.4 Solid waste

(1) Marine litter generated by ships arriving at the port.

(2) Domestic waste produced by workers in the course of production and living.

(3) The mobile gridding cleaning opportunities set up in the water intake pump house trap large objects and the rotary filter screen will filter the fine suspended matter and sediment in the sea water, resulting in the filtering material of the seawater intake pump house.

(4) Sludge from sewage treatment facilities, etc.

(5) Dangerous wastes such as machine repair oil cotton yarn, waste oil mud, waste oil and so on resulting from maintenance of equipment of Receiving terminal engineering facilities.

5.1.2.5 Environmental risk accidents

(1) Due to human or natural factors such as misoperation and collision of ships, the leakage of fuel oil from ships arriving at the port results in sudden pollution accidents. The main pollutants are petroleum.

(2) Methane Diffusion in LNG Delivery Pipeline Leakage Accident of Receiving terminal.

(3) Environmental risk effects of CO associated with incomplete combustion of natural gas.

5.2 Estimation of the pollution source strength

5.2.1 Pollution source strength during construction period

5.2.1.1 Air pollution source strength

The main factors affecting the atmospheric environment during the construction of the proposed project are dust from civil construction, material transportation and concrete mixing station. Smoke and dust generated during welding; Spray painting waste gas and construction machinery, equipment, vehicles, ships produced in the process of spray painting.

(1) Dust

①Dust source strength in construction site

Dust pollution during construction mainly depends on construction operation mode, material stacking and wind power, among which the influence of wind force is the greatest.

The results of the analogical survey of dust emissions from various construction activities are detailed in Table 5.2-1.

Table 5.2-1 Summary of the results of the analogical survey of dust emissions from construction activities

Sequence number	Construction area	Type of construction activity	Dust emissions (kg/d)
1	Surface excavation	Excavators and bulldozers	36
		Truck loading	0.48
		Site wind erosion	36.5
2	Site Landfill	Unloading vehicle	0.75
		Site wind erosion	46.1
		Truck loading	0.48
3	Temporary yard site	Truck unloading	0.75

		Bulldozer soil pushing	36
		Site wind erosion	36.5
4	In-and-out line	Transport vehicle running on temporary road surface	432
		Transport vehicle running on cement road	213

Compared with the actual monitoring during the construction of Beilun Port in Ningbo in 1997, the surface source pollution of the construction site is 539 g/s.km when no environmental protection measures have been taken under the combined action of wind erosion, dust pollution from unloading of trucks, dust pollution from road, dust pollution from cement unpacking and dust from the site. The construction site shall be hardened, the site shall be regularly pressed, watered and cleaned, and the transport vehicle shall be flushed on time ; The pollution source of construction site can be reduced to 140 g/s . km after the environmental protection measures such as timely removal and transportation of construction garbage from temporary warehouse

②Dust pollution source strength from transport vehicle

According to the monitoring results of 20~25m and 400 vehicle/d flow on both sides of the transportation line of sand-stone vehicles in Ningbo Beilun Port in 1997, the increase of TSP between 20~25m and 0.158 mg/m3 on both sides of the transportation line was 0.072-0.158 mg/m3, with an average increase of 0.115 mg/m3.

(2) Welding fume

The welding fume produced in the welding process of the proposed project belongs to the unorganized discharge, and its production is calculated according to the theoretical generation of welding fume in " Labor Protection of Welding Work ". During the welding process of this project, the amount of welding fume produced by welding wire and flux is about 4.5 t, 1 kg welding wire and flux is 0.3 g.

(3) Paint exhaust gas

Spray painting is needed in the construction of the LNG tank of the proposed project . The exhaust gas containing organic gas will affect the local working environment.

After communicating with the designer, the water-based paint does not meet the requirements of the project. The reference composition of the paint used in the proposed project is shown in Table 5.2-2.

Table 5.2-2 List of paint reference components used in the proposed project

Sequence number	Paint name	Solids content (%)	Volatile Organic compounds Content (%)
1	Polyurethane finish	63	37
2	Epoxy resin primer	62	38
3	Epoxy zinc-rich primer	72	28
4	Inorganic zinc-rich primer	97	3
5	Thick slurry type epoxy coating	83	17

According to the name of paint, coating area, thickness, paint consumption, etc. provided by the design unit, when painting, the ratio of paint primer to diluent shall be calculated as 1: 0.8 , the ratio of top paint to diluent shall be calculated as 1: 1, combined with the solid content and volatile organic matter content in the paint, the amount of volatile organic matter shall be calculated according to the composition and dosage of paint is detailed in Table 5.2-3.

Table 5.2-3 Summary of paint components and VOC emissions for proposed projects

Paint name	Coating area	Coating thickness	Paint consump	Amount of solids	Amount of volatile organic	Amount of diluent

	(M2)	(μ m)	tion		matter in paint	
Red iron oxygen two-component epoxy resin primer	1867	50	0.1957	0.1214	0.0461	0.1566
Iron-oxygen two-component epoxy resin primer	35	50	0.0037	0.0023	0.0009	0.0030
Thick slurry type epoxy coating	35	100	0.0055	0.0046	0.0009	0.0055
Polyurethane	35	50	0.0036	0.0023	0.0013	0.0036
Inorganic zinc-rich primer	406	75	0.0408	0.0396	0.0012	0.0326
Thick slurry type epoxy coating	406	125	0.0795	0.0660	0.0135	0.0795
Polyurethane	406	50	0.0419	0.0264	0.0155	0.0419
Epoxy zinc-rich primer	4609	75	0.6241	0.4494	0.1748	0.4993
Thick slurry type epoxy coating	4609	100	0.7219	0.5992	0.1227	0.7219
Polyurethane	4609	50	0.4755	0.2996	0.1759	0.4755
Epoxy resin primer	1670	60	0.2101	0.1303	0.0495	0.1681
Polyurethane	1670	30	0.1034	0.0651	0.0383	0.1034
Polyurethane	1670	25	0.0862	0.0543	0.0319	0.0862
Polyurethane	420	35	0.0303	0.0191	0.0112	0.0303
Polyurethane	420	35	0.0303	0.0191	0.0112	0.0303
Epoxy zinc-rich primer	142	1400	0.3589	0.2584	0.1005	0.2871
Epoxy zinc-rich primer	1276	75	0.1728	0.1244	0.0484	0.1382
Thick slurry type epoxy coating	1276	100	0.1999	0.1659	0.0340	0.1999
Polyurethane	1276	50	0.1317	0.0829	0.0487	0.1317
Total consumption			3.5158	2.5301	0.9266	3.1946

Table 5.2-3 shows that the proposed project consumes a total of 6.7104 t/a of paint and diluent and 4.1212 t of volatile organic compounds in spray paint waste gas, representing an unorganized emission.

(4) Exhaust gas from construction machinery, equipment, vehicles and vessles

All construction machinery, equipment, vehicles and ships will discharge tail gas, the main pollutants are NOX, CO, non-methane total hydrocarbons, etc., all are unorganized emissions, large diffusion area, small total emission of pollutants, less impact on the surrounding environment, this evaluation no longer quantitative analysis.

5.2.1.2 Water pollution source strength estimation

(1) Calculation of the source strength of suspended material during offshore construction

During the construction period of this project, suspended sediment is mainly caused by construction links such as pile sinking at the terminal, dredging at the port pool, riprap at the drainage port, etc. The source strength of suspended material at each link is 1.0 kg/s, 9.72 kg/s and 3.80 kg/s, respectively.

(2) Domestic sewage of onshore constructer of the receiving terminal

The daily sewage production per person is estimated at 25L, according to 100 constructers in the field, and the daily sewage generated by the construction team is about 2.5 m^3. The CODC and ammonia nitrogen concentrations in sewage are calculated at 350 mg/L and 40 mg/L, respectively, and the estimated COD and ammonia nitrogen emissions from domestic sewage during construction are about 0.88 kg/d and 0.10 kg/d, respectively.

Mobile toilets will be constructed at the construction site for collection, storage and initial treatment of domestic sewage for construction in the land area, and will be regularly transported by tanker to the Nangang Industrial Zone sewage treatment plant.

(3) Domestic sewage of offshore constructer

According to the feasibility study construction design scheme, 10 ships are operating on water at the same time. At the rate of 10 crew members per ship per person per day, sewage is estimated at 25L per person, and the daily domestic sewage capacity of the crew on board the ship is approximately 2.5 m3. The COD and ammonia nitrogen concentrations in sewage are calculated at 350 mg/L and 40 mg/L, respectively . The estimated COD and ammonia nitrogen emissions from domestic sewage during construction are about 0.88 kg/d and 0.10 kg/d, respectively.

Domestic sewage is collected from the land area and sent to the Nangang Industrial Zone for treatment.

(4) Oil-containing Sewage from ships

Compared with similar construction projects, a construction ship produces an average of 0.5 m3 of oily sewage per day . According to the construction conditions, the number of construction ships is calculated according to 10 m3, and 5.0 m3 of oily water is produced every day. The oil concentration in the sewage is calculated at 5000 mg/L, and the oil emission in the engine room of the ship during construction is estimated to be about 25.0 kg/d.

The oily water in the engine room of the ship is entrusted to qualified units for receiving treatment.

(5) Sand and gravel washing wastewater

Compared with similar construction projects, the amount of sand and gravel material washing waste water produced at construction site is about 100 m3/d, the main pollutant is suspended material, the concentration is calculated according to 1000 mg/L, the estimated amount of SS production during construction is about 100 kg/d. The sedimentation tank set up on the construction site shall be used for washing sand and gravel, but not for discharging.

(6) Sewage from mechanic oil

Mainly for the construction machinery, equipment and other maintenance of the oil pollution caused by machine repair water, the construction peak construction period of the proposed project about 100 construction machinery, equipment repair rate per day according to 5% of the same vehicles, mechanical parts maintenance, machine repair oil pollution water production of 0.2 m3/t, then the amount of oil pollution 1.0 m3/d. The main pollutants are petroleum, with a concentration of 500 mg/L, estimated to be about 0.5 kg/d during construction. After separation by oil-water separator, the sedimentation tank set in the construction site shall be discharged, and after treatment, it shall be used for washing the construction machinery and equipment. The waste oil produced in the process of oil-water separation shall be received and treated by qualified units.

(7) Domestic sewage from the construction of send-out pipeline

According to the analogical investigation of the construction process in the west section of the second line, the discharge amount of domestic sewage, COD and ammonia nitrogen in general pipeline construction is 26m3/km, 7.8 kg/km, 0.78 kg/km respectively, then the discharge amount of domestic sewage, COD and ammonia nitrogen in this project construction period is 5954 m3, 1.79 t, 0.18 t respectively.

(8) Wastewater from Pipeline Pressure Testing

Clean water is usually used for pressure test, and the section of pressure test pipe shall be divided into three sections according to the region grade and the topography, and shall not exceed 32 km. The maximum discharge of the pressure test wastewater of Φ 1219 and Φ 1016 is about 1.86 × 104 m3 and 1.29 × 104 m3 respectively.

In general, the bidding section of pipeline construction does not span provinces or cities, and most of the length is between 70 km and 80 km. The main pollutants in the pressure test wastewater of the cleaning pipe are suspended substances, which are used for agricultural irrigation, road watering or selecting suitable places to discharge. The project pressure test wastewater discharge is 12.53 × 10^4 m^3.

5.2.1.3 Estimation of Noise Source Strength

According to the normal construction method, the main factors affecting the sound environment during construction are the noise of machinery, equipment, vehicles and ships.

Table 5.2-4 List of main noise sources and source strength during construction of terminal and receiving station works

S.N	Pollution source	Maximum sound level DB (A)	Distance between measuring point and sound source	Noise-reducing mode
1	Construction ship	From 68 to 75	Ten to 20	Choose the construction equipment with low noise, arrange the construction time scientifically and reasonably
2	Pipe hanger	88	2	
3	Dump truck	88	7.5	
4	Pile driver	82	30	
5	Electric welder	85	60	
6	Excavator	92	10	
7	Dozer	90	5	
8	Loader	90	5	
9	Cutting machine	95	8	
10	Handling machinery	89	3	

Table 5.2-5 List of main noise sources and source strength during construction of send-out pipeline project

S.N	Noise source	Noise Intensity DB	S.N	Noise source	Noise Intensity DB
1	Excavator	92	6	Concrete mixer	95
2	Pipe hanger	88	7	Concrete dumper	90
3	Electric welder	85	8	Concrete vibrator	105
4	Directional drill	90	9	Cutting machine	95
5	Dozer	90	10	Diesel generator	100

5.2.1.4 Estimation of Solid Waste Source Strength

(1) Construction waste

Construction waste is the waste of construction materials, waste soil and waste slag produced by the project construction . Compared with similar construction projects, the average amount of production is about 5.0 t/d . It is piled up to the designated temporary stacking point.

(2) Terrestrial domestic refuse

About 100 construction personnel, the production of domestic waste is calculated according to 1.0 kg/d, the amount of construction personnel's domestic waste is 100 kg/d, and the municipal sanitation department shall handle it uniformly.

(3) Waste welding rod and slag

In the process of welding, lead-free welding rod is used, and the waste welding rod and slag is about 100 kg/d.

(4) Ship solid waste

①Marine litter

The amount of domestic garbage produced by the construction ship is 1.0 kg/d for 100 people and 100 kg/d for the marine garbage.

②Ship maintenance refuse

The amount of national body waste generated from ship maintenance shall be measured at 10 kg/d, and the amount of solid waste generated from ship maintenance shall be 100 kg/d.

Domestic and maintenance wastes of construction ships shall be accepted and disposed by qualified units.

(5) Machine Repair Oil Cotton Yarn

During the construction of the use of machinery and vehicles, maintenance will inevitably produce machinery oil cotton yarn. Machinery repair oil cotton yarn belongs to hazardous waste, hazardous waste number HW49, similar to similar works, the production of about 10 kg/d. It is included in the list of management exemptions for hazardous wastes and is blended into domestic waste as required under the conditions of exemption and is handled uniformly by the municipal sanitation sector.

Paint residue and barrel

The paint residue and barrel produced in the process of painting are hazardous waste . The dangerous waste number HW12 is about 10 kg/d according to the amount of paint used in the project.

(6) Waste oil

The waste oil produced in the process of oil-water separation at the construction site belongs to the hazardous waste, and the hazardous waste number HW08 is similar to similar works, with a production capacity of about 5 kg/d. It shall be temporarily stored in the temporary storage room of hazardous waste at the construction site, and shall be entrusted to the qualified units to receive and dispose of it on a regular basis.

(7) Waste engin oil

The waste oil produced during the maintenance and repair of construction machinery belongs to the hazardous waste, and the hazardous waste number HW08 is similar to similar works, with a production capacity of about 10 kg/d. It shall be temporarily stored in the temporary storage room of hazardous waste at the construction site, and shall be entrusted to the qualified units to receive and dispose of it on a regular basis.

5.2.1.5 Summary

The production and discharge of major pollutants during the construction of the terminal and Receiving terminal of this project are shown in Table 5.2-6.

Table 5.2-6 Summary of major pollutant production and emissions during construction of terminal and receiving station works

Species	Pollution source	Generating situation	Main contaminants	Disposal measures	Discharge condition
Exhaust gas	Construction site	KM 539 g/s	Dust	Regular watering and cleaning ; The transport vehicle shall be washed on time ; Construction of temporary warehouse ; Timely removal and	KM 140 g/s
	Traffic	0.115 mg/m 3			0.115 mg/m 3

				transportation of construction wastes	
	Welding operation	0.001 t	Welding fume	A.	0.001 t
	Painting operation	4.1212 t	Volatile organic matter	A.	4.1212 t
	Construction machinery, equipment, vehicles, ship exhaust gas		Total NOX, CO, non-methane hydrocarbon	Adopt vehicle construction machinery with low fuel consumption to operate normally ; Maintain normal operation of construction machinery	A.
Waste water	Pier pile sinking construction	1.0 kg/s	SS	A.	1.0 kg/s
	Basin dredging	9.72 kg/s	SS	A.	9.72 kg/s
	Riprap	3.80 kg/s	SS	A.	3.80 kg/s
	Land construction personnel Domestic sewage	2.5 M3/D	CODCR (350 mg/L), 0.88 kg/d ammonia-nitrogen (40 mg/L), 0.10 kg/d	Mobile toilets will be built at the construction site for collection, storage and initial treatment of domestic sewage for construction in the land area, and will be collected regularly by tanker to be sent to the Nangang Industrial Zone Sewage Treatment Plant for treatment	0
	Ship construction personnel Domestic sewage	2.5 M3/D	CODCR (350 mg/L), 0.88 kg/d Ammonia nitrogen (40 mg/L), 0.10 kg/d	Treatment of Sewage Treatment Plant in Nangang Industrial Zone	0
	Marine engine room oil sewage	5.0 M3/D	Petroleum (5000 mg/L), 25 kg/d	Processing received by qualified units	0
	Sand-gravel material washing waste water	100 M3/D	SS (1000 mg/L), 100 kg/d	The sedimentation tank set up on the construction site shall be used for washing sand and gravel, but	0

				not for discharging	
	Machine repair oil sewage	1.0 M3/D	Petroleum (500 mg/L), 0.5 kg/d	After being separated by oil-water separator, it is discharged into the sedimentation tank set in the construction site, which is returned to be used for washing the construction machinery and equipment, but not for discharging	0
Noise	Construction ship	From 68 to 75	Equivalent sound level	The construction equipment with low noise is chosen, and the equipment with large noise is prohibited at night	From 68 to 75
	Pipe hanger	88			88
	Dump truck	88			88
	Pile driver	82			82
	Electric welder	85			85
	Excavator	92			92
	Dozer	90			90
	Loader	90			90
	Cutting machine	95			95
	Handling machinery	89			89
Solid waste	Building waste	5.0 t/d	Spoil and spoil	Pile up to designated temporary stacking point and make comprehensive use of it after unified planning	0
	Terrestrial domestic refuse	100 kg/d	Domestic garbage	Unified treatment by municipal sanitation department	0
	Waste welding rod and slag	100 kg/d	Lead-free waste welding rod and slag	Factory recovery and utilization	0
	Marine domestic garbage	100 kg/d	Marine domestic garbage	Processing received by qualified units	0
	Ship maintenance refuse	100 kg/d	Ship maintenance refuse		0
	Machine	Ten kg/d	Hazardous	To be included in the	0

	repair oil cotton yarn		Waste, Hazardous Waste Number HW 49	list of management exemptions for hazardous wastes and to be integrated into domestic wastes in accordance with the conditions for exemption and to be handled uniformly by municipal sanitation authorities	
	Paint dreg	Ten kg/d	Hazardous Waste, Hazardous Waste Number HW 12	It shall be temporarily stored in the temporary storage room of hazardous waste at the construction site, and shall be periodically entrusted to the competent units for receiving and processing	0
	Waste oil	Five kg/d	Hazardous Waste, Hazardous Waste Number HW 08		0
	Waste engine oil	Ten kg/d	Hazardous Waste, Hazardous Waste Number HW 08		0

5.2.2 Estimation of the pollution source strength in Operation Period

5.2.2.1 Estimation of air pollution source strength

The types of waste gas pollution sources in the proposed project are divided into two categories: organized and non-organized.

(1) Emission sources of organized waste gases under normal operating conditions

①Combustion exhaust gas of SCV

According to the process requirements, an submerged Combustion vaporizer is set up to meet the gasification requirements of LNG at low seawater temperature in winter. At the same time, according to the operation experience of the gasifier in China, the gasifier can only be opened at low sea water temperature.

According to the feasibility study report, the efficiency and operation days of the SCV are listed in Table 5.2-7

Table 5.2-7 SCV Process Design Parameters

Operation period	External gas delivery (10^4 nm^3/d)	Operation Days	Single SCV Gasifier (m3/h)	SCV Total Daily Hours of Work	SCV Workbench Count (s)
Emergency security	6000	5	25.89	231.8	10
Peak regulation	4000	57		154.5	7

Other	650	28		25.1	2

According to the feasibility study report, the consumption of natural gas is 2.5 t/h at a SCV load of 200 t/h (see Table 5.2-8 for details), and the density of natural gas under standard conditions is 0.7724 kg/m^3, i.e., the consumption of natural gas is 0.3237 n10000 m^3/h at a single SCV load of 200 t/h. According to Table 5.2-8, when the SCV is operating at full load, the maximum amount of gas per unit of natural gas is required for gasification. This evaluation according to SCV full load source strength accounting.

Table 5.2-8 SCV Energy Consumption Per Hour

LNG Load t/h	Fuel gas t/h	Gas fee (yuan)	Electricity consumption kwh	Electricity fee (yuan)	total cost (yuan)
10	0.12	360	450	360	720
20	0.23	690	450	360	1050
22	0.25	750	450	360	1110
30	0.35	1050	450	360	1410
40	0.46	1380	450	360	1740
50	0.58	1740	450	360	2100
60	0.69	2070	450	360	2430
70	0.8	2400	450	360	2760
80	0.92	2760	450	360	3120
100	1.15	3450	450	360	3810
120	1.38	4140	450	360	4500
140	1.71	5130	450	360	5490
160	1.96	5880	450	360	6240
180	2.21	6630	450	360	6990
200	2.5	7500	450	360	7860

According to the amount of natural gas provided by the design unit, the output of flue gas and the emission of sulfur dioxide are calculated according to the boiler fouling system . Due to the use of low nitrogen and high efficiency combustion technology in the submerged combustion gasifier, the difference between the emission of nitrogen oxides and that of nitrogen oxides in the National Pollutant Source Survey Coefficients Manual is large . based on the supplier's records and design unit experience, the NOX emission concentration is 70 mg/m3. Taking into account the pollutant emission factors of oil and gas fuels in the Social Region Category of Occupational Qualification Training Textbook for EIA Engineer (published by China Environmental Science Publishing House), 0.14 kg of smoke and dust per 1000 cubic meters of natural gas is emitted, while the National Pollution Source Survey Coefficient Manual considers that the smoke and dust content of natural gas combustion is less, and the dust emission is not counted.

According to the gas temperament analysis report of this project provided by the construction unit, the hydrogen sulfide content is 0.569 ppm, the concentration is very low . This evaluation conservatively estimated that the natural gas entering the long distance pipeline in reference to " natural gas " (GB 17820-2018) should meet the quality requirements of a type of gas . The total sulfur content of a type of natural gas is ≤20 mg/m3.

Table 5.2-9 4430 Pollution coefficient of gas industrial boiler

Material name	Pollutant index	Units	Emissions
Natural gas	Amount of exhaust gas	Standard cubic meter/10000 cubic meter raw material	139854.28

	Sulfur dioxide	Kg/m3 raw material	0.02 S
	Nitrous oxide	Kg/m3 raw material	18.71

According to the above calculation, the exhaust emission parameters of the SCV gasifier are shown in Table 5.2-11.

②Boiler

According to the information provided by the design unit, a gas boiler is built in this project with a maximum heat load of 650 kW and a maximum consumption of 250 m3/h of natural gas.

③Flare stacks

Flare stacks is the direct discharge of flammable gas, and exhaust pipe is the standard discharge pipe of flue gas after treatment . At present, the discharge standard of pollutants from petroleum refining industry (GB 31570-2015), petrochemical industry (GB 31571-2015), boiler air pollutants discharge standard (GB 13271) and other existing discharge standards are formulated for exhaust pipe.

The burning mode of the flare stacks is divided into the long lamp discharge under normal working conditions and the accident discharge under abnormal working conditions. According to the information provided by the design unit, there are 9 burner nozzles for each flare stacks under normal operating conditions, the natural gas consumption per burner is 1.5 nm^3/h, and the natural gas consumption per ground flare stacks under normal operating conditions is 13.5 m3/h.

Under normal working conditions, due to the low consumption of natural gas and the complete combustion of natural gas, the pollutant production amount of natural gas is referred to the pollutant emission factors of natural gas fuel in the Social Area Class of the Professional Qualification Training Textbook for EIA Engineers (published by China Environmental Science Publishing House), and the smoke volume of 1m3 natural gas combustion is 10.5 m3 . the sulfur content is calculated according to the total sulfur content of natural gas 20 mg/m3, and the SO2 emission concentration is 3.81 mg/m3.

Under abnormal working conditions, the production of flare stacks waste gas shall be calculated according to the application and technical specification for petrochemical industry of the National Environmental Protection Standard of the People's Republic of China (HJ 833-2017).

(2) Non-organized Strong exhaust gas from receiving station

①The non-condensable gas in the BOG system of the LNG Receiving terminal under normal operating conditions is condensed by pressure and pressurized by a booster pump.

②Due to the addition of flanges and other valve fittings at the Receiving terminal, some unorganized emissions are generated. The leakage rate is calculated according to the notice issued by the former Ministry of Environmental Protection of “Guidelines for Printing and Distributing the Pollutant Sources of VOCs in the Petrochemical Industry” and the Guidelines for Leak Detection and Repair of Petrochemical Enterprises (Circular [2015] No. 104 of Ministry of Environmental Protection), the unorganized emissions from the new added number of valve parts are calculated according to the average emission coefficient method.

Table 5.2-10 Average emission factors for petroleum refining and petrochemical components

Unit	Device type	Media	Petroleum refining emission factor Kg/h/source of emission b	Petrochemical Emission Factor (kg/h/source of emission) c
Receiving terminal	Valve	Gas	0.0268	0.00597
	Compressor	Gas	0.636	0.228
	Pressure relief device	Gas	0.16	0.104
	Sampling	Gas	0.0150	0.0150

Unit	Device type	Media	Petroleum refining emission factor Kg/h/source of emission b	Petrochemical Emission Factor (kg/h/source of emission) c
	connection system			
	Flange, connector	Gas	0.00025	0.00183

Based on the calculation of petrochemical emission coefficient, the unorganized gas emission rate of the project is about 6.0 kg/h according to the parameters provided by the design unit. According to the component calculation of natural gas provided by the research report, the percentage of total non-methane hydrocarbon in the rich gas of the project is 11. 8% , and the total non-methane hydrocarbon in the lean gas is 0 . The maximum emission rate of non-methane total hydrocarbon in the Receiving terminal is about 0.36 kg/h.

(3) Accounting for the amount of waste gas generated under abnormal conditions

The accident state of this evaluation is the state of gasifier emptying and tank emptying . According to the parameters provided by the design unit, the maximum gas venting capacity is 200 t/h.

Under abnormal conditions, the maximum handling capacity of the flare stacks is 130 t/h and the density of liquefied natural gas is 0.45 g/cm3 . Therefore, the natural gas consumption of the flare stacks under abnormal conditions is 288.89 m3/h, and the discharge parameters of the flare stacks under abnormal conditions are listed in Table 5.2-12.

Therefore, the emissions from this project can be up to standard. The project exhaust emissions are shown in the following table.

Table 5.2-11 Emissions from the Operation Period of the Works

Pollution source	Number of units	Natural gas consumption (m3/h)	Total flue gas (m3/h)	NOx Emission Rate (kg/h)	Soot discharge rate (kg/h)	SO 2 Emission Rate (kg/h)	Concentration of NOx contaminants (mg/m3)	Concentration of soot and dust contaminants (mg/m3)	Concentration of SO 2 contaminants (mg/m3)	Chimney			Discharge frequency	Discharge condition
										Height	Inside diameter	Outlet temperature ℃		
SCV	One	3237	45271	3.1690	0.4527	0.3884	70	10	2.86	25	1.0	220	See Table 4.2-1 for details	Normal operating condition
Boiler	One	250	3496	0.2447	0.0350	0.0300	70	10	2.86	15	0.6	200	Annual operating days 120 days	Normal operating condition
Flare stacks beacon	One	13.5	141.75	0.0238	0.0019	0.00054	167.62	13.33	3.81	30	9	Less than 800	8760 h	Normal operating condition

Table 5.2-12 Emissions from Unusual Operating Conditions

Pollution source	Run Number of units	Natural gas consumption (m3/h)	Total flue gas (m3/h)	NOx Emission Rate (kg/h)	Soot discharge rate (kg/h)	SO 2 Emission Rate (kg/h)	Concentration of NOx contaminants (mg/m3)	Concentration of soot and dust contaminants (mg/m3)	Concentration of SO 2 contaminants (mg/m3)	Chimney			Discharge frequency	Discharge condition
										Height	Inside diameter	Outlet temperature ℃		
Flare stacks beacon	2	288.89 x 2	3033.34 x 2	0.5093 x 2	0.0407 x 2	0.0116 x 2	70	10	3.81	30	9	Less than 800	Discontinuous	Abnormal condition

5.2.2.2 Water pollution source strength estimation

(1) Process cooling water

The seawater needed for gasification of the proposed project will be heat exchange only, and the temperature will be reduced after heat exchange, and the residual chlorine content will be controlled within 0.2 mg/L. Filter screen is arranged at the water intake to protect the safe operation of the water extraction pump . There is no special requirement for water quality.

In the process of production, the heat source of seawater gasifier is used, the direct current seawater is only used for heat exchange, the water quality is not polluted, only the temperature after heat exchange is reduced, the discharged seawater temperature is lower than 4~5°C, and the discharge is 58800 m3/h (16.33 m3/s).

(2) Domestic sewage

①Terrestrial domestic sewage

After the completion of the project, the design and operation personnel shall be 150 (four shift three operation system), the annual operation time shall be calculated as 365 D, and the water consumption shall be 100 L/D • For persons, the annual water consumption is 4124.5 t (based on the 365 days of operation per year of the Receiving terminal). The coefficient of domestic sewage production is 0.8 , and the annual sewage production is 3299.6 t. The COD and ammonia nitrogen concentrations in sewage were calculated at 300 mg/L and 40 mg/L respectively, and the annual production of COD and ammonia nitrogen during the operation of the project was estimated at about 0.990 t and 0.132 t, respectively. During the operation period, domestic sewage from the land area is sent to the self-built sewage treatment station through the pipeline network for treatment to meet the standard of " urban sewage reuse water quality " (GB/T 18920-2002), and the non-heating season is partly used for greening of the Receiving terminal, road spraying and ground washing water. The heating season is treated by the self-built sewage treatment station and discharged to the south port sewage treatment plant.

②Domestic sewage from ships

In accordance with Article 8 of Annex IV to MARPOL 73 / 78 , Article 8 of the MARPOL Convention, ships are required to have domestic sewage treatment devices approved by the competent authority and to ensure the normal operation of domestic sewage treatment facilities, which can be discharged during navigation and beyond 12 nautical miles after the standards have been met.

According to the throughput and design type of the project, the average number of ships arriving in the port during the year is about 19, with an average staff of about 20 persons per ship and a residence time of about 2 days in the port. Water consumption per 100 l/d • For persons, the annual domestic water consumption of ships arriving in the port is 76 t and the coefficient of domestic production is 0.8 t, the annual production of domestic sewage is 60.8 t. The COD and ammonia nitrogen concentrations in sewage were calculated at 300 mg/L and 40 mg/L, respectively . The estimated COD and ammonia nitrogen production during operation were about 0.018 t and 0.002 t, respectively.

The domestic sewage of the ship is collected and sent to the self-built sewage treatment station for treatment.

(3) Oily sewage from ships

The oily sewage of the ship is mainly oily water at the bottom of the ship's cabin . The oily water at the bottom of the cabin is mainly due to leakage, discharge and the accumulation of oily sewage at the bottom of the main and auxiliary engine rooms.

In accordance with the Design Code for Environmental Protection of Port Works (JTS 149-1-2007), the amount of oily water produced at the bottom of the LNG cabin shall be 18.3 t/d • The oil content of bilge water shall be 2000 mg/L. The project will have about 19 LNG ships arriving in the port for the whole year, with a residence time of about 2 days . It is calculated that the annual oil pollution water of the bilge bottom will be 695.4 t and the oil content of the bilge bottom will be 1.391 t. Oily sewage from ships is entrusted to qualified units for receiving treatment.

(4) Sewage from mechanic oil

During the evaluation period, the main machinery and equipment shall be counted according to 100 units, the daily repair rate shall be 1% , and the water used for repairing the parts shall be 0.6 m3/d, 219 m3/a (according to the annual operation days of the Receiving terminal 365 days). Based on 80% of the water used, the amount of oil pollution water produced by the machine repair is 175.2 m3/a and 0.5 m3/d. The machine repair oil pollution water is collected uniformly and sent to the self-built sewage treatment station for treatment.

(5) Surface flushing wastewater

The amount of wastewater produced by surface washing is about 10 m3/h, which is discontinuous drainage. The surface washing wastewater is collected and discharged into the self-built sewage treatment station for treatment.

(6) Initial rainwater

This project is a LNG Receiving terminal project . The initial rainwater mainly concentrates on the initial rainwater in the loading area of tank truck . The total area of tank truck loading area is 5.2835 hectares. According to the formula of rainfall intensity in Tianjin area, the rainfall amount in the first 15 minutes is calculated.

The formula of storm intensity is adopted in Tianjin :

Q = 3833.34 (1 + 0.885 LGP)/ (T + 17) 0.85 .

P-Design recurrence period, this project takes 1 year ;

T--The rainfall duration (min) is involved and 20 min is taken.

Calculated Q = 178.08 L/ (S.HA)

If the loading area of the tanker is 5.2835 hectares, the initial rainfall amount in the loading and unloading area of the terminal 10 minutes ago will be as follows :

Q = 178.08 × 5.2835 × 10 × 60 / 1000 = 564.531 m 3

After calculation, the initial rain water volume of the tank truck loading area of this project is 564.531 m3/times, and a wall sill is set around the tank truck loading area to collect and deliver the initial rainwater to the self-built sewage treatment station for treatment, and the remaining unpolluted clean rain water is discharged through the rainwater discharge port. The initial rainwater is discharged into the accident tank (the effective capacity of the accident tank is 2500 m3) and then pumped to the project's own sewage treatment station for treatment.

(7) Ballast water

Ballast water is the water specially injected to keep the ship in balance when the ship carrying the export goods is not loaded on the way to port. Therefore, ships carrying imported goods will not have ballast water, which is mainly produced by ships transporting exported goods. The proposed project is designed to discharge 5000000 tonnes of LNG.

The water quality, quantity of water, mode of discharge and location of wastewater generated by the proposed project are shown in Table 5.2-13

Table 5.2-13 List of wastewater quality, quantity, discharge methods and whereabouts generated by the LNG terminals

S. N	Waste water specie	Wastewater name	Main pollution	Producing concentrat	Amount of waste	Pollutant production	Discharge mode and direction

	s		factor	ion (mg/L)	water	(T/A)	
1	Domestic sewage	Terrestrial domestic sewage	COD	300	3299.6 M3/A	0.990	Intermittent, after collection into the self-built sewage treatment station treatment.
2			NH 3-N	40		0.132	
3		Domestic sewage of ship	COD	300	60.8 M3/A	0.018	
4			NH 3-N	40		0.002	
5	Oily sewage	Ship oily sewage	Petroleum	2000	695.4 M3/A	1.391	Intermittent, delegated to qualified units to receive processing
6		Machine repair oil sewage		20	175.2 M3/A	0.004	Discontinuous, unified collection after being fed into the self-built sewage treatment station treatment.
7		Ground washing wastewater		5	Ten m3/h	0.00005	
8		Initial rain		5	564.531 m3/s	0.003	
9	Cooling water	Low temperature Residual chlorine		≤ 0.2 mg/L	58800 m3/h	A.	Direct drainage

5.2.2.3 Noise source strength estimation

The main noise sources of the proposed project under normal operating conditions are the loading and unloading pump, compressor and gasifier . The noise value is about 80-95 dB (A).

Table 5.2-14 The noise source list of the LNG receiving terminal project

Categories	Noise source name	Indoor/outdoor	Noise value after noise reduction (DB (A))	Operating equipment platform sleeve
Port engineering	Ship conveying pump	Inboard	91	4
BOG recovery system	BOG compressor	Outdoor	90	2
	High-pressure BOG compressor	Outdoor	93	1
Gasification system	Seawater gasifier	Indoor	85	1
	Submerged combustion gasifier	Indoor	85	1
	Sea water pump	Indoor	93	7
	External pump	Indoor	85	2
Air pressing nitrogen system	Instrument air compressor	Indoor	90	1
	PSA nitrogen system	Indoor	90	1

Water supply system	Pressurizing pump for water supply system	Outdoor	85	2
	Circulating water pump	Outdoor	85	1
Sewage treatment system	Various lift pumps	Outdoor	80	6
	Roots blower	Indoor	95	1

5.2.2.4 Solid waste estimation

(1) Land area domestic refuse

Land domestic waste is estimated at 1.0 kg/d per capita, 150 people are appointed for the proposed project (four shifts and three operation systems), and the annual operation days are calculated at 365 d, and the annual production of the proposed project domestic waste is 41.245 t/a, which shall be handled uniformly by the municipal sanitation department.

(2) Filter material for seawater intake pump house

The mobile gridding decontamination opportunities set up in the pump house of the proposed project will trap large objects and the rotary filter screen will filter the fine suspended matter and sediment in the sea water to produce the filter material of the pump house of the seawater intake. According to the scale of seawater intake, the filter output of the seawater intake pump house of the proposed project is about 50.0 t/a, which belongs to general solid waste, and is handled uniformly by the municipal sanitation department.

(3) Sewage Treatment Facilities Sludge

The operation of the self-built comprehensive sewage treatment station will produce sludge with a production capacity of about 2.5 t/a, which will be handled uniformly by the municipal sanitation department.

(4) Ship solid waste

①Ship domestic garbage

According to the throughput and design type of the project, the average number of ships arriving in Port for the whole year is about 19, with an average staff of about 20 persons per ship and a residence time of about 2 days. The domestic garbage from the epidemic area shall be treated by the competent health inspection and quarantine department after quarantine. Domestic garbage from ships in non-epidemic areas shall be received and disposed by qualified units.

②Ship maintenance wastes

The ship maintenance waste can be calculated according to 20 kg/d per ship . The average number of ships arriving in Port during the operation period of the project is about 19, the length of stay in Port is about 2 days, and the waste generated from the ship maintenance is 0.76 t/a. The ship maintenance wastes from the epidemic area shall be treated by the competent health inspection and quarantine department after the quarantine ; Ship maintenance wastes in non-epidemic areas shall be accepted and disposed by qualified units.

(5) Machine Repair Oil Cotton Yarn

During the repair of machinery and equipment, oily waste cotton yarn is produced, which belongs to the hazardous waste. It is included in the list of management exemptions for hazardous wastes and is blended into domestic waste as required under the conditions of exemption and is handled uniformly by the municipal sanitation sector.

(6) Waste oil sludge

The oil removal process will produce waste oil sludge, which belongs to hazardous waste, code 900-210-08. It is temporarily stored in the project's own temporary storage room for hazardous waste, which is regularly disposed of safely by qualified units.

(7) Waste oil

Waste oil is produced during the operation of equipment and machinery, which belongs to hazardous waste . Hazardous waste code 900-214-08 is about 1.5 t/a. It is temporarily stored in the project's own temporary storage room for hazardous waste, which is regularly disposed of safely by qualified units.

The solid waste and disposal methods resulting from the proposed project terminal and Receiving terminal works are shown in Table 5.2-15.

Table 5.2-15 List of solid wastes and disposal methods generated by the LNG receiving terminals

Sequence number	Solid waste	Solid waste property	Production (T/A)	Disposition
1	Terrestrial domestic refuse	General solid waste	41.245	Unified treatment by municipal sanitation department
2	Seawater intake pump house filter		50	
3	Sewage treatment facility sludge		2.5	
4	Marine domestic garbage	Ship solid waste	0.76	The solid waste of ships from the epidemic area shall be handled by the competent health inspection and quarantine department after quarantine ; Solid waste of ships in non-epidemic areas shall be accepted and disposed by qualified units
5	Ship maintenance waste		0.76	
6	Machine repair oil cotton yarn	Hazardous Waste (HW49)	0.5	To be included in the list of management exemptions for hazardous wastes and to be integrated into domestic wastes in accordance with the conditions for exemption and to be handled uniformly by municipal sanitation authorities
7	Waste oil sludge	Hazardous Waste (HW08)	1	Be temporarily stored in the project's own temporary storage room for hazardous waste, and be disposed of safely by qualified units on a regular basis
8	Waste engine oil		1.5	
Total			98.265	Be properly disposed of in all categories

6 Baseline of Environmental and Social Conditions

6.1 Natural Environment

6.1.1 Meteorology

The LNG recieiving terminal project are in the northern hemisphere warm and semi-humid continental monsoon climate. Because it is near the Bohai Sea, it is influenced by the monsoon circulation, and the change of wind is obvious in winter and summer. In winter, cold and dry northwest winds prevail in the troposphere at low altitudes, which is influenced by cold high pressure centers in Mongolia and Siberia. In summer, a southeasterly wind of high temperature and high humidity prevail, which is influenced by the subtropical high center of the North Pacific at low continental pressure and low latitude. Therefore, Dagang area has the climate features of long winter and short spring, hot summer and cold winter, four distinct seasons and strong monsoon.

(1) Temperature

The average annual temperature in the project area is 12.1 ℃, with the highest average temperature of 12.9 ℃ and the lowest average temperature of 11.6 ℃. The extreme maximum temperature was 40.3 degrees Celsius (13 June 1988) and the extreme minimum temperature was 20.3 degrees Celsius (31 January 1979). The average temperature in January was -4.9 ℃. The average temperature in July was 26.3 degrees Celsius. The average temperature is slightly higher in autumn than in spring.

(2) Precipitation

The average precipitation days is 55 days in a year, and the average annual precipitation is 593.6 mm. Precipitation mainly concentrates in June to September, and the average precipitation is 491.5 mm, accounting for 84% of the total precipitation. Seasonal and monthly precipitation is concentrated in summer, autumn is more than spring, winter is the least. July has the largest precipitation of the year, with an average of 232.2 mm in a calendar year. The lowest rainfall was recorded in January, with a calendar year average of 3.2 mm.

(3) Fog

There are 14.2 days over a year with a visibility less than 1 km, which happen mostly in winter.

(4) Wind

Dagang area is located in the monsoon climate zone. Winter and summer are controlled by different air masses, forming different wind directions. The normal wind direction of the sea area is S direction with a frequency of 11. 97% , and sub-normal wind direction is E direction with the frequency of 11. 08% ; The strong wind direction is in the E direction with the measured maximum wind speed is 19.7 m/s, and the next strong wind direction is ENE direction with the maximum wind speed measured is 17.5 m/s. The average annual wind speed in the region was 4.43 m/s, and the maximum winds come from E of 6.51 m/s. The area has more NW wind in winter, SE wind in summer and SW wind in spring and autumn. The main cause of strong wind is cold wave in winter and spring. Typhoons occur less frequently.

(5) Humidity

The averaged absolute humidity in Dagang area is 11. 3% over the years. The averaged relative humidity is 65% , the maximum relative humidity 69% (1990), and the minimum 60. 5% (1988). The largest annual averaged relative humidity is in July and August with a value of 80%, and the lowest humidity is from January to May with a value of 57%.

The pipelines are in the eastern monsoon region. It has a warm temperate coastal semi-humid continental monsoon climate with a certain sea climate characteristics. The winter is cold with snows; the spring is dry and windy; the summer has a high temperature, humidity, and precipitation concentration ; the autumn is crisp and sunny. The main meteorological data along the line are shown in the table below:

Table 6.1-1 Statistics of main meteorological data along the route

Place	Temperature (℃)			Wind			Annual average Precipitation (mm)	Max Frozen soil Depth (cm)
	Extreme maximum	Extreme minimum	Annual average	Maximum frequency wind direction	Minimum frequency wind direction	Max Wind speed (m/s)		
Binhai New Area			12.6	Northwest		31	566	
Jinghai District			12.4	South Southwest		25	552.5	
Xiqing District			12.2	South Southwest		33	549.4	
Wuqing District	39.9	- 22.0	11.6	SW	Northwest		666	72
Anci District	40.2	- 29.2	11.5	North North West	West		509	60
Yongqing County	39.1	- 29.4	10.9	North North West	West		690	70
Guangyang District	40.2	-25.5	11.9	North North West			554.9	70
Daxing District	41.9	-17.0	11.6	South South West			556	

6.1.2 Hydrology

(1) Tides and tidal currents

Dagang area experiences irregular semidiurnal tides with two tides in a day. There are two spring tides and two neap tides in one month. According to the investigation of Qikou located to the southern boundary of Dagang District in Tianjin City in 1985, the duration of ebb tide was 7 hrs 20 mins and the duration of high tide was 5 hrs 5 mins. The mean high water level was 1.92 m and the mean low water level was 0.52 m. The average spring tide difference is 1.81 m, and the average small tide difference is 1.02 m. The ebb tide flows to southeast while flood tide flows to northwest.

(2) Sea ice

The coastal area in Tianjin has an ice age 3 months in each year, and from mid-January to mid-February is the glacial maximumThe fixed ice width along the coast is generally within 500 m with the thickness of 10-25 cm and the maximum of 40 cm ; The range of drift ice is 20~30 km, with the thickness of 10~25 cm and the outer line within the 10~15 m isobath. The direction of ice flow is mostly in SE~NW direction, and the flow velocity is about 30 cm/s with the maximum value of 100 cm/s.

6.1.3 Geology

The geological structure in Tianjin is complex, with the Ninghe-Baoyu fault as the boundary, the northern part is the Yinshan zonal tectonic system, and the mountainous area is controlled by the secondary Yanshan settlement belt. The piedmont plain is formed between the Jixian fault and the

Ninghe-Baoyu fault. The Tangshan uplift of the east-west distribution and the compression and torsion fractures of the Xinhuaxia system, as well as the existence of the front and west wing reflex arcs of the eastern wing reflex arc of the Luhelan type structure and the Malanyan character structure. The southern part of the Xinhuaxia tectonic system runs through the north and south, and is a series of north-north-eastward uplift depressions and tectonic faults. From the west to the east, there are the Jizhong depression, the Jixian uplift, the Huanghua depression and a series of NE-trending faults. . The Tianjin section of the project is located in the Ninghe-Baoyu fault. It is a Class I tectonic unit in the Taipei section of the North China quasi-district, and the II-level tectonic unit is located in the North China fault zone. It is divided into two Grade III tectonic units in the Huanghua depression and the Jixian uplift.

Hebei province is divided into three distinct zones from north to south. Along the northern edge of the Kangbao storage field, which is about 42° N line, is a qualitative change boundary: to the north is the pre-Mesozoic Canine Ocean and to the south lies the continent. The main tectonic line and modern geomorphic trend are different along the central line of latitude 40°. The north side of the mountain range is the Yanshanian mountain, and the direction of the mountain and the main tectonic line are near east and west. To the south, the vast and flat North China Plain lies side by side with the towering Taihang Mountains to the NNE and SSW.

6.1.4 Earthquake

According to the " China Earthquake Peak Acceleration Zoning Map " (GB 18306-2015), combined with the results of the intermediate edition of seismic safety assessment, the peak earthquake acceleration along the project is shown in the following table.

Table 6.1-2 Characteristic periodic values of the response spectra of the basic ground motion peak acceleration and the basic ground motion acceleration along the line

Provinces	City (County)	Peak acceleration	Response spectrum characteristic period	Remark
Beijing	Daxing District	0.20	0.40	Fifty year probability of exceeding 10%
Hebei Province	Guangyang District, Langfang City	0.20	0.40	Fifty year probability of exceeding 10%
	Langfang Yongqing County	0.15	0.40	Fifty year probability of exceeding 10%
	Langfang Anji District	0.15	0.40	Fifty year probability of exceeding 10%
Tianjin	Wuqing District	0.15	0.40	Fifty year probability of exceeding 10%
	Xiqing District	0.15	0.40	Fifty year probability of exceeding 10%
	Jinghai District	0.15	0.40	Fifty year probability of exceeding 10%
	Binhai New Area	0.20	0.40	Fifty year probability of exceeding 10%

6.1.5 Topography and geomorphology

Tianjin is located in the transitional zone from Yanshan Mountain to Binhai Plain. The northern mountainous area belongs to Yanshan Mountain, the southern plain is part of North China Plain, and the southeast is near Bohai Bay. The topography is high in the north and low in the south: from the northern mountains to the southeast coastal plain the highest peak is Jiuding Mountain with the elevation of 1078.5 m, and the lowest is Dagu mouth of the coastal zone with the elevation of zero. The main geomorphic units passing by the pipeline are water network and plain, and the surface conditions are mostly farmland, fish pond, forest land, orchard, etc.

Water network: mainly distributed in the front section of Tianjin Binhai New Area, Jinghai District and Xiqing District, mainly for continuous fish ponds distributed in a grid pattern. The length of the water network in Tianjin is 48.2 km, accounting for 30% of the total length of the pipeline in Tianjin.

Plain: about 70% of the pipeline passing through Tianjin is plain, mainly alluvial plain, coastal alluvial plains and Coastal alluvial low plains. The topography is low and slightly undulating with local ditches and fish ponds. The southeast of coastal zone has salt flats and wetlands, and the soil salinity is serious ; Vegetation development along the remaining areas is mainly forest land and arable land. The other part is formed by artificial reclamation, and most of the surface area has been leveled. There are earth pits, water puddles and earth mounds distributed locally. Gravels are in individual areas, mostly wasteland, mainly in the section of the Beijng Gas-Nangang LNG terminal.

Langfang City is mostly in the depressed area. With the subsidence of the earth's crust, the ground is gradually filled up by Quaternary sediments, resulting in the large subsidence of the boundary strata. The topography of the city is relatively flat and monotonous, with the plain as the main. The general elevation is between 2.5-30 meters, and the average elevation is about 13 meters above sea level.

Beijing is surrounded by mountains in west, north and northeast. Southeast is a gently sloping toward the Bohai Sea. The elevation of the Beijing Plain is 20-60 meters. In Langfang City, Hebei Province and Daxing District, Beijing, the main pipeline passing along the area is alluvial flood plain area, which is a typical North China Plain landform. It is a flat and open landform, with mostly dry land, maize, cotton, wheat and so on.

6.1.6 Sediment condition

The nearshore part of Dagang area is a typical silty coast, with a flat slope and a relatively steady shoreline position.

6.2 Social Enviroment

Regarded as a world-class petrochemical industry and port comprehensive functional area, Tianjin Nangang Industrial Zone is a demonstration base for the new industrial petrochemical industry, a national energy reserve base and a pilot unit for Tianjin recycling economy. It has a planned area of 200 km^2, with an increase of RMB 20,94 billion in 2018.

The Nangang Railway is scheduled to open at the end of June 2020, with the completion of the Haibin Expressway and the construction of the Jinshi Expressway (Tianjin Section). The primary trunk road network of the park has been basically formed, and a hundred kilometers of roads have been opened to traffic. Six general bulk cargo berths of 20,000 dwt, one general berth of 70,000 dwt, seven liquid chemical terminals of 50,000 dwt , one LNG terminal of 100,000 dwt and eight working vessel berths have been put into use, and the 100000 ton class navigation channel has been officially opened to the public. Some important public works have started construction, such as China Electric Power and Co-generation and Industrial Gas in Liquid and Air. The Seawater Desalination Project has completed detailed design and is ready for construction. At present, the park has 480,000 kV • A power supply capacity of 50,000 tons/day water supply and distribution center, with a 790,000 tons/day steam supply capacity, 200,000 m^3/day air supply capacity, m^3/day sewage treatment capacity.

It has gathered Sinopec, PetroChina, CNOOC, Bohua, Shell, BP, Shabik, Hensmail, graceful, FCL, Oldfield, Veolia, Akzo Nobel and other leading domestic and foreign enterprises. Sinopec LNG, Shell Lubricating Oil, graceful catalyst and other 25 projects have been completed and put into production. China Sha polycarbonate, Bohua and Akzo Nobel peroxide, BP lubricating oil and other 14 projects are under construction.

Nangang Industrial Zone adheres to the concept of " low-carbon development, green development and circular development ", and focuses on the construction of ecological parks with the coordinated development of economic society and ecological civilization. Nangang Industrial Zone does not plan and build residential areas such as communities and villages. Strict access to the project forms a comprehensive system of project access indicators. An environment monitoring and early warning system were formed to monitor the environmental quality and trend of the park. Safety supervision system and emergency management system of chemical industrial park have been constructed. Closed management has been implemented. Nangang Industrial Zone is the first chemical industrial park in China to implement " Responsibility Concern ", and has signed the " Global Charter for Responsibility Concern ".

7 Investigation and evaluation of the ecological status

7.1 Seawater environmental quality status

7.1.1 Seawater quality status

The North Sea Environmental Monitoring Center of the National Oceanic Administration conducted a survey into the water quality, sediment environmental quality, biomass quality and current ecology of the target location of marine area on Spring (May 2017) and Autumn (September 2017). The material and results collected by the North Sea Environmental Monitoring Center of the National Oceanic Administration lays a foundation for this survey of current environment of target marine area. The location of survey stations are shown in Table 7.1-1 and Figure 7.1-1 below.

Table 7.1-1 The coordination of the marine environment survey stations

Station No.	Latitude	Longitude	Objectives
Z1	117° 38' 00"	38° 48' 01"	water quality
Z2	117° 39' 48"	38° 47' 58"	Water quality, biology, sediments
Z3	117° 41' 33"	38° 47' 54"	water quality
Z4	117° 43' 15"	38° 47' 47"	water quality, biology, sediments
Z5	117° 45' 18"	38° 47' 43"	water quality
Z6	117° 47' 10"	38° 47' 35"	water quality, biology, sediments
Z7	117° 37' 55"	38° 46' 25"	water quality, biology, sediments
Z8	117° 39' 37"	38° 46' 17"	water quality
Z9	117° 41' 20"	38° 46' 16"	water quality, biology, sediments
Z10	117° 43' 12"	38° 46' 11"	water quality
Z11	117° 45' 13"	38° 46' 03"	water quality, biology, sediments
Z12	117° 47' 06"	38° 45' 59"	water quality
Z16	117° 45' 03"	38° 44' 31"	water quality
Z17	117° 47' 01"	38° 44' 27"	water quality, biology, sediments
Z21	117° 44' 56"	38° 43' 05"	water quality, biology, sediments
Z22	117° 46' 49"	38° 42' 59"	water quality
Z23	117° 39' 23"	38° 42' 01"	water quality, biology
Z24	117° 40' 59"	38° 41' 56"	water quality, biology, sediments
Z25	117° 42' 49"	38° 41' 53"	water quality, biology, sediments
Z26	117° 44' 53"	38° 41' 45"	water quality
Z27	117° 46' 46"	38° 41' 39"	water quality, biology, sediments
Z28	117° 39' 14"	38° 40' 36"	water quality, biology, sediments
Z29	117° 40' 51"	38° 40' 31"	water quality, biology, sediments
Z30	117° 42' 41"	38° 40' 27"	water quality
Z31	117° 44' 44"	38° 40' 19"	water quality, biology, sediments
Z32	117° 46' 44"	38° 40' 15"	water quality
Z33	117° 37' 19"	38° 39' 15"	water quality, biology, sediments
Z34	117° 39'04"	38° 39' 07"	water quality, biology, sediments
Z35	117° 40' 41"	38° 39' 01"	water quality, biology, sediments
Z36	117° 42' 23"	38° 39' 06"	water quality, biology, sediments
Z37	117° 44' 37"	38° 38' 51"	water quality
Z38	117° 46' 32"	38° 38' 45"	water quality, biology, sediments
Z39	117°37' 07"	38°37' 41"	water quality, sediments
Z40	117° 38' 55"	38° 37' 38"	Water quality
Z41	117° 40' 39"	38° 37' 28"	water quality, biology, sediments
Z42	117° 42' 32"	38° 37' 23"	water quality
Z43	117° 44' 32"	38° 37' 19"	water quality, biology, sediments
Z44	117° 46' 22"	38° 37' 11"	water quality, biology, sediments

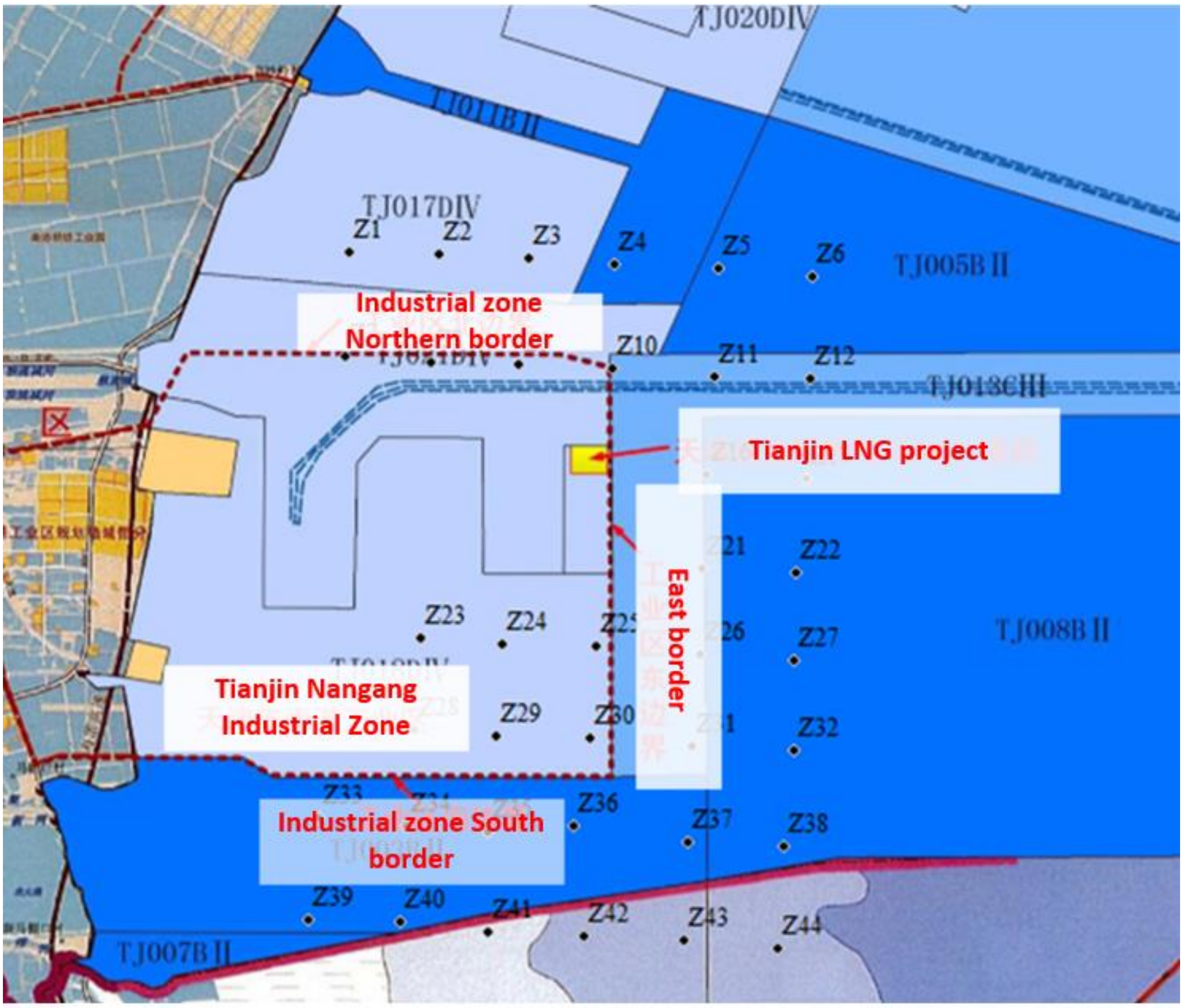


Figure 7.1-1 The locations of the marine environment survey stations and local marine area

7.1.1.1 The investigation and evaluation of the status of seawater quality in May 2017

1 The investigation of the status of seawater quality

(1) Monitoring items

The monitoring objectives include 15 items: water temperature, salinity, pH, Dissolved Oxygen (DO), Suspended matter (SS), Chemical Oxygen Demand (COD), inorganic nitrogen (including NH_4^+, NO_2^- and NO_3^+), active phosphate, oil (petroleum), Cu, Pb, Zn, Ge, Hg, As.

(2) The frequency and method of monitoring

One time monitoring was conducted in May 2017, and all water samples were collected, preserved, transported and analyzed according to <Marine Monitoring Regulations> (GB17378-2007) and <Marine Survey Regulations> (GB/T12763-2007).

(3) Results

All results of this marine investigation is shown in Table 7.1-2 below.

2.The evaluation of the status of seawater quality

(1) Items for evaluation

The pH, DO, COD, inorganic nitrogen, Cu, Pb, Zn, Ge, Hg, As and petroleum.

(2) Methods of evaluation

The single factor index (P_i) method is employed here, and the it is calculated by:

$$Pi = \frac{Ci}{Cio}$$

Where P_i is standard index of the i^th^ factor, which is the single factor index for the the i^th^ item. C_i is the measured concentration of the i^th^ factor; Cio is the standard evaluation value of the i^th^ factor.

According to properties of pH, DO, the calculation of their P_i should follow equations below.

For DO,

$$P_{DO} = \frac{\left|DO_f - DO\right|}{DO_f - DO_s}$$, when $DO \geq DO_s$

$$P_{DO} = 10 - 9\frac{DO}{DOs}$$, when $DO < DO_s$

Where $DO_f = \frac{468}{31.6+T}$, $DO_f = \frac{468}{(31.6+T)}$, and DO is the measured concentration of DO, DOf is the saturated dissolved oxygen concentration; DO_S is the standard evaluation value of DO; T is the water temperature.

For pH,

$$P_{pH,j} = \frac{7.0-pH_j}{7.0-pH_{sl}}, \quad \frac{7.0-pHj}{7.0-pHsl}$$ when $pH_j \leq 7.0$

$$P_{pH,j} = \frac{pH_j-7.0}{pH_{sl}-7.0}, \quad \frac{pHj-7.0}{pHsu-7.0}$$ when $pH_j \geq 7.0$

Where pH_j is the pH value of the j^th^ location; pH_{sl} is the lower bound of pH in water quality regulation; pH_{sl} is the upper bound of pH in water quality regulation.

Table 7.1-2 Table of results of seawater quality monitoring in May 2017

Station No.	Water temperature ℃	salinity	pH	DO	COD	SS	phosphate	inorganic nitrogen	oil	Cu	Pb	Zn	Ge	Hg	As
				mg/L			μg/L								
Z1	21.12	31.372	8.17	8.64	2.01	36.6	14.2	287	16.4	0.777	1.28	15.1	0.16	0.0347	2.2
Z2	21.14	31.516	8.13	8.24	2.31	38.5	15.3	304	19.8	0.901	1.35	12.4	0.206	0.03	2.41
Z3	21.19	31.44	8.06	7.2	1.99	28.2	21.6	372	18.4	0.862	1.95	12.5	0.228	0.0386	2.06
Z4	21.32	31.325	8.06	6.88	1.61	35.4	20.9	429	17	2.13	2.16	19.3	0.133	0.0431	2.3
Z5	21.43	31.344	8.08	7.2	1.83	35.6	20	366	17.9	2.43	1.72	21.3	0.155	0.0473	2.27
Z6	21.31	31.423	8.11	7.31	2.6	32.4	18.2	312	22	0.977	1.34	22	0.11	0.0633	2.37
Z7	19.25	31.717	8.12	7.62	1.88	31.8	19.6	380	20.3	1.5	1.63	21.3	0.097	0.0375	2.46
Z8	19.83	31.673	8.07	7.58	1.83	25.1	10.3	388	16.4	2.08	1.39	8.3	0.109	0.0328	2.3
Z9	21.33	31.221	8.1	7.74	2.08	32	20	384	37.4	1.46	1.77	17.8	0.093	0.024	2.1

Z10	21.38	31.365	8.17	7.46	1.83	37.1	20.2	363	20.8	2.07	1.24	21.2	0.194	0.075	2.27
Z11	21.49	31.411	8.15	7.2	2.01	28.2	18.3	322	20.2	1.63	1.38	20.4	0.141	0.0588	2.01
Z12	21.4	31.418	8.08	7.04	1.4	36.8	14.4	346	25	2.51	1.06	15.2	0.183	0.0256	2.2
Z16	21.72	31.433	8.06	7.81	2.99	29.4	25.9	428	16	2.15	1.66	11.9	0.086	0.0387	2.17
Z17	21.36	31.282	8.06	7.25	1.71	43.4	21.3	441	20	2.46	1.54	12.2	0.146	0.022	2.22
Z21	21.98	31.314	8.08	8.19	1.87	26	25.6	437	15.6	1.32	0.966	16.7	0.125	0.0324	2.18
Z22	21.92	31.343	8.04	7.18	1.61	31.8	31.6	502	17.2	1.72	1.07	16.8	0.106	0.0344	2.07
Z23	21.61	31.358	8.18	7.38	2.29	36.2	16.8	356	41.3	0.733	2.06	22.6	0.211	0.0301	2.11
Z24	21.65	31.347	8.18	7.12	2.12	55.6	14.2	262	33	2.04	1.62	17.6	0.209	0.0301	2.02
Z25	21.89	31.394	8.14	7.09	1.89	53.1	14.9	274	39.9	2.71	1.72	11.7	0.159	0.0343	2.21
Z26	21.97	31.496	8.13	6.5	2	61.6	16.2	272	35.2	0.852	0.888	21.8	0.095	0.0426	2.12
Z27	22.05	31.504	8.13	6.4	2.08	82.4	57.8	529	30	1.42	2.02	19.6	0.087	0.0339	2.22
Z28	21.41	31.438	8.18	5.95	2.11	32.8	16.8	335	38.5	2.17	0.697	9.76	0.2	0.0502	2.14
Z29	21.8	31.513	8.14	6.67	1.81	45.8	16.6	273	34.6	2.69	1.92	19.2	0.15	0.0537	2.09
Z30	22.28	31.505	8.13	6.69	1.63	42.2	16.8	302	35.8	0.839	1.39	14.8	0.199	0.0295	2.22
Z31	22.32	31.5	8.06	6.26	1.63	30.6	21.3	395	30.7	1.38	1	8.47	0.109	0.0247	2.04
Z32	22.15	31.47	8.07	6.75	1.87	32.8	27.5	419	32	1.12	1.01	15.7	0.212	0.0194	1.97
Z33	23.5	31.478	8.02	6.58	0.872	35.5	34.7	482	35.5	2.02	1.56	16.7	0.097	0.0357	2.2
Z34	23.01	31.589	8.08	7.31	1.04	37.8	15	210	30.5	1.84	2.15	20	0.148	0.0277	2.18
Z35	22.31	31.594	8.08	6.46	1.59	78.5	24	370	25.6	1.98	0.745	14.2	0.082	0.0498	2.02
Z36	22.37	31.638	8.09	6.56	1.25	91.8	21	348	27.8	0.774	1.86	16.1	0.125	0.0212	2.18
Z37	22.38	31.643	8.12	6.75	2.07	71.8	15.7	277	31.8	1.97	1.57	11.7	0.127	0.0216	1.91
Z38	22.12	31.414	8.11	6.75	2.03	96.7	17.5	354	27.6	1.18	1.7	11	0.21	0.0389	2.09
Z39	22.35	31.436	8.14	6.88	1.84	53.8	16.4	326	27	0.76	2.14	12.9	0.15	0.0243	2
Z40	22.18	31.278	8.12	6.78	1.64	55.4	13.6	287	21	0.99	1.97	17.3	0.232	0.0239	2.05
Z41	22.15	31.286	8.11	6.78	1.57	53.4	14.9	373	22.2	2.19	1.81	11.9	0.12	0.0232	1.98
Z42	22.14	31.475	8.12	6.5	1.83	81.2	17.7	321	27.8	1.14	0.734	14	0.104	0.0185	2.02
Z43	22.22	31.478	8.13	6.69	1.95	73	12.5	233	21.8	1.75	0.853	8.65	0.139	0.0214	2.11
Z44	21.98	31.268	8.12	6.53	1.81	53.6	23.6	411	28.6	1.36	1.98	21.4	0.218	0.0285	2.16

(3) Criteria of evaluation

The criteria of evaluation is based on <Seawater Quality Standard > (GB3097-1997). According to the environmental function zoning of Tianjin coastal waters, the seawater quality standard for target marine area of and near station no. Z4-Z6，Z16-Z17，Z22，Z27，Z32-Z44 Category II; marine area of and near station no. Z10-Z12，Z21，Z26，Z31 follows Category III; marine area of and near station no. Z1-Z3，Z7-Z9，Z23-Z25，Z28-Z30 follows the Category IV, see Table 7.1-3 for more details.

Table 7.1-3 Criteria of evaluation for seawater quality in May 2017

Criteria	Station no.
Category II	Z4-Z6，Z16-Z17，Z22，Z27，Z32-Z44
Category III	Z10-Z12，Z21，Z26，Z31
Category IV	Z1-Z3，Z7-Z9，Z23-Z25，Z28-Z30

(4) Results

From all monitoring items collected in May 2017 shown before, 7.89 percent of stations in the target marine area have high concentrationof phosphate exceeding its regulated standard value which are the three monitoring stations numbered Z22, Z27 and Z33. The excess rate of inorganic nitrogen is 44.74% and there are 17 monitoring stations which are the three monitoring stations numbered Z4-Z6, Z16-Z17, Z21-Z22, Z27, Z32-Z33, Z35-Z36, Z38-Z39, Z41-Z42, Z44. The seawater quality of the rest of monitoring stations and their adjacent marine area all meet the standard standard. Table 7.1-4 shows the results of this evaluation.

Table 7.1-4 The results of each factor in each monitoring location according to the seawater quality evaluation in May 2017

Station no.	pH	DO	COD	phosphate	inorganic nitrogen	oil	Cu	Pb	Zn	Ge	Hg	As
Z1	0.65	0.04	0.40	0.32	0.57	0.03	0.02	0.03	0.03	0.02	0.07	0.04
Z2	0.63	0.11	0.46	0.34	0.61	0.04	0.02	0.03	0.02	0.02	0.06	0.05
Z3	0.59	0.28	0.40	0.48	0.74	0.04	0.02	0.04	0.03	0.02	0.08	0.04
Z4	0.71	0.51	0.54	0.70	1.43	0.34	0.21	0.43	0.39	0.03	0.22	0.08
Z5	0.72	0.42	0.61	0.67	1.22	0.36	0.24	0.34	0.43	0.03	0.24	0.08
Z6	0.74	0.40	0.87	0.61	1.04	0.44	0.10	0.27	0.44	0.02	0.32	0.08
Z7	0.62	0.26	0.38	0.44	0.76	0.04	0.03	0.03	0.04	0.01	0.08	0.05
Z8	0.59	0.25	0.37	0.23	0.78	0.03	0.04	0.03	0.02	0.01	0.07	0.05
Z9	0.61	0.19	0.42	0.44	0.77	0.07	0.03	0.04	0.04	0.01	0.05	0.04
Z10	0.65	0.28	0.46	0.67	0.91	0.07	0.04	0.12	0.21	0.02	0.38	0.05
Z11	0.64	0.34	0.50	0.61	0.81	0.07	0.03	0.14	0.20	0.01	0.29	0.04
Z12	0.60	0.37	0.35	0.48	0.87	0.08	0.05	0.11	0.15	0.02	0.13	0.04
Z16	0.71	0.26	1.00	0.86	1.43	0.32	0.22	0.33	0.24	0.02	0.19	0.07
Z17	0.71	0.41	0.57	0.71	1.47	0.40	0.25	0.31	0.24	0.03	0.11	0.07
Z21	0.60	0.12	0.47	0.85	1.09	0.05	0.03	0.10	0.17	0.01	0.16	0.04
Z22	0.69	0.42	0.54	1.05	1.67	0.34	0.17	0.21	0.34	0.02	0.17	0.07
Z23	0.66	0.24	0.46	0.37	0.71	0.08	0.01	0.04	0.05	0.02	0.06	0.04
Z24	0.66	0.29	0.42	0.32	0.52	0.07	0.04	0.03	0.04	0.02	0.06	0.04
Z25	0.63	0.29	0.38	0.33	0.55	0.08	0.05	0.03	0.02	0.02	0.07	0.04
Z26	0.63	0.47	0.50	0.54	0.68	0.12	0.02	0.09	0.22	0.01	0.21	0.04
Z27	0.75	0.62	0.69	1.93	1.76	0.60	0.14	0.40	0.39	0.02	0.17	0.07
Z28	0.66	0.49	0.42	0.37	0.67	0.08	0.04	0.01	0.02	0.02	0.10	0.04
Z29	0.63	0.36	0.36	0.37	0.55	0.07	0.05	0.04	0.04	0.02	0.11	0.04
Z30	0.63	0.35	0.33	0.37	0.60	0.07	0.02	0.03	0.03	0.02	0.06	0.04
Z31	0.59	0.52	0.41	0.71	0.99	0.10	0.03	0.10	0.08	0.01	0.12	0.04
Z32	0.71	0.53	0.62	0.92	1.40	0.64	0.11	0.20	0.31	0.04	0.10	0.07
Z33	0.68	0.55	0.29	1.16	1.61	0.71	0.20	0.31	0.33	0.02	0.18	0.07
Z34	0.72	0.35	0.35	0.50	0.70	0.61	0.18	0.43	0.40	0.03	0.14	0.07
Z35	0.72	0.60	0.53	0.80	1.23	0.51	0.20	0.15	0.28	0.02	0.25	0.07
Z36	0.73	0.58	0.42	0.70	1.16	0.56	0.08	0.37	0.32	0.03	0.11	0.07
Z37	0.75	0.52	0.69	0.52	0.92	0.64	0.20	0.31	0.23	0.03	0.11	0.06
Z38	0.74	0.53	0.68	0.58	1.18	0.55	0.12	0.34	0.22	0.04	0.19	0.07
Z39	0.76	0.49	0.61	0.55	1.09	0.54	0.08	0.43	0.26	0.03	0.12	0.07
Z40	0.75	0.52	0.55	0.45	0.96	0.42	0.10	0.39	0.35	0.05	0.12	0.07
Z41	0.74	0.52	0.52	0.50	1.24	0.44	0.22	0.36	0.24	0.02	0.12	0.07
Z42	0.75	0.60	0.61	0.59	1.07	0.56	0.11	0.15	0.28	0.02	0.09	0.07
Z43	0.75	0.54	0.65	0.42	0.78	0.44	0.18	0.17	0.17	0.03	0.11	0.07
Z44	0.75	0.59	0.60	0.79	1.37	0.57	0.14	0.40	0.43	0.04	0.14	0.07
Min	0.59	0.04	0.29	0.23	0.52	0.03	0.01	0.01	0.02	0.01	0.05	0.04
Max	0.76	0.62	1.00	1.93	1.76	0.71	0.25	0.43	0.44	0.05	0.38	0.08
Exceed rate%	0			7.89	44.74	0						

7.1.1.2 The investigation and evaluation of seawater quality status in September 2017

1 The investigation of current situation of seawater quality

(1) Monitoring items

The monitoring objectives include 15 items: water temperature, salinity, pH, Dissolved Oxygen (DO), Suspended matter (SS), Chemical Oxygen Demand (COD), inorganic nitrogen (including NH_4^+, NO_2^- and NO_3^+), active phosphate, oil (petroleum), Cu, Pb, Zn, Ge, Hg, As.

(2) The frequency and method of monitoring

One time monitoring was conducted in September 2017, and all water samples were collected, preserved, transported and analyzed according to <Marine Monitoring Regulations> (GB17378-2007) and <Marine Survey Regulations> (GB/T12763-2007).

(3) The results of monitoring in each station

The results are shown in Table 7.1-5.

Table 7.1-5 Results of seawater quality monitoring in September 2017

Station no.	Water temperature ℃	Salinity	pH	DO	COD	SS	phosphate	inorganic nitrogen	oil	Cu	Pb	Zn	Ge	Hg	As
				mg/L			μg/L								
Z1	25.81	30.781	8.13	7.10	1.46	12.9	14.1	227	28.9	1.08	2.07	18.80	0.097	0.135	2.38
Z2	25.80	30.8	8.15	7.34	1.40	21.0	25.3	382	35.6	1.96	1.28	7.27	0.151	0.0481	2.39
Z3	25.76	30.788	8.16	7.58	1.43	23.1	25.3	388	23.6	1.29	1.3	15.00	0.169	0.152	2.30
Z6	25.67	30.762	8.20	7.33	1.39	45.6	55.2	572	17.4	0.959	0.589	11.30	0.102	0.0626	2.42
Z5	25.69	30.765	8.19	7.44	1.38	43.4	53.3	547	18.2	1.03	2.04	14.80	0.105	0.06	2.39
Z4	25.74	30.531	8.17	7.96	1.46	25.6	23.1	437	25.0	1.94	1.52	10.10	0.116	0.042	2.33
Z7	25.91	30.239	8.15	7.14	1.46	22.5	18.4	329	14.6	1.4	1.3	10.30	0.196	0.14	2.64
Z8	25.94	30.206	8.16	7.15	1.58	21.3	14.0	402	22.4	1.23	1.3	17.70	0.218	0.0864	2.60
Z9	25.96	30.347	8.17	7.81	1.50	18.1	21.5	392	13.0	2.17	1.56	12.50	0.173	0.0387	2.61
Z10	25.96	30.566	8.14	7.71	1.49	19.5	12.5	304	16.6	1.24	1.58	20.80	0.215	0.1	2.32
Z11	25.92	30.573	8.16	7.54	1.52	23.8	15.6	426	16.1	2.63	1.15	19.60	0.115	0.157	2.37
Z12	25.90	30.56	8.16	7.62	1.47	23.6	15.5	404	18.6	1.58	0.604	21.60	0.083	0.0811	2.31
Z16	25.57	30.754	8.23	7.65	1.50	70.6	46.4	1334	25.4	1.46	1.74	21.60	0.218	0.0219	2.23
Z17	25.55	30.742	8.24	7.62	1.56	54.5	52.4	1340	23.9	1.73	1.44	9.14	0.220	0.0375	2.23
Z21	25.46	30.279	8.24	7.60	1.54	42.0	39.2	1064	22.6	2.05	1.13	21.40	0.081	0.0252	2.00
Z22	25.50	30.066	8.26	7.71	1.67	46.1	41.9	1112	24.8	1.87	0.921	12.90	0.228	-	2.15

Station no.	Water temperature ℃	Salinity	pH	DO	COD	SS	phosphate	inorganic nitrogen	oil	Cu	Pb	Zn	Ge	Hg	As
				mg/L			μg/L								
Z24	25.46	30.035	8.22	7.46	1.62	65.8	23.0	539	18.2	2.01	0.869	9.18	0.095	0.043	2.15
Z25	25.42	28.493	8.20	7.60	1.65	49.0	45.5	801	16.6	2.29	1.44	18.00	0.227	0.0755	2.14
Z28	25.47	30.099	8.15	7.42	1.42	62.9	20.4	515	31.9	1.17	1.5	13.00	0.157	0.0563	2.06
Z29	25.52	30.111	8.16	7.50	1.56	79.8	29.9	808	28.3	1.45	0.93	8.25	0.088	0.053	2.06
Z26	25.46	30.022	8.23	7.55	1.71	48.0	42.5	1146	23.6	1.15	1.22	8.15	0.171	0.0476	2.16
Z27	25.42	30.006	8.26	7.63	1.33	50.2	22.9	760	23.8	2.42	0.929	15.70	0.159	0.0465	2.16
Z30	25.53	30.141	8.18	7.62	1.66	65.4	59.6	935	20.6	1.53	1.38	21.40	0.180	0.0582	2.16
Z31	25.56	30.112	8.22	7.63	1.59	65.0	21.9	850	24.2	1.66	1.67	9.91	0.207	0.0585	2.08
Z32	25.57	29.66	8.24	7.39	1.63	58.9	25.6	897	23.3	2.1	1.96	12.90	0.173	0.0518	2.12
Z33	25.74	28.527	8.14	7.46	1.41	48.2	45.3	796	55.4	1.25	1.89	11.80	0.135	0.036	1.97
Z34	25.74	28.504	8.14	7.84	1.38	52.8	28.0	613	35.3	1.97	0.558	11.40	0.201	0.0639	1.94
Z35	25.71	28.898	8.14	7.20	1.42	51.4	27.2	605	29.2	1.89	1.43	14.60	0.128	0.141	1.97
Z36	25.63	30.066	8.17	7.58	1.47	53.9	44.4	705	45.8	1.87	0.87	21.20	0.206	0.175	1.98
Z37	25.61	30.102	8.16	7.37	1.45	56.5	25.5	518	30.4	1.61	1.41	15.00	0.137	0.0337	1.94
Z38	25.57	30.218	8.15	7.49	1.30	22.4	9.9	354	18.8	1.92	1.72	14.60	0.110	0.0682	1.99
Z39	25.77	28.52	8.13	7.55	1.39	47.6	45.9	790	48.1	2.25	1.58	21.80	0.227	0.04	1.95
Z40	25.77	28.494	8.13	7.68	1.31	38.3	19.9	459	42.0	1.86	1.85	14.50	0.188	0.0748	1.92
Z41	25.70	28.91	8.12	7.51	1.35	54.8	45.3	706	47.4	1.36	0.937	9.60	0.223	0.177	2.03
Z42	25.65	29.289	8.13	7.40	1.49	53.6	43.7	662	36.0	2.1	1.59	21.30	0.140	0.166	1.95
Z43	25.61	30.687	8.14	7.70	1.38	61.3	26.9	547	36.4	1.8	1.13	12.40	0.127	0.183	2.10
Z44	25.60	30.627	8.13	7.62	1.32	60.8	27.1	546	33.8	2.41	0.829	12.40	0.093	0.108	1.93

2 The evaluation of current situation of seawater quality

(1) Evaluation factor

The pH, DO, COD, active phosphate, inorganic nitrogen, Cu, Pb, Zn, Ge, Hg, As and petroleum.

(2) Evaluation methods

Same as the method aforehand.

(3) Evaluation critea

The criteria of evaluation is based on <Seawater Quality Standard > (GB3097-1997). According to the environmental function zoning of Tianjin coastal waters, the seawater quality standard for target marine area of and near station no. Z4-Z6，Z16-Z17，Z22，Z27，Z32-Z44 follows Category II of seawater quality standard; marine area of and near station no. Z10-Z12，Z21，Z26，Z31 follows Category III of seawater quality standard; marine area of and near station no. Z1-Z3，Z7-Z9，Z23-Z25，Z28-Z30 follows Category IV of seawater quality standard, see Table 6.1-3 for more details.

Table 7.1-6 Criteria of evaluation for seawater quality in September 2017

Criteria	Station no.
Category II	Z4-Z6，Z16-Z17，Z22，Z27，Z32-Z44
Category III	Z10-Z12，Z21，Z26，Z31
Category IV	Z1-Z3，Z7-Z9，Z23，Z25，Z28-Z30

(4) Results

From all monitoring items collected in September 2017 shown before, 37.84 percent of stations in the target marine area have high concentration of phosphate exceeding its regulated standard value which are the 14 monitoring stations numbered Z5-Z6、Z16-Z17、Z21-Z22、Z25-Z26、Z30、Z33、Z36、Z39、Z41-Z42. The excess rate of inorganic nitrogen is 81.08%, and there are 30 monitoring. The exceed rate of oil (petroleum) is 2.70%, and there is one station has high value of concentration of oil exceeding its regulated standard. The seawater quality of the rest of monitoring stations and their adjacent marine area all meet the standard. Table 6.1-7 shows the results of this evaluation.

Table 7.1-7 Seawater quality evaluation in September 2017

Station no.	pH	DO	COD	phosphate	inorganic nitrogen	oil	Cu	Pb	Zn	Ge	Hg	As
Z1	0.63	0.20	0.29	0.31	0.45	0.06	0.02	0.04	0.04	0.01	0.27	0.05
Z2	0.64	0.16	0.28	0.56	0.76	0.07	0.04	0.03	0.01	0.02	0.10	0.05
Z3	0.64	0.11	0.29	0.56	0.78	0.05	0.03	0.03	0.03	0.02	0.30	0.05
Z4	0.78	0.06	0.49	0.77	1.46	0.50	0.19	0.30	0.20	0.02	0.21	0.08
Z5	0.79	0.23	0.46	1.78	1.82	0.36	0.10	0.41	0.30	0.02	0.30	0.08
Z6	0.80	0.27	0.46	1.84	1.91	0.35	0.10	0.12	0.23	0.02	0.31	0.08
Z7	0.64	0.19	0.29	0.41	0.66	0.03	0.03	0.03	0.02	0.02	0.28	0.05
Z8	0.64	0.19	0.32	0.31	0.80	0.04	0.02	0.03	0.04	0.02	0.17	0.05
Z9	0.65	0.06	0.30	0.48	0.78	0.03	0.04	0.03	0.03	0.02	0.08	0.05
Z10	0.63	0.10	0.37	0.42	0.76	0.06	0.02	0.16	0.21	0.02	0.50	0.05
Z11	0.64	0.14	0.38	0.52	1.07	0.05	0.05	0.12	0.20	0.01	0.79	0.05
Z12	0.64	0.13	0.37	0.52	1.01	0.06	0.03	0.06	0.22	0.01	0.41	0.05
Z16	0.82	0.17	0.50	1.55	4.45	0.51	0.15	0.35	0.43	0.04	0.11	0.07
Z17	0.83	0.18	0.52	1.75	4.47	0.48	0.17	0.29	0.18	0.04	0.19	0.07
Z21	0.69	0.14	0.39	1.31	2.66	0.08	0.04	0.11	0.21	0.01	0.13	0.04
Z22	0.84	0.15	0.56	1.40	3.71	0.50	0.19	0.18	0.26	0.05	/	0.07
Z24	0.68	0.14	0.32	0.51	1.08	0.04	0.04	0.02	0.02	0.01	0.09	0.04
Z25	0.67	0.12	0.33	1.01	1.60	0.03	0.05	0.03	0.04	0.02	0.15	0.04
Z26	0.68	0.16	0.43	1.42	2.87	0.08	0.02	0.12	0.08	0.02	0.24	0.04
Z27	0.84	0.18	0.44	0.76	2.53	0.48	0.24	0.19	0.31	0.03	0.23	0.07
Z28	0.64	0.15	0.28	0.45	1.03	0.06	0.02	0.03	0.03	0.02	0.11	0.04

Station no.	pH	DO	COD	phosphate	inorganic nitrogen	oil	Cu	Pb	Zn	Ge	Hg	As
Z29	0.64	0.13	0.31	0.66	1.62	0.06	0.03	0.02	0.02	0.01	0.11	0.04
Z30	0.66	0.11	0.33	1.32	1.87	0.04	0.03	0.03	0.04	0.02	0.12	0.04
Z31	0.68	0.13	0.40	0.73	2.13	0.08	0.03	0.17	0.10	0.02	0.29	0.04
Z32	0.83	0.25	0.54	0.85	2.99	0.47	0.21	0.39	0.26	0.03	0.26	0.07
Z33	0.76	0.22	0.47	1.51	2.65	1.11	0.13	0.38	0.24	0.03	0.18	0.07
Z34	0.76	0.10	0.46	0.93	2.04	0.71	0.20	0.11	0.23	0.04	0.32	0.06
Z35	0.76	0.31	0.47	0.91	2.02	0.58	0.19	0.29	0.29	0.03	0.71	0.07
Z36	0.78	0.19	0.49	1.48	2.35	0.92	0.19	0.17	0.42	0.04	0.88	0.07
Z37	0.77	0.25	0.48	0.85	1.73	0.61	0.16	0.28	0.30	0.03	0.17	0.06
Z38	0.77	0.22	0.43	0.33	1.18	0.38	0.19	0.34	0.29	0.02	0.34	0.07
Z39	0.75	0.19	0.46	1.53	2.63	0.96	0.23	0.32	0.44	0.05	0.20	0.07
Z40	0.75	0.15	0.44	0.66	1.53	0.84	0.19	0.37	0.29	0.04	0.37	0.06
Z41	0.75	0.21	0.45	1.51	2.35	0.95	0.14	0.19	0.19	0.04	0.89	0.07
Z42	0.75	0.24	0.50	1.46	2.21	0.72	0.21	0.32	0.43	0.03	0.83	0.07
Z43	0.76	0.15	0.46	0.90	1.82	0.73	0.18	0.23	0.25	0.03	0.92	0.07
Z44	0.75	0.18	0.44	0.90	1.82	0.68	0.24	0.17	0.25	0.02	0.54	0.06
Min	0.63	0.06	0.28	0.31	0.45	0.03	0.02	0.02	0.01	0.01	0.08	0.04
Max	0.84	0.31	0.56	1.84	4.47	1.11	0.24	0.41	0.44	0.05	0.92	0.08

7.1.2 The trend of the seawater quality

7.1.2.1 The trend of sea water quality within the scope

We refer to the historical monitoring records of local marine environment, which have been collected since the implementation of Nanguang industrial zone planning, to understand how local marine environment changes. The historical records are shown in Table 7.1-8 and all monitoring stations are installed within the marine area around the Nanguang industrial zone. The development plan of the Nanguang industrial zone in Tianjin was approved in 2009, therefore the monitoring records in 2008 could be a representation of the marine environment before the construction of the industrial district, and the monitoring records from 2009 to 2017 reflected the marine environment during the construction.

Table 7.1-8 Monitoring data collection

No.	Investigation time	Information source
1	2008 Autumn	The track monitoring report of reclamation projects by petrochemicals express base in Dagang district in Tianjin
2	2010 Autumn	The track monitoring report of the marine environment of the second phase project—land backfill in Nanguang industrial zone in Tianjin
3	2012 Autumn	The track monitoring report of the marine environment of the third phase project in Nanguang industrial zone in Tianjin
4	2014 Autumn	The track monitoring report of regional planning in Nanguang industrial zone in Tianjin
5	2017 Autumn	The track monitoring report of regional planning in Nanguang

		industrial zone in Tianjin

The statistical analysis shown in Table 7.1-9 displays the maximum, minimum, average and the exceed rate of each item used for marine seawater quality evaluation. The trend of the exceed rate of each item is shown in Figure 7.1-2. From the table and figure we can notice that: before the construction of Nanguang industrial zone, the items which exceeded their standard concentration were inorganic nitrogen, phosphate and oil (petroleum); but since the construction of the industrial district, the concentration of inorganic nitrogen, phosphate have been much higher than before, and they still are main pollutants. Meanwhile, the pollution caused by petroleum is weakened.

Table 7.1-9 The statistical results of marine seawater quality evaluation from 2008 to 2017

Year		inorganic nitrogen	phosp hate	COD	pH	DO	oil	Cu	Pb	Zn	Hg
2008 Autumn	Max	1.65	1.20	0.77	0.79	0.33	2.44	0.30	0.34	0.38	0.17
	Min	0.73	0.16	0.24	0.62	0.17	0.07	0.04	0.03	0.03	0.05
	Mean	1.03	0.49	0.41	0.68	0.22	0.57	0.10	0.09	0.09	0.09
	Exceed rate	65	10	0	0	0	20	0	0	0	0
2010 Autumn	Max	1.59	0.65	0.51	0.83	0.32	0.83	0.32	9.72	0.59	0.42
	Min	0.43	0.05	0.27	0.62	0.25	0.62	0.25	0.11	0.03	0.02
	Mean	0.70	0.18	0.42	0.72	0.28	0.72	0.28	0.89	0.25	0.17
	Exceed rate	10	0	0	0	0	0	0	0	0	0
2012 Autumn	Max	1.62	0.37	0.72	0.92	0.39	0.88	0.25	0.47	0.05	0.54
	Min	0.56	0.06	0.49	0.73	0.07	0.11	0.02	0.09	0.02	0.16
	Mean	1.18	0.10	0.64	0.87	0.25	0.54	0.14	0.29	0.03	0.29
	Exceed rate	64.70	0	0	0	0	0	0	0	0	0
2014 Autumn	Max	1.17	1.67	0.55	0.95	0.32	1.19	0.26	0.44	0.45	0.27
	Min	0.31	0.08	0.21	0.73	0.15	0.03	0.01	0.01	0.02	0.08
	Mean	0.64	0.40	0.39	0.84	0.23	0.34	0.09	0.19	0.18	0.18
	Exceed rate	2.56	0	0	0	0	7.96	0	0	0	0
2017 Autumn	Max	0.45	0.31	0.28	0.63	0.06	0.03	0.02	0.02	0.01	0.08
	Min	4.47	1.84	0.56	0.84	0.31	1.11	0.24	0.41	0.44	0.92
	Mean	1.88	0.95	0.41	0.72	0.17	0.37	0.11	0.17	0.19	0.34
	Exceed rate	81.08	37.84	0	0	0	2.70	0	0	0	0

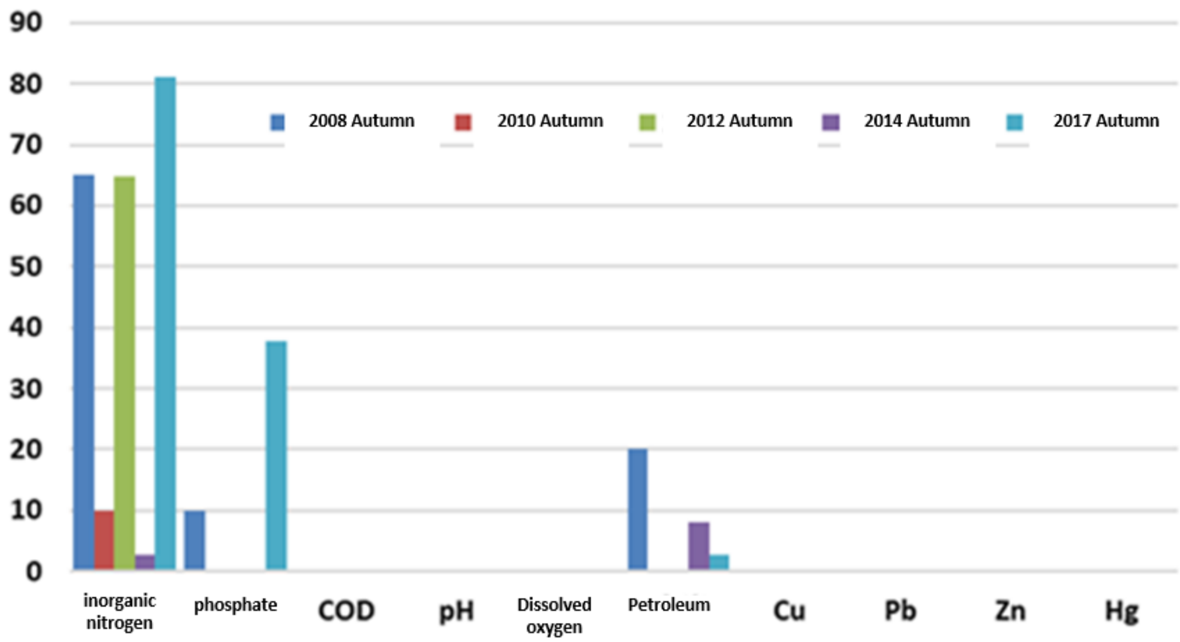


Figure 7.1-2 Trend analysis of the exceed rate(%) of each marine seawater quality item from 2008 to 2017

7.1.2.2 The trend analysis to the water quality around the project area

In this subsection, one investigating station located near Nanguang industrial zone is chosen to analyse the trend of five pollutants (inorganic nitrogen, active phosphate, petroleum oil, Pb and Hg) during investigating time. The investigating time is November 2008, October 2010, October 2012, November 2014 and September 2017.

Despite the fact that the survey station may not be exactly the same for each year, the survey station used for evaluation of seawater quality can be taken as the same one due to their very adjacent orientation. Based on this principle, we choose one station located in the marine area close to the north of Nangang industrial zone to conduct the trend analyse (see Figure 7.1-3).

Figure 7.1-3 The location of analysis station of the survey area

According to the results of the survey, the concentration of five pollutants within five years are considered for trend analysis, and the results are presented in Figure 7.1-4~8.

(1) Inorganic nitrogen：

From Figure 7.1-4, the investigated data of inorganic nitrogen shows that the concentration of it in 2010, 2012 and 2014 met the requirement of the second type of seawater quality standard, and that in 2017 met the requirement of the third type of seawater quality standard. In 2008, the concentration of it reaches its peak at 0.52 mg/L, and the seawater quality is much worse than the fourth type of seawater quality standard.

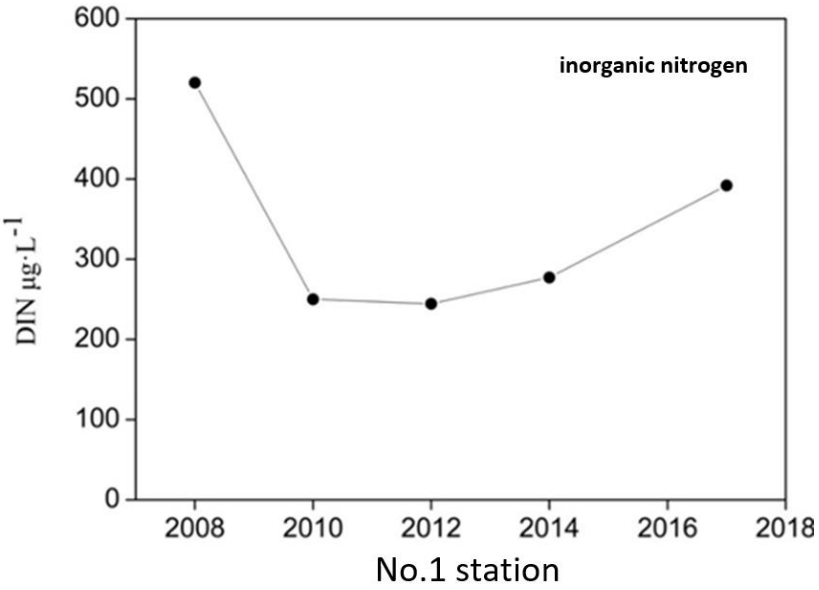


Figure 7.1-4 Trend of the concentration of inorganic nitrogen

(2) Phosphate

From Figure 7.1-5, one can find the concentration of phosphate meets the regulation of the fourth category seawater quality standard. In 2012, the concentration of phosphate is lower than the other investigating years, and the concentration of it increases after 2012 but it still meets the third category. The highest value of phosphate is in 2017, which is nearly 0.021mg/L, 46.7 percent of the lower bound of the fourth category (0.045mg/L), and 70 percent of the lower bound of Category. II &III

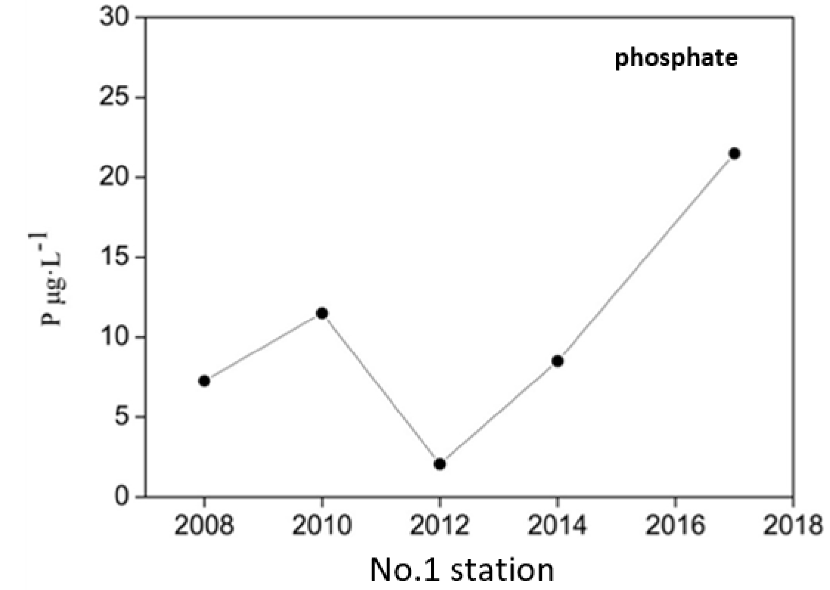


Figure 7.1-5 Trend of the concentration of phosphate

(3) Petroleum

From Figure 7.1-6, the concentration of petroleum meets the requirement of the first or second type of seawater quality standard during investigating years. It is clear that its maxima concentration is in 2014, nearly 0.042mg/L, 8.4 percent of the lower bound of the fourth type seawater standard.

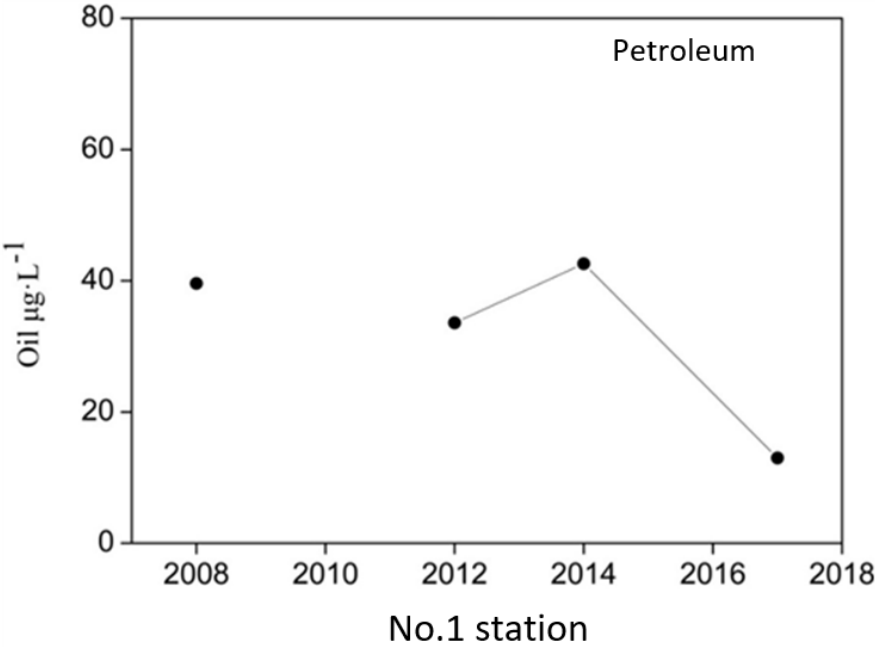


Figure 7.1-6 Trend of the concentration of petroleum

(4) Pb

From Figure 7.1-7, the concentration of Pb meets the second category of seawater quality, and there is a decreasing trend from 2010 to 2012, but an increasing trend from 2012 to 2017. Even so, the concentration is still very lower and meets the first and second category. The maxima value appears in 2010, nearly 0.0016mg/L, 3.2 percent of the lower bound of the fourth category (0.05mg/L), 16 percent of the lower bound of the third category (0.01mg/L), and 80 percent of the lower bound of Category II (0.005mg/L).

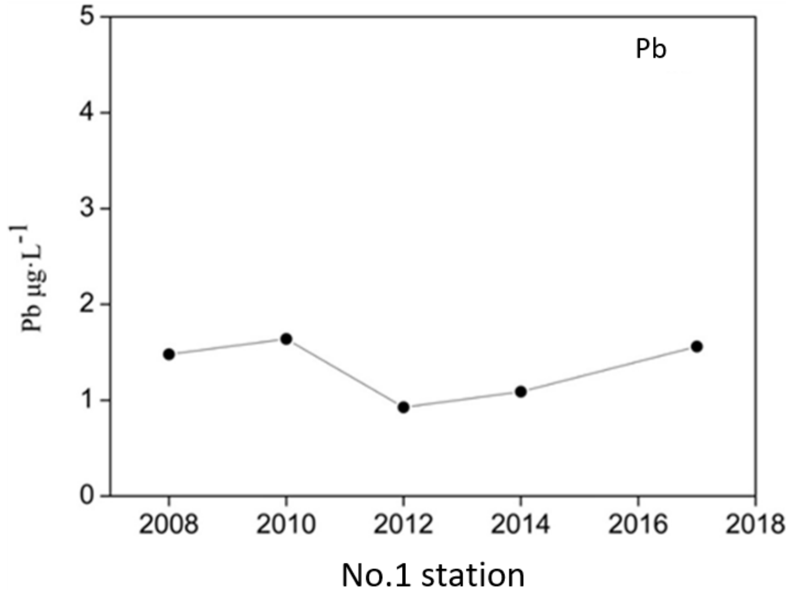


Figure 7.1-7 Trend of the concentration of Pb

(5) Hg

From Figure 7.1-8, the concentration of Hg meets the requirement of the first type of seawater quality. The highest value is in 2012, nearly 0. 044μg/L, and it is 8.8 percent of the lower bound of Category IV of seawater (0.5μg/L), 22 percent of the second or third type of seawater (0.2μg/L) and 88 percent of the lower bound of the first type of seawater (0.05μg/L). Since 2012, the concentration of Hg is steady and shows slightly decreasing trend.

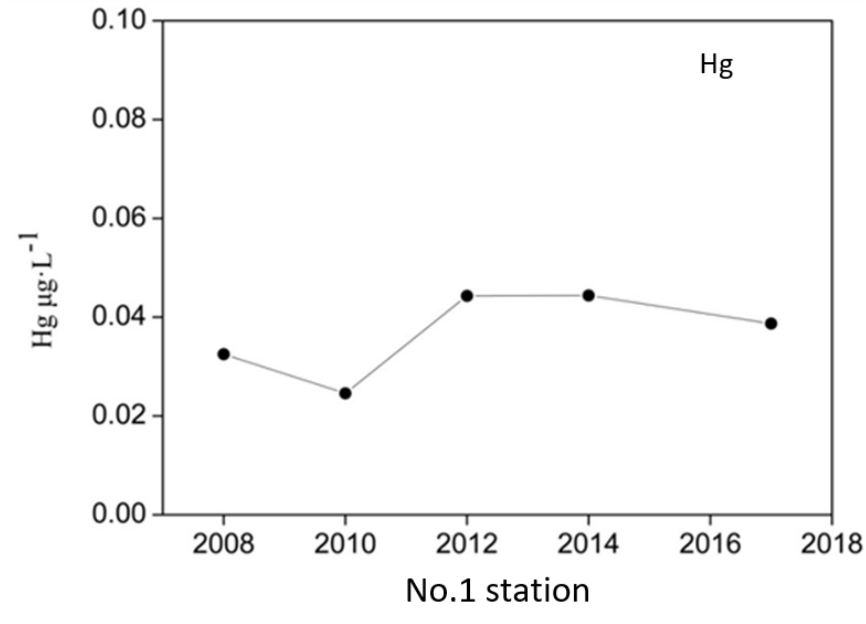


Figure 7.1-8 Trend of the concentration of Hg

(6) Analysis Results from Tianjin Municipal Marine Ecological Environment Bulletin

According to the relative statistical results shown in <The bulletin on the status of marine ecological environment in Tianjin>, seawater monitoring stations were located in the coastal waters of Tianjin from 2013 to 2017. These monitoring stations monitored in winter, spring, summer and autumn each year, and in 2013 and 2014, they monitored in spring, summer and autumn.

The statistical results show that in the spring of 2013, the water quality was poor, and the main pollutant was inorganic nitrogen; The water quality was normal in summer, and the main pollutant was inorganic nitrogen; The water quality in autumn was poor, and the main pollutants were inorganic nitrogen and active phosphate. The marine areas which water quality are inferior to the fourth type of seawater quality standards are mainly distributed in the adjacent waters of Hangu and Tanggu and the adjacent waters of the Dagangziyaxinhe estuary. In 2014, the seawater quality in the Tianjin sea area improved significantly compared with the previous year. The area of seawater which water quality are inferior to the fourth type of seawater quality standard and mainly located in the adjacent waters of Hangu and Tanggu, decreased. The annual monitoring results showed that the seawater quality was the best in autumn (October), followed by summer (August) and spring (May). In 2015, the seawater quality was the worst in spring, and the water quality in autumn was the best. It was inferior to the fourth type of seawater quality standard. The marine areas were mainly distributed in the sea near Dagang in spring, and in other seasons they were mainly located in the waters near Hangu and Tanggu. The main pollutants affecting the water quality of Tianjin sea area were inorganic nitrogen and active phosphate. In 2016, the water quality improved, in spring, the seawater quality was the best, and in winter seawater quality was the worst. Among them, the seawater which water quality was inferior to the fourth type of seawater in winter was mainly distributed in the areas near Hangu and Dagang. In 2017, the overall water quality was basically stable, and in spring the seawater quality was the best and in autumn and winter the water quality was poor. The main pollutants affecting the water quality of Tianjin sea area were inorganic nitrogen and active phosphate.

7.1.3 Evaluation of environmental quality of marine sediments

7.1.3.1 A survey of the current situation of sediments

1 The location and time of sampling

The North Sea Environmental Monitoring Center of the National Oceanic Administration conducted a sediment survey on the planned marine area and surrounding sea areas in September 2017. There were 37 monitoring stations were arranged, and their locations as well as orientations can be found in Figure 7.1-1 and Table 7.1-1 respectively.

2 Monitoring items

Particle size, organic carbon, petroleum, sulfide, heavy metals (Hg, Cu, Pb, Ge, Zn, Cr).

3 Monitoring methods

Samples were collected from the surface layer, and all samples were collected, preserved, transported and analyzed according to <Marine Monitoring Regulations> (GB17378-1998) and <Marine Survey Regulations> (GB12763-1999). The

4 Monitoring results

The monitoring results of the target marine sediment is shown in Table 7.1-8.

7.1.3.2 The evaluation of sediment status

1 Methods of evaluation

The standard index method is applied here and it can be calculated by equation below.

$$P_{i,j}=C_{i,j}/S_{i,j}$$

Where $P_{i,j}$ is the standard index of the i^{th} pollutant which located at j place; $C_{i,j}$ is measured concentration of the the i^{th} pollutant which located at j place, mg/L; $S_{i,j}$ is standard concentration of the the i^{th} pollutant which located at j place, mg/L.

2 Criteria of evaluation

The criteria of sediment evaluation is based on <The Marine Sediment Quality> (GB18668-2002). According to the environmental function zoning of Tianjin coastal waters, in the target monitoring marine area, monitoring stations numbered Z4, Z6, Z17, Z27, Z33-Z36, Z38-Z39, Z41, Z43-Z44 and marine area nearby will base on the standard for the first type marine sediments; stations numbered Z11, Z21 and Z31 will follow the standard for the second type of marine sediments; Z2, Z7, Z9, Z4, Z25, Z28 and Z29 will follow the standard for the third type of marine sediments. See Table 7.1-10 for details.

Table 7.1-10 The evaluation critiea of marine sediments in 2017

Evaluation critia	Monitoring station no.
Category I	Z4，Z6，Z17，Z27，Z33-Z36，Z38-Z39，Z41，Z43-Z44
Category II	Z11，Z21，Z31
Category III	Z2，Z7，Z9，Z,4，Z25，Z28，Z29

3 Results of evaluation

All results can be found in Table 7.1-12. It is clear that all monitoring items of all monitoring stations meet the requirement of their corresponding standards described in <The Marine Sediment Quality> (GB18668-2002）, therefore the status of the sediments in the target marine area is great.

Table 7.1-11 The analysis results of all sediment samples in the target marine area

Station no.	Sediment type	Color	Smell	Oil (10^{-6})	Cu (10^{-6})	Pb (10^{-6})	Zn (10^{-6})	Ge (10^{-6})	sulfide (10^{-6})	Organic carbon (%）
Z2	YT	black	No	598	15.6	18.4	19.0	0.165	28.0	0.527
Z4	YT	tan	No	78.8	16.5	12.0	20.7	0.138	22.2	0.51
Z6	YT	tan	No	24.8	24.4	13.6	30.1	0.125	28.2	0.483
Z7	YT	tan	No	97.1	19.5	20.8	26.6	0.103	19.8	0.724
Z9	YT	tan	No	136	21.3	14.4	17.6	0.175	35.5	0.724
Z11	YST	tan	No	46.8	15.1	11.8	24.9	0.159	33.3	0.255
Z17	YT	black	No	134	24.0	17.1	28.9	0.231	43.1	0.564
Z21	YT	black	No	170	27.9	12.7	19.5	0.167	33.3	0.596
Z24	YT	tan	No	166	15.0	14.4	17.6	0.208	24.0	0.620
Z25	YT	tan	No	50.6	24.1	16.6	20.7	0.234	39.1	0.620
Z27	YT	black	No	320	25.3	13.3	23.9	0.129	29.1	0.591
Z28	YT	tan	No	35.6	16.2	11.2	18.7	0.201	27.7	0.543
Z29	YT	tan	No	20.1	22.0	12.6	23.9	0.0719	20.1	0.502
Z31	YT	tan	No	30.1	22.0	15.9	21.3	0.207	21.3	0.491
Z33	YT	tan	No	30.9	24.3	11.3	19.7	0.179	20.8	0.663
Z34	YT	tan	No	49.2	14.8	21.4	18.5	0.090	17.2	0.664
Z35	YT	tan	No	101	18.3	17.3	27.2	0.113	27.3	0.483
Z36	YT	tan	No	21.9	24.3	19.1	18.5	0.140	18.6	0.519
Z38	TY	tan	No	151	19.6	18.6	17.2	0.150	28.2	0.531
Z39	YT	tan	No	79.9	27.8	17.4	24.7	0.232	13.6	0.527
Z41	YT	tan	No	90.7	19.1	13.1	23.6	0.127	33.6	0.302
Z43	YT	tan	No	38.4	15.1	14.2	21.5	0.227	19.6	0.499
Z44	YT	tan	No	114	25.8	12.4	18.1	0.142	40.8	0.507

Table 7.1-12 The evaluation results of all sediment samples in the target marine area

Station no.	Oil	Cu	Pb	Zn	Ge	sulfide	Organic carbon
Z2	0.40	0.08	0.07	0.03	0.03	0.05	0.13

Z4	0.16	0.47	0.20	0.14	0.28	0.07	0.26
Z6	0.05	0.70	0.23	0.20	0.25	0.09	0.24
Z7	0.06	0.10	0.08	0.04	0.02	0.03	0.18
Z9	0.09	0.11	0.06	0.03	0.04	0.06	0.18
Z11	0.05	0.15	0.09	0.07	0.11	0.07	0.09
Z17	0.27	0.69	0.29	0.19	0.46	0.14	0.28
Z21	0.17	0.28	0.10	0.06	0.11	0.07	0.20
Z24	0.11	0.08	0.06	0.03	0.04	0.04	0.16
Z25	0.03	0.12	0.07	0.03	0.05	0.07	0.16
Z27	0.64	0.72	0.22	0.16	0.26	0.10	0.30
Z28	0.02	0.08	0.04	0.03	0.04	0.05	0.14
Z29	0.01	0.11	0.05	0.04	0.01	0.03	0.13
Z31	0.03	0.22	0.12	0.06	0.14	0.04	0.16
Z33	0.06	0.69	0.19	0.13	0.36	0.07	0.33
Z34	0.10	0.42	0.36	0.12	0.18	0.06	0.33
Z35	0.20	0.52	0.29	0.18	0.23	0.09	0.24
Z36	0.04	0.69	0.32	0.12	0.28	0.06	0.26
Z38	0.30	0.56	0.31	0.11	0.30	0.09	0.27
Z39	0.16	0.79	0.29	0.16	0.46	0.05	0.26
Z41	0.18	0.55	0.22	0.16	0.25	0.11	0.15
Z43	0.08	0.43	0.24	0.14	0.45	0.07	0.25
Z44	0.23	0.74	0.21	0.12	0.28	0.14	0.25
Min	0.01	0.08	0.04	0.03	0.01	0.03	0.09
Max	0.64	0.79	0.36	0.20	0.46	0.14	0.33
Excced rate (%)	0						

7.1.4 Trends of the environmental quality of marine sediments

7.1.4.1 The trend analysis of the environmental quality of marine sediments in target marine area

Table 7.1-13 shows the maximum, minimum, average and the exceed rate (%) of each items to show the quality of marine sediments based on the samples collected from 2008 to 2017.

From the Table 7.1-13, one can find that in 2008 the oil category exceeded its standard value, and the over-standard rate was 8.33%. Since the construction of the industrial area has been completed, the pollution caused by petroleum has improved. In recent years, the sediments in the target marine area has basically met the marine sediment quality standards. Overall, the impact of the project construction on the quality of sediments in the surrounding waters is not significant.

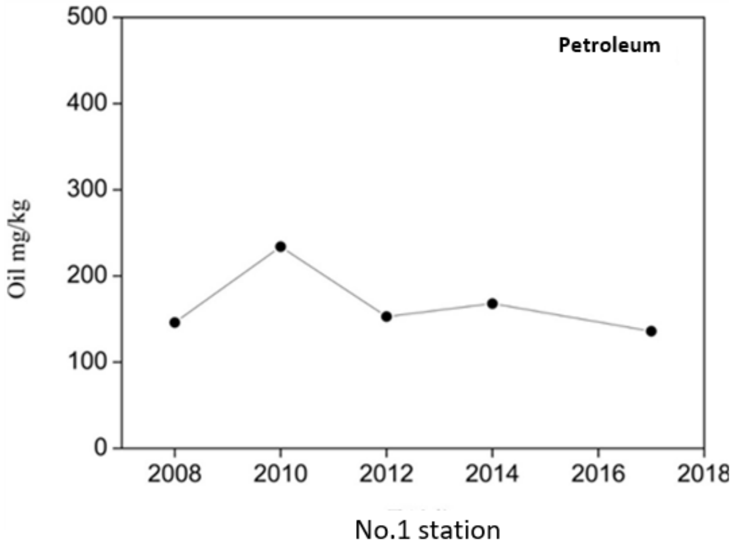
Table 7.1-13 Statistics of the evaluation of the marine sediment quality

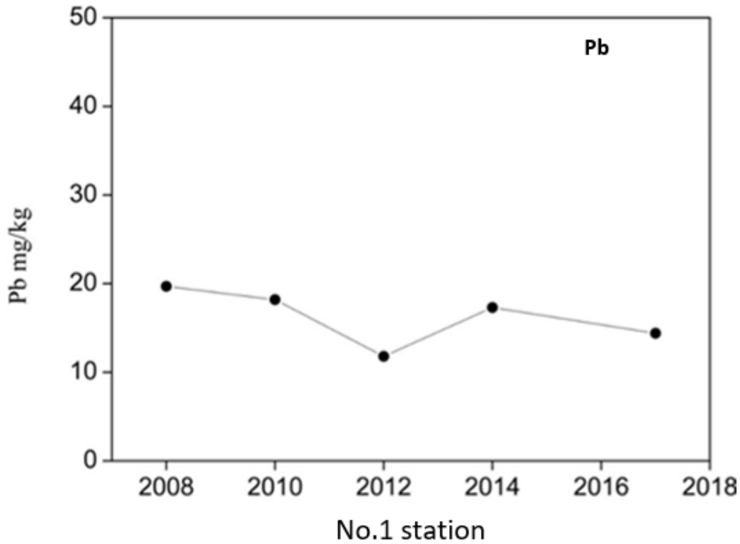
Year		Oil	Cu	Pb	Zn	Ge	Sulfide	Organic carbon
2008 Autumn	Max	1.71	0.89	0.45	0.31	0.48	0.14	0.29
	Min	0.04	0.10	0.05	0.03	0.03	0.06	0.14
	Mean	0.31	0.30	0.15	0.11	0.13	0.09	0.18
	Exceed rate (%)	8.33	0	0	0	0	0	0
2010 Autumn	Max	0.62	0.84	0.42	0.22	0.44	0.10	0.32
	Min	0.01	0.09	0.07	0.04	0.03	0.03	0.12
	Mean	0.23	0.44	0.23	0.12	0.24	0.07	0.20
	Exceed rate (%)	0	0	0	0	0	0	0

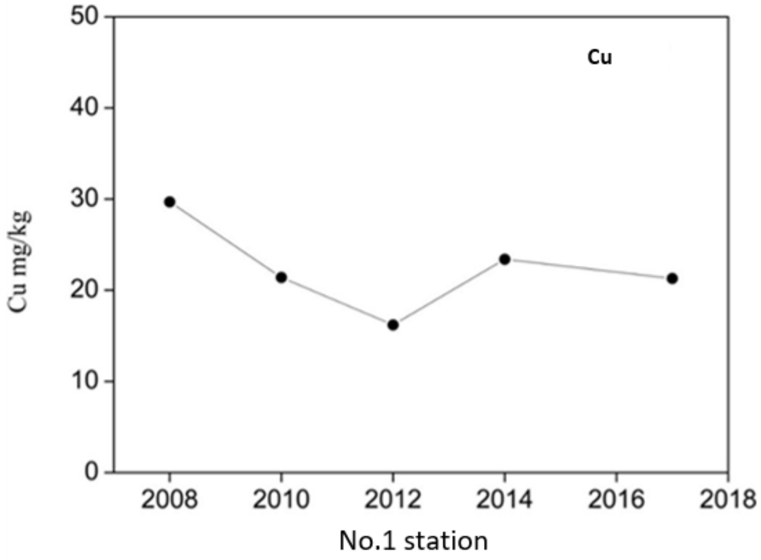
2012 Autumn	Max	0.99	0.68	0.30	0.19	0.51	0.16	0.28
	Min	0.06	0.16	0.09	0.07	0.06	0.06	0.17
	Mean	0.23	0.48	0.20	0.13	0.32	0.12	0.24
	Exceed rate (%)	0	0	0	0	0	0	0
2014 Autumn	Max	0.49	0.67	0.30	0.18	0.47	0.13	0.33
	Min	0.06	0.21	0.08	0.07	0.10	0.07	0.20
	Mean	0.17	0.47	0.20	0.13	0.28	0.11	0.27
	Exceed rate (%)	0	0	0	0	0	0	0
2017 Autumn	Max	0.64	0.79	0.36	0.20	0.46	0.14	0.33
	Min	0.01	0.08	0.04	0.03	0.01	0.03	0.09
	Mean	0.15	0.40	0.18	0.10	0.20	0.07	0.21
	Exceed rate (%)	0	0	0	0	0	0	0

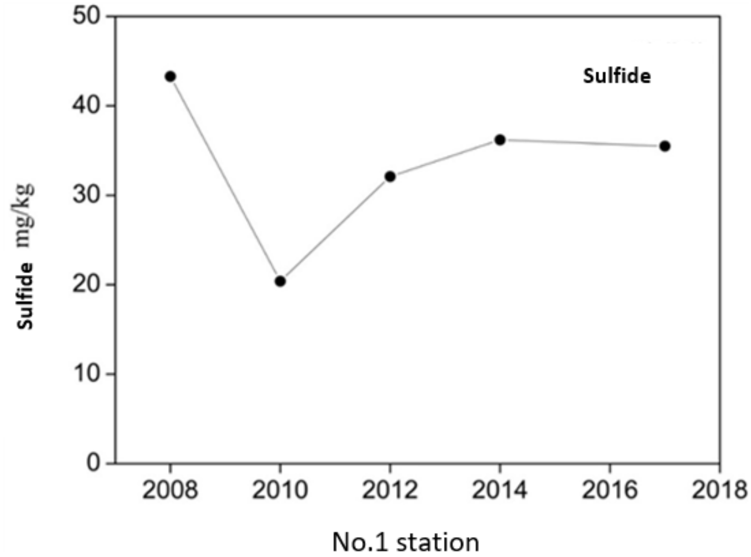
7.1.4.2 The trend analysis of the seawater quality and environmental quality near the project area

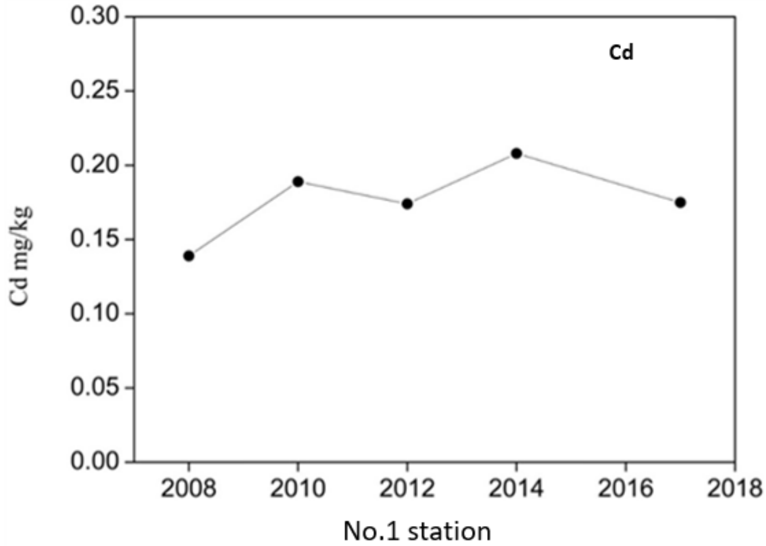
This section choses one survey station in the survey year of the marine area near Nangang in 2008 (November), 2010 (October), 2012 (October), 2014 (November) and 2017 (September). Based on the survey data, we analyze the trends of seven pollution items of petroleum, Pb, Cu, Ge, Zn, sulfide and organic carbon in each survey year, see Figure 7.1-9.

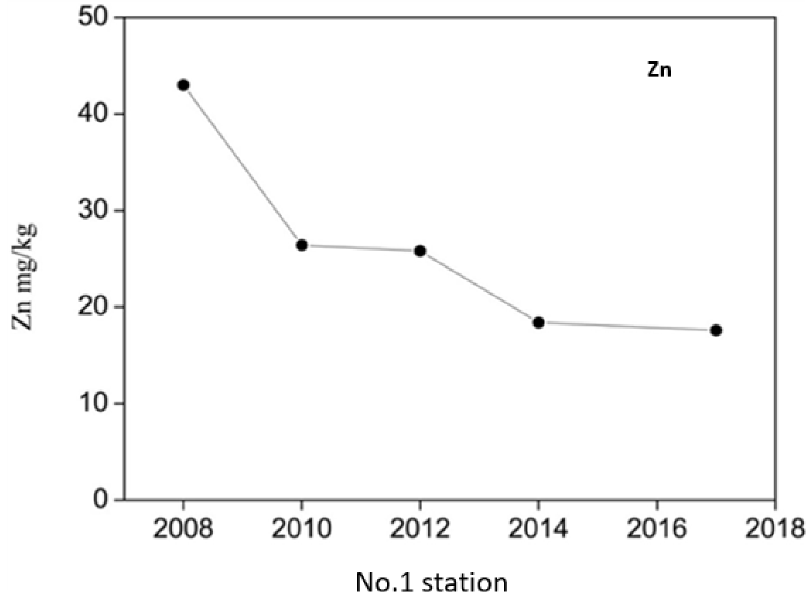





Cu
Cu mg/kg
0
10
20
30
40
50
2008
2010
2012
2014
2016
2018
No.1 station


Sulfide
Sulfide mg/kg
0
10
20
30
40
50
2008
2010
2012
2014
2016
2018
No.1 station


Cd
Cd mg/kg
0.00
0.05
0.10
0.15
0.20
0.25
0.30
2008
2010
2012
2014
2016
2018
No.1 station



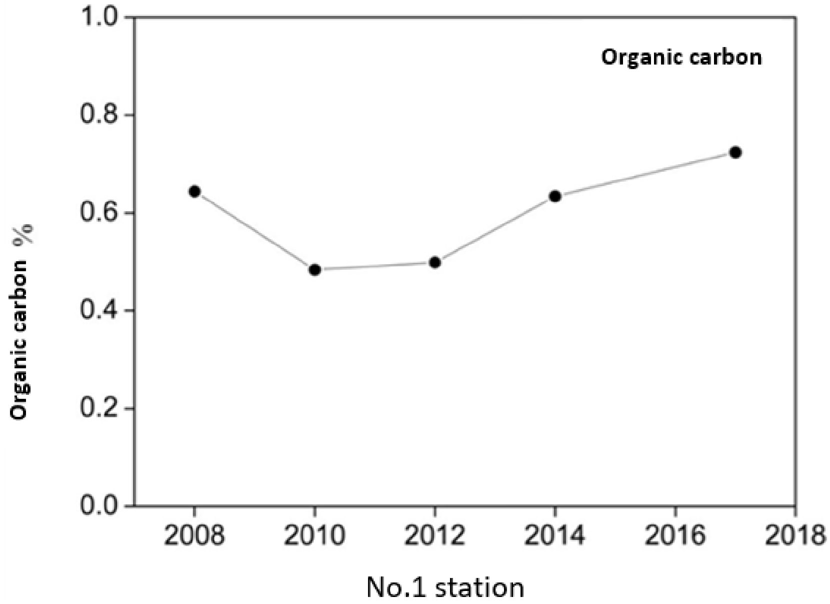


Figure 7.1-9 The trend of each pollutants in marine sediment

It can be seen from Figure 7.1-9 that the sediment pollutants analyzed during the analysis year meet the first type of sediment standards. The oil category showed the largest value in 2010 and a downward trend from 2010 to 2017; Pb and Cu showed a decreasing trend overall in the analysis year, and increased slightly in 2014; sulfide decreased significantly in 2010 and then gradually increased; Ge and organic carbon changed more smoothly during the research year; Zn showed a downward trend year by year.

7.1.4.3 Analysis results released by Tianjin Marine Environmental Status Bulletin

According to the relevant statistical data of the "Tianjin Marine Ecological Environment Bulletin" from 2013 to 2017, the concentration of Cu of a small amount of stations in Tianjin's coastal waters exceeded the first type of marine sediment quality standard in 2013, but it conformed to the second type of marine sediments quality standards. The rest of items are in line with the first type of marine sediment quality standards. The comprehensive status of sediment quality in Tianjin sea area in 2015 and 2017 were all good.

7.2 Investigation and evaluation of marine ecology and fishery resources

In order to obtain a complete picture of the quality of the marine environment in the area where the project is to be located, the project team gathered information from the survey of the marine ecological status of the sea area conducted by the North Sea Environmental Monitoring Centre of the National Oceanic Administration in May 2017 and September 2017. The monitoring station shall set up 8 survey sections perpendicular to the shoreline in the sea area near the project . Twenty-three marine biological survey stations shall be detailed in Table 7.2-1 and Figure 7.2-1 . The sampling and analysis methods shall be carried out in accordance with the Ocean Monitoring Specifications (GB 17378.3-2007).

7.2.1 Investigation and evaluation of marine ecology

7.2.1.1 Chlorophyll A

①Spring

The change range of chlorophyll a content in the surface layer of each station in the investigation area is (2.69-13.38) g g/L, average value is 7.00 g g/L, the highest value appears at the Z34 station in the southwest of the investigation area, and the lowest value appears at the Z11 station in the northeast of the investigation area. The distribution trend of surface chlorophyll a in the survey area is higher in the west and lower in the east.

②Autumn

The change range of chlorophyll a content in the surface layer of the stations surveyed was (0.68-2.69) 2.69 g/L, and the mean value was 1.56) g/L.

The highest value appears at station Z34, southwest of the survey area, and the lowest value appears at station Z36, south-central of the survey area. The distribution trend of surface chlorophyll a in the survey area is higher in the west and lower in the east.

7.2.1.2 Phytoplankton

（1）Species composition

①Spring

In May, 30 species of phytoplankton appeared in the sea area, belonging to four phyla of diatom, alga, cyanobacteria and green algae . Among them, 19 species of diatomas accounted for 63. 33% of the total number of phytoplankton species and 62. 28% of the total density of phytoplankton. One species of Chlorophyta, accounting for 3. 33% of the phytoplankton species, only 0. 08% of the total phytoplankton density ; Four species of cyanobacteria, accounting for 13. 33% of species, density of the total density of 9. 30% ; Six species of green algae account for 20% of species and 28. 33% of total density. The species composition of phytoplankton is detailed in Appendix 1.

②Autumn

There were 32 species of phytoplankton in the survey area, belonging to diatom, dinoflagellate and golden algae, 27 species of diatomaceous phylum accounted for 84. 38% of the total number of phytoplankton species and 99. 13% of the total density of phytoplankton. Four species of Phytoplankton, accounting for 12. 50% of the total number of phytoplankton species, only 0. 86% of the total density of phytoplankton ; A species of golden algae accounting for 3. 13% of species and 0. 02% of total density. The species composition of phytoplankton is detailed in Appendix 1.

(2) Density distribution

①Spring

The change range of phytoplankton density was 104 /m3 (5.00-227), and the average density was 49.71104 /m3.

The lowest value appears at the Z39 station in the southeast of the survey area and the highest value appears at the Z11 station in the northeast of the survey area. Phytoplankton density was higher in the northeastern part of the survey area, and decreased gradually to the southwest.

②Autumn

The change range of phytoplankton density was 104 /m3 (29.69-1071.34), and the average density was 199.68104 /m3.

The lowest value appears at the Z36 station south of the survey area and the highest value appears at the Z39 station southwest of the survey area. Phytoplankton density is higher in the west and lower in the east.

(3) Distribution characteristics of community and dominant species

①Spring

The community index of phytoplankton diversity and dominance in each station is shown in Table 7.2-1.

Table 7.2-1 Phytoplankton community characteristic index statistical table

Station No.	Diversity index（H′）	Evenness（J）	Abundance（D）	Dominance（d）
Z2	2.13	0.92	1.42	0.57
Z4	2.52	0.98	1.78	0.43
Z6	2.88	0.96	1.62	0.40
Z7	1.58	0.68	1.12	0.75
Z9	2.89	0.84	1.40	0.38
Z11	2.71	0.78	1.28	0.48
Z17	2.51	0.70	1.43	0.55
Z21	2.71	0.68	1.99	0.64
Z23	2.32	0.77	1.36	0.60
Z24	1.68	0.65	1.11	0.78
Z25	1.83	0.91	0.84	0.67
Z27	1.91	0.95	1.00	0.63
Z28	1.28	0.81	0.56	0.92
Z29	1.69	0.73	0.85	0.85
Z31	1.25	0.79	0.77	0.83
Z33	1.52	0.76	0.79	0.86
Z34	2.52	0.98	1.51	0.40
Z35	2.59	0.92	1.35	0.45
Z36	1.91	0.68	1.13	0.75
Z38	2.29	0.81	1.20	0.66
Z39	1.92	0.96	1.29	0.60
Z41	2.24	0.96	1.42	0.57
Z43	1.81	0.91	1.00	0.75
Z44	1.25	0.42	1.00	0.87

The phytoplankton diversity index was between 1.25 and 2.89 , and the average index was 2.08 . In this survey, phytoplankton diversity was higher, the dominant species were Navicula sp. and Cyclonella sp.

②Autumn

The community index of phytoplankton diversity and dominance in each station is shown in Table 7.2-2.

Table 7.2-2 Phytoplankton community characteristic index statistical table

Station No.	Diversity index（H′）	Evenness（J）	Abundance（D）	Dominance（d）
Z2	3.34	0.79	2.03	0.43
Z4	3.68	0.84	2.82	0.29
Z6	3.02	0.79	1.80	0.54
Z7	2.41	0.62	1.67	0.65
Z9	1.78	0.45	1.80	0.80
Z11	2.95	0.69	2.69	0.57
Z17	3.20	0.80	2.34	0.49
Z21	2.09	0.81	0.92	0.63
Z24	2.11	0.70	0.87	0.64
Z25	2.51	0.79	0.96	0.55
Z27	2.04	0.79	0.87	0.66
Z28	2.23	0.79	0.82	0.57
Z29	2.64	0.88	1.16	0.49
Z31	2.24	0.75	1.33	0.59
Z33	1.53	0.46	1.15	0.86
Z34	2.50	0.66	1.68	0.66
Z35	2.55	0.77	1.24	0.54
Z36	2.39	0.80	1.43	0.68
Z38	2.46	0.82	1.32	0.61
Z39	2.37	0.71	0.89	0.60
Z41	2.53	0.73	1.18	0.57
Z43	2.53	0.84	1.40	0.51
Z44	2.91	0.88	1.74	0.49
Mean	2.49	0.74	1.44	0.59
Max.	3.68	0.88	2.82	0.86
Min.	1.53	0.45	0.82	0.29

The phytoplankton diversity index was between 1.53 and 3.68 , and the average index was 2.49 . In this survey, phytoplankton diversity was higher, the dominant species were Chaetoceros curvisatus cleve and Coconodiscus asteromphalus ehrenberg.

7.2.1.3 Zooplankton

(1) Species composition of large zooplankton

①Spring

There were 23 large zooplankton species in this area, including 11 copepods (47. 83%). There were 1 species of hairy jaw, 1 species of ripple and 1 species of telopod, accounting for 4. 35% respectively. There were 2 species of shrimps (8. 70%). There were 7 species of larvae, accounting for 30. 43% .

②Autumn

There were 23 large zooplankton species in this area, including 7 copepods (39. 13%). Three species, accounting for 13. 04% ; There were 1 species of hairy jaw, telopoda, Dentida and Capsules, accounting for 4. 35% respectively. There were 7 species of larvae, accounting for 39. 13% .

(2) Plane Distribution of Biomass and Biomass Density of Large Zooplankton

①Spring

The change range of biomass (wet weight) of macrozooplankton in the sea area was (54.3-6250.00) mg/m3, and the average biomass was 800.06 mg/m3.

The highest values of large zooplankton were found at the Z39 station in the southeast of the survey area and the lowest values were found at the Z9 station in the northern part of the survey area. The plane distribution characteristic is that the biomass of large zooplankton is generally high in some stations in the middle and south of the survey sea area, but the high value area appears in the southeast and north of the sea area, and the biomass in the other areas is obviously low.

The density fluctuation range of large zooplankton is (49.90-9980.00)/m3, and the average density is 1418.50 /m3.

The high value area appeared in the northwest of the investigation area and in the middle of the project.

②Autumn

The change range of biomass (wet weight) of macrozooplankton in the sea area was (7.5-1070) mg/m3, and the average biomass was 198.80 mg/m3. The highest values of large zooplankton were found at the Z36 station, south of the survey area, and the lowest values were found at the Z21 station, west of the survey area. The plane distribution characteristic is that the biomass of large zooplankton is generally high in some stations in the middle and south of the survey sea area, but the high value area appears in the west and north of the sea area, and the biomass in the other areas is obviously low.

The density fluctuation range of large zooplankton is (1.54-245.00)/m3, and the average density is 35.30 /m3. The high value area appeared in the south of the survey area, which gradually decreased to the north.

(3) Distribution characteristics of macrozooplankton community and dominant species

①Spring

The community index of macrozooplankton diversity and dominance in each station is shown in Table 7.2-3.

Table 7.2-3 Zooplankton community characteristic index

Station No.	Diversity index (H)	Evenness (J)	Abundance (D)	Dominance (d)
Z2	2.44	0.68	1.05	0.63
Z4	2.45	0.71	1.24	0.66
Z6	2.22	0.64	1.32	0.66
Z7	2.25	0.71	0.85	0.65
Z9	1.37	0.59	0.71	0.84
Z11	1.23	0.39	1.00	0.87
Z17	1.58	0.48	1.04	0.79
Z21	1.28	0.40	0.94	0.86
Z23	2.70	0.81	0.86	0.50
Z24	1.57	0.52	0.53	0.82
Z25	2.50	0.68	1.17	0.68
Z27	2.48	0.83	1.14	0.53
Z28	1.57	0.50	0.77	0.80
Z29	1.79	0.56	0.62	0.79
Z31	2.43	0.77	1.06	0.62
Z33	2.83	0.82	1.39	0.52
Z34	1.42	0.45	0.85	0.85
Z35	1.18	0.37	0.85	0.89
Z36	2.51	0.79	0.98	0.59
Z38	2.52	0.80	1.08	0.59
Z39	2.08	0.55	1.03	0.74
Z41	2.44	0.77	1.18	0.65
Z43	3.14	0.82	1.79	0.46

Z44	2.54	0.73	1.40	0.61
Mean	2.11	0.64	1.04	0.69
Min.	1.18	0.37	0.53	0.46
Max.	3.14	0.83	1.79	0.89

The zooplankton diversity index was between 1.18 and 3.14 , and the average index was 2.11 . This study investigated the overall stability of biodiversity in large zooplankton populations. According to the analysis of zooplankton population structure, the dominant zooplankton were calanus sinicus brodsky and paracalanus parvus (claus).

②Autumn

The community index of macrozooplankton diversity and dominance in each station is shown in Table 7.2-4.

Table 7.2-4 Zooplankton community characteristic index

Station No.	Diversity index (H)	Evenness (J)	Abundance (D)	Dominance (d)
Z2	1.89	0.95	0.55	0.67
Z4	2.32	1.00	1.72	0.40
Z6	2.67	0.89	1.60	0.55
Z7	1.87	0.80	1.34	0.73
Z9	2.89	0.87	1.98	0.47
Z11	2.27	0.81	1.46	0.63
Z17	0.81	0.81	0.58	1.00
Z21	1.00	1.00	1.36	1.00
Z24	1.58	1.00	0.60	0.67
Z25	2.00	1.00	0.80	0.50
Z27	1.35	0.85	0.72	0.89
Z28	1.92	0.96	0.82	0.60
Z29	1.00	1.00	0.43	1.00
Z31	1.00	1.00	1.61	1.00
Z33	1.85	0.71	0.96	0.73
Z34	2.11	0.81	1.00	0.71
Z35	0.77	0.49	0.52	0.92
Z36	2.18	0.78	1.22	0.70
Z38	2.18	0.73	1.29	0.71
Z39	2.08	0.74	0.76	0.69
Z41	2.00	0.77	0.76	0.72
Z43	2.30	0.77	1.15	0.66
Z44	2.37	0.79	1.13	0.54
Mean	1.89	0.85	1.08	0.70
Max	2.89	1.00	1.98	1.00
Min	0.77	0.49	0.43	0.40

The zooplankton diversity index was between 0.77 and 3.14 , and the average index was 1.89 . This study investigated the overall stability of biodiversity in large zooplankton populations. According to the analysis of zooplankton population structure, the dominant zooplankton were Sagitta crassa and Centropages dorsispinatus.

(4) Medium zooplankton

①Spring

In this survey, 21 medium zooplankton species were found, including 9 copepods (42. 86%). There were 1 species (4. 76%) of hairy jaw, 1 species of ripple and 1 species of chaff shrimp. Larvae

larvae of 9 species, accounting for 42. 86% . Details of the species composition of medium-sized zooplankton are given in appendix 2.

Medium zooplankton density fluctuates between (2.36-80.15) × 104 /m3 and average density is 15.00 × 104 /m3. The plane distribution is characterized by the high position density in the middle part of the surveyed sea area, which decreases gradually around the area and the high position density in the northwest.

The dominant medium zooplankton is Daphnia bimaculata, with the occurrence rate of 100% , the number of individuals at each station is between (0.75-65) × 104 /m3, the average is 11.56 × 104 /m3, and the number of individuals is 77. 07% of the total number of zooplankton. The density distribution of the species is similar to that of medium-sized zooplankton . The density of the species is higher in the middle of the survey area and lower in all directions.

②Autumn

In this survey, 23 species of medium-sized zooplankton were collected, including 3 species of spiny, accounting for 13. 04% . There were nine copepods (42. 86%) ; There were 1 species of trichognathae and 4. 35% of cysts. Larvae larvae of 9 species, accounting for 39. 13% . Details of the species composition of medium-sized zooplankton are given in appendix 2.

Medium zooplankton density fluctuates between (937.50-26375.00)/m3 with an average density of 5607.83 /m3. The plane distribution is characterized by the high density of the stations in the southern part of the survey area, which gradually decreases to the north and the high density of individual stations in the north.

The dominant medium zooplankton is the small daphnia magnoides, whose site occurrence rate is 100% , the number of individuals in each station is between (200-19500)/m3, the average 3019.6 /m3, the number of individuals account for 53. 86% of the total number of zooplankton. The species's density distribution is similar to that of medium-sized zooplankton.

7.2.1.4 Benthos

(1) Species composition

①Spring

A total of 50 species of benthos were found in this study, belonging to 8 families of flat, nevoid, link, soft, knot, brachiopod, acanthoid and notochord (see appendix 4). Among them, there were 1 species, 2. 00% , of flat, nuciform, brachiopod and notochord. There are 20 kinds of links, accounting for 40. 00% ; There were 13 kinds of arthropods, accounting for 26. 00% ; There are 11 species of molluscs, accounting for 22. 00% ; Two species of acanthoderm, accounting for 4. 00% .

There are 13 species of benthos in Z28 station. No samples were obtained at station Z33.

②Autumn

A total of 37 species of benthos were found, belonging to the 6 families of nuciform, segment, soft body, arthropod, acanthoid and notochord (see appendix 4). Among them, there were 1 species, accounting for 2. 70% . There are 16 kinds of links, accounting for 43. 24% ; There were 9 kinds of arthropods, accounting for 24. 32% ; There are 8 species of molluscs, accounting for 21. 62% ; Two species of acanthoderm, accounting for 5. 41% .

(2) Composition and distribution of biomass

①Spring

The change range of benthic biomass was (0.00-123.00) g/m2, with an average of 30.11 g/m2. Echinoderms dominated the benthic biomass composition, accounting for 44. 67% of the total biomass. Secondly, arthropods (crustaceans) occupy the second place, for the total biomass of 37. 53% ; Software ranks third with 10. 14% .

The surface distribution of benthic biomass is patchy, and the biomass difference of each station is small . Z31 station around the southeast of the sea area is the highest value of the area.

②Autumn

The change range of benthic biomass was (0.00-227.10) g/m2, with an average of 35.80 g/m2. Echinoderms dominated the benthic biomass composition, accounting for 66. 57% of the total biomass. Secondly, arthropods (crustaceans) occupy the second place, for the total biomass of 17. 51% ; Software ranks third with 11. 29% .

The surface distribution of benthic biomass is patchy, and the biomass difference of each station is small . Z7 station around the northeast of the sea area is the highest value of the area.

(3) Density Composition and Distribution

①Spring

The biomass density of benthos in the survey area ranged from (0-610)/m2, with an average of 225.83 /m2. The density composition of benthos in marine area was dominated by annelids (polychaetes), accounting for 73. 43% of the total density. Molluscs occupy the second place, accounting for 10. 52% of the total density ; Arthropods (crustaceans) occupy the third place, accounting for 9. 41% .

The biodensity plane distribution of benthic organisms is characterized by the highest value around the northern part of the Z4 station in the survey sea area and the higher density in the middle part and the quilt part of the engineering survey sea area.

②Autumn

The biomass density of benthos in the survey area ranged from (0-220)/m2, with an average of 76.5 /m2. The density composition of benthos in marine area was dominated by annelids (polychaetes), accounting for 38. 07% of the total density. Molluscs occupy the second place, accounting for 20. 45% of the total density ; Arthropods (crustaceans) occupy the third place, accounting for 18. 75% .

The biodensity plane distribution of benthic organisms is characterized by the highest value around the northern part of the Z9 station in the survey area, and the higher density in the central and northern part of the engineering survey area.

(4) Community characteristics

①Spring

The community index of benthic biodiversity and dominance of each site is shown in Table 7.2-5. The benthic biodiversity index ranged from 1.52 to 3.44 , with an average index of 2.62 . In this survey, the average diversity index of macrobenthos in this area was above 2.

Table 7.2-5 Benthic community characteristics index

Station No.	Diversity index	Evenness	Abundance	Dominance
Z2	2.73	0.86	1.02	0.57
Z4	2.41	0.67	1.19	0.64
Z6	1.52	0.46	0.99	0.81
Z7	2.05	0.68	0.83	0.79
Z9	1.79	0.90	0.51	0.67
Z11	2.19	0.78	0.75	0.69
Z17	2.61	0.93	0.84	0.50
Z21	3.34	0.93	1.44	0.35
Z23	2.37	0.79	0.80	0.61
Z24	3.26	0.88	1.44	0.44
Z25	3.13	0.87	1.31	0.41
Z27	2.42	0.94	0.77	0.56

Z28	3.28	0.89	1.35	0.38
Z29	1.92	0.96	0.51	0.67
Z31	3.03	0.95	1.18	0.36
Z33	0.00	0.00	0.00	0.00
Z34	1.58	1.00	0.41	0.67
Z35	3.44	0.93	1.48	0.36
Z36	2.92	0.97	1.05	0.40
Z38	3.34	0.93	1.40	0.35
Z39	2.50	0.75	1.11	0.68
Z41	3.42	0.99	1.45	0.25
Z43	2.25	0.97	0.68	0.50
Z44	2.85	0.95	1.05	0.40
Mean	2.62	0.87	1.02	0.52
Min	1.52	0.46	0.41	0.25
Max	3.44	1.00	1.48	0.81

②Autumn

The community index of benthic biodiversity and dominance of each site is shown in Table 7.2-6. The benthic biodiversity index at each site ranged from 0.81 to 3.10 (no samples were obtained at station Z39, so the diversity index was 0), with an average index of 1.94 . In this survey, the average diversity index and abundance of macrobenthos were above 1, and the structure of benthic community was stable.

Table 7.2-6 Benthic community characteristics index

Station No.	Diversity index	Evenness	Abundance	Dominance
Z2	1.77	0.76	1.20	0.70
Z4	2.58	1.00	1.93	0.33
Z6	1.50	0.95	1.00	0.75
Z7	2.35	0.84	1.41	0.63
Z9	2.31	0.82	1.35	0.64
Z11	2.41	0.93	1.67	0.50
Z17	1.37	0.86	0.86	0.80
Z21	1.92	0.96	1.29	0.60
Z24	2.97	0.94	1.92	0.39
Z25	2.42	0.94	1.58	0.56
Z27	2.00	1.00	1.50	0.50
Z28	1.00	1.00	1.00	1.00
Z29	2.06	0.89	1.26	0.67
Z31	1.58	1.00	1.26	0.67
Z33	1.50	0.95	1.00	0.75
Z34	1.76	0.88	0.81	0.77
Z35	0.92	0.92	0.63	1.00
Z36	1.50	0.95	1.00	0.75
Z38	1.58	1.00	1.26	0.67
Z39				
Z41	3.10	0.98	2.31	0.36
Z43	2.65	0.94	1.81	0.50
Z44	0.81	0.81	0.50	1.00
Mean	1.94	0.93	1.32	0.65
Min	0.81	0.76	0.50	0.33
Max	3.10	1.00	2.31	1.00

7.2.2 Marine organism quality

The survey of the current status of biological quality was drawn from the results of a survey conducted by the North Sea Environmental Monitoring Centre of the National Oceanic Administration (NOAA) in December 2016 on the waters around the planning area. A total of 8 sites of biological mass were arranged. Details of the station locations are shown in Figure 7.2-1 and Table 7.2-7.

(1) Survey Time

The monitoring was implemented in December 2016.

Monitoring projects

(2) Copper, lead, cadmium, chromium, zinc, mercury, petroleum hydrocarbons.

Monitoring results

(3) The results of monitoring the marine biological quality are shown in Table 7.2-8.

Table 7.2-7 Monitoring Station

Station No.	longitude	latitude
Z4	117° 43' 15"	38° 47' 47"
Z7	117° 37' 55"	38° 46' 25"
Z21	117° 44' 56"	38° 43' 05"
Z22	117° 46' 49"	38° 42' 59"
Z25	117° 42' 49"	38° 41' 53"
Z32	117° 46' 44"	38° 40' 15"
Z38	117° 46' 32"	38° 38' 45"
Z41	117° 40' 39"	38° 37' 28"

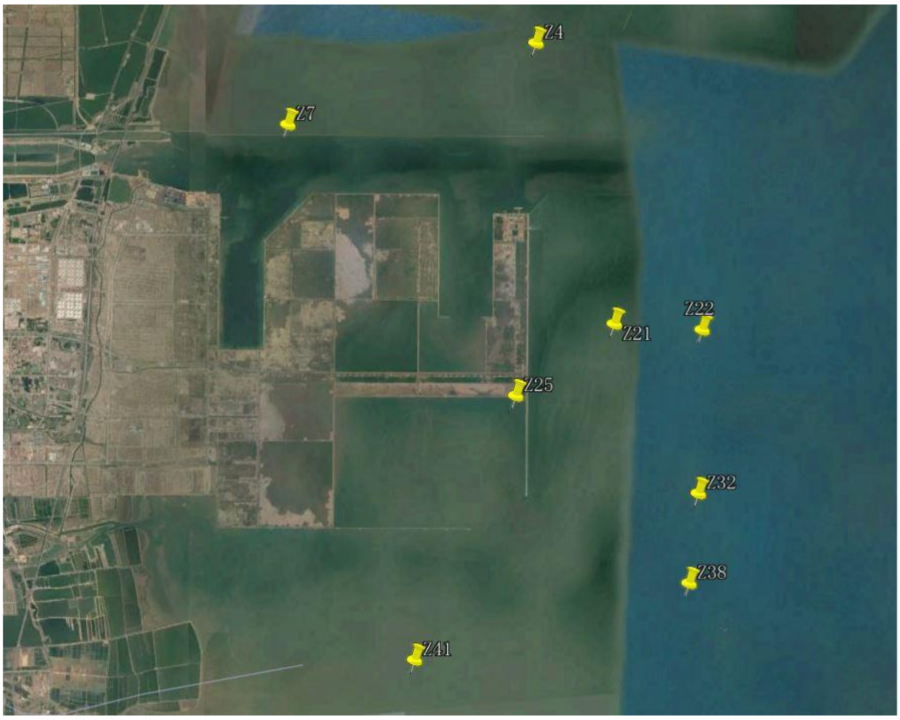


Figure 7.2-1 Marine Biomass Monitoring Station Bitmap

Table 7.2-8 Survey of marine biological quality test results in December 2016

S.N	Binomial Nomenclature	analysis	Cu	Pb	Cd	Zn	Hg	Petroleum

		Part						hydrocarbon
			(dry 10^{-6})					(wet 10^{-6})
Z4	*Rapana venosa* (Valenciennes)	Shelling	2.45	1.39	2.63	23.5	0.0283	2.40
	Synechogobius hasta (Temminck et Schlegel)	whole	0.645	0.303	0.727	6.46	0.0268	0.569
	Octopus cf.minor (Sasaki)	whole	0.993	0.627	1.17	11.7	0.0315	3.04
Z7	*Rapana venosa* (Valenciennes)	Shelling	2.60	1.27	2.43	26.7	0.0288	4.52
	Synechogobius hasta (Temminck et Schlegel)	whole	0.430	0.290	0.662	6.07	0.0254	0.406
	Octopus cf.minor (Sasaki)	whole	0.962	0.528	0.938	8.66	0.0227	1.85
Z21	*Rapana venosa* (Valenciennes)	Shelling	2.30	1.25	1.98	21.5	0.0160	2.56
	Synechogobius hasta (Temminck et Schlegel)	whole	0.628	0.342	0.847	6.56	0.0181	0.617
	Octopus cf.minor (Sasaki)	whole	0.852	0.605	1.03	9.03	0.0180	2.85
Z22	*Rapana venosa* (Valenciennes)	Shelling	2.62	1.29	2.53	22.4	0.0229	4.26
	Synechogobius hasta (Temminck etSchlegel)	whole	0.602	0.264	0.569	6.70	0.0235	0.589
	Octopus cf.minor (Sasaki)	whole	0.898	0.567	1.11	10.7	0.0186	2.12
Z25	*Rapana venosa* (Valenciennes)	Shelling	2.27	1.13	2.20	26.5	0.0420	5.12
	Synechogobius hasta (Temminck et Schlegel)	whole	0.605	0.262	0.633	8.53	0.0377	0.579
	Octopus cf.minor (Sasaki)	whole	0.938	0.526	0.878	8.76	0.0258	1.84
Z32	*Rapana venosa* (Valenciennes)	Shelling	2.14	1.19	2.33	20.6	0.0175	4.41
	Synechogobius hasta (Temminck et Schlegel)	whole	0.748	0.344	0.491	7.69	0.0184	0.533
	Octopus cf.minor (Sasaki)	whole	0.899	0.624	1.11	10.6	0.0132	1.55
Z38	*Rapana venosa* (Valenciennes)	Shelling	2.09	1.28	2.17	22.6	0.0140	4.10
	Synechogobius hasta (Temminck et Schlegel)	whole	0.646	0.303	0.700	8.00	0.0143	0.432
	Octopus cf.minor (Sasaki)	whole	0.862	0.596	1.00	10.7	0.0139	2.05
Z41	*Rapana venosa* (Valenciennes)	Shelling	2.33	1.22	2.12	23.7	0.0539	2.38
	Synechogobius hasta (Temminck et Schlegel)	whole	0.690	0.307	0.686	6.92	0.0384	0.629
	Octopus cf.minor (Sasaki)	whole	0.790	0.548	0.887	9.57	0.0226	3.90

(4) Evaluation criteria

In the quality assessment of living organisms, marine fish and software quality assessment has not yet been issued a uniform evaluation standard . This report uses the " Simple Criterion for Comprehensive Investigation of Coastal Zones and Marine Coatings Resources " for the evaluation . The petroleum hydrocarbon evaluation standard is based on the technical regulations of the Second National Baseline Survey of Marine Pollution (Volume II, 1998, Ocean Publishing House) . The standard limits are shown in Table 7.2-9.

Table 7.2-9 Evaluation criteria for contaminants in fish and soft organisms (mg/kg)

Biological category	Copper ≤	Lead ≤	Cadmium ≤	Zinc ≤	Total mercury ≤	Petroleum hydrocarbon ≤
Fish	20	2.0	0.6	40	0.3	20
Software class	100	10.0	5.5	250	0.3	20

The calculation formula of single factor pollution index method is as follows.

$$P_i = C_i / S_i$$

In the formula: PI-pollution index of pollutant I ; CI--the measured value of contaminant I ; SI-Quality standard values for contaminant I.

(5) Evaluation results

The results of the evaluation are presented in tables 7.2-10. The contents of copper, lead, zinc and mercury in fish and software samples collected at the eight stations meet the limits of " Marine Life Quality Assessment Standard " in the Concise Code for Comprehensive Survey of Coastal and Marine Resources ; The content of petroleum hydrocarbon accords with the corresponding standard of the Second National Baseline Survey of Marine Pollution.

Table 7.2-10 Monthly survey of marine quality assessment results (fish and mollusca

Species	S.N	Cu	Pb	Cd	Zn	Hg	Petroleum hydrocarbon
Fish	Z4	0.0323	0.152	1.21	0.162	0.0893	0.0285
	Z7	0.0215	0.145	1.10	0.152	0.0847	0.0203
	Z21	0.0314	0.171	1.41	0.164	0.0603	0.0309
	Z22	0.0301	0.132	0.948	0.168	0.0783	0.0295
	Z25	0.0303	0.131	1.06	0.213	0.126	0.0290
	Z32	0.0374	0.172	0.818	0.192	0.0613	0.0267
	Z38	0.0323	0.152	1.17	0.200	0.0477	0.0216
	Z41	0.0345	0.154	1.14	0.173	0.128	0.0315
Mollusca	Z4	0.0245	0.139	0.478	0.0940	0.0943	0.120
		0.00993	0.0627	0.213	0.0468	0.105	0.152
	Z7	0.026	0.127	0.442	0.107	0.096	0.226
		0.00962	0.0528	0.171	0.0346	0.0757	0.0925
	Z21	0.023	0.125	0.360	0.086	0.0533	0.128
		0.00852	0.0605	0.187	0.0361	0.06	0.143
	Z22	0.0262	0.129	0.460	0.0896	0.0763	0.213
		0.00898	0.0567	0.202	0.0428	0.0620	0.106
	Z25	0.0227	0.113	0.400	0.106	0.140	0.256
		0.00938	0.0526	0.160	0.0350	0.0860	0.092
	Z32	0.0214	0.119	0.424	0.0824	0.0583	0.221
		0.00899	0.0624	0.202	0.0424	0.044	0.0775
	Z38	0.0209	0.128	0.395	0.0904	0.0467	0.205
		0.00862	0.0596	0.182	0.0428	0.0463	0.103
	Z41	0.0233	0.122	0.385	0.0948	0.180	0.119
		0.0079	0.0548	0.161	0.0383	0.0753	0.195
Excess rate		0%	0%	25%	0%	0%	0%

7.2.3 Investigation on the Status of Fishery Resources

The investigation and evaluation data of fishery resources are drawn from the " Report on the Impact of Beijing Gas Tianjin Nangang LNG Emergency Reserve Project on Laizhou Bay National Aquatic Germplasm Resources Protection Zone in Bohai Bay " (Draft for Approval), which was prepared by the Yellow Sea Aquatic Institute of the Chinese Academy of Aquatic Sciences in March 2019.

7.2.3.1 Survey station

The fisheries resources survey stations for May and October 2017 are shown in Figure 7.2-2 and Table 7.2-11.

Table 7.2-11 Fishery Resources Survey Station Longitude and Latitude

Station No.	latitude（N）	longitude（E）	Survey
1	38°15'17"	118°32'15"	Fish eggs, larvae,
2	38°21'22"	118°14'10"	

3	38°23'35"	117°52'12"	swimming animals
4	38°39'25"	118°32'05"	
5	38°31'25"	118°20'05"	
6	38°32'10"	118°02'30"	
7	38°31'30"	117°45'15"	
8	38°50'38"	118°29'22"	
9	38°42'44"	118°06'48"	
10	38°44'24"	117°47'45"	
11	38°58'16"	118°14'38"	
12	38°54'14"	117°48'34"	

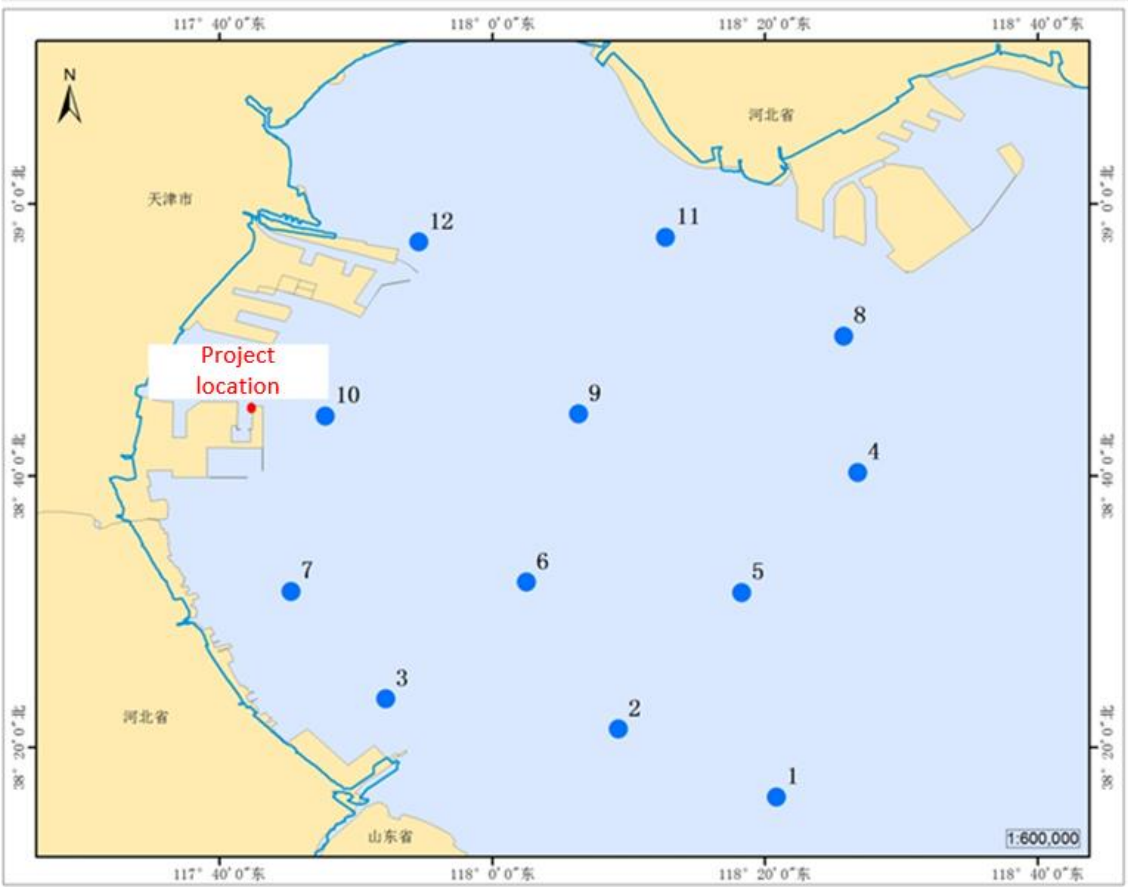


Figure 7.2-2 Location map of fishery resources survey

7.2.3.2 Investigation method

This is done in accordance with relevant methodologies such as the Marine Monitoring Code, the Marine Survey Code, the Marine Aquatic Resources Survey Manual and the Technical Procedures for Assessment of the Impact of Construction Projects on Marine Living Resources (SC/T 9110-2007).

7.2.3.3 Survey results

1. Eggs and larvae

As the only inner sea in China, Bohai Sea is a natural bait fish, fattening, spawning place. The Bohai Sea fishery is usually divided into four sub-fisheries: Liaodong Bay fishery, Bohai Bay fishery, Laizhou Bay fishery and Luanhekou fishery. This area is located in the Bohai Bay fishing grounds, every April, migratory fish began to enter the Bohai Sea, except for a few species in the middle of the Bohai Sea spawning, most species have successively entered the central Liaodong Bay, Bohai Bay, Laizhou Bay near the mouth of the sea area for spawning. Generally from May to October in the whole Bohai Sea almost all have fish eggs distribution, in which may to June to reach the peak spawning.

(1) Species composition

①Spring

During the spring voyage, 7 species of fish eggs were collected, including mackerel, red nose, Tongue sole, blue mackerel, blue scale, Barracuda and Black sheep. Five species of juvenile fish were collected, respectively, mackerel, red nose, blue scale, Barracuda and Tiger fish (Table 7.2-12).

Table 7.2-12The composition of fish eggs, larvae and larvae in the sea area in spring

Species name	Latin	Classification		Ecological type	
		Order	Section	Fish eggs	Juvenile fish
Mackerel	Clupanodon Pareatus	Clupeformes	Clupeidae	+	+
Red nose	Thrissa Kammalensis	Clupeformes	Pterocarpus	+	+
Tongue sole	Cynosus Joyneri	Pleuroidea	Cynoglossi dae	+	
Blue mackerel	Sawara Niphonia	Perciformes	Pterocarpus	+	
Blue scale	Harengula Zunasi	Clupeformes	Clupeidae	+	+
Barracuda	Liza Haematocheila	Mullet	Mullet family	+	+
Tiger fish	Chaeturichthys Stigmatias	Perciformes	Pterodontid ae		+
Black sheep	Platycephalus Indicus	Scorpiformes	Pterocarpus	+	
Total				7	5

From the composition of fish eggs, 116 eggs were collected, 56. 03% of which were mackerel eggs and 18. 97% of tongue sole. According to the number of juvenile fish, 427 larvae were collected, of which 69. 56% were juvenile mackerel and 25. 76% were piranha (Table 7.2-13).

Table 7.2-13 Number of juvenile fish eggs in spring (unit: IND)

Species	Fish eggs			Juvenile fish		
	Vertically	Level	Subtotal	Vertically	Level	Subtotal
Mackerel	22	43	65	2	295	297
Red nose		2	2	3		3
Tongue sole		22	22			
Blue mackerel		9	9			
Blue scale	1		1	2		2
Barracuda		4	4	5	10	15
Tiger fish				33	77	110
Black sheep	1	12	13			
Total	24	92	116	45	382	427

②Autumn

A total of 1 species of fish eggs were collected during the autumn voyage. One species of juvenile fish was collected, which was Cynoglossus semilaevis (Table 7.2-14).

Table 7.2-14 The composition of fish eggs and larvae in the sea area in autumn

Species name	Latin	Classification		Ecological type	
		Order	Section	Fish eggs	Juvenile fish
Sea bass	*Lateolabrax Maculatus*	Perch	Anthurid	+	

			ae		
Cynoglossus semilaevis	*Cynosus Semilaevis Gunther*	Pleuroidea	Cynoglossidae		+
Total				1	1

According to the composition of fish eggs, only 1 species of sea bass eggs were collected. Only one species of Cynoglossus semilaevis larvae was collected, including 1 tail (Table 7.2-15)

Table 7.2-15 Number of juvenile fish eggs in autumn (unit: IND)

Species	Ovum				Juvenile fish		
	Vertically	Level	Subtotal		Vertically	Level	Subtotal
Sea bass		13	13				
Cynoglossus semilaevis					1		1
Total		13	13		1		1

(2) Quantity and Distribution

①Spring

During the Spring Voyage Survey, fish eggs were captured in 9 horizontal and vertical trawl sites in 12 stations, with a frequency of 75% . Juvenile fish were caught in 11 stations with a frequency of 91. 7% .

The egg density of vertical trawlers ranged from 0 to 1.24 ind/m m with an average density of 0.31 ind/m m and the maximum was at position 2. The density of juvenile fish ranged from 0 to 1.36 ind/m 。 with an average density of 0.50 ind/m ³ and the maximum was at position 3 (Table 7.2-16).

Table 7.2-16 Spring fish eggs and larvae density (ind/m3)

S.N	Fish egg density	Juvenile fish density
1	0.23	0.68
2	1.24	0.47
3	0	1.36
4	0.68	0
5	0.55	0.35
6	0.16	0.24
7	0.45	0.87
8	0.13	0.11
9	0.09	0.57
10	0.19	0
11	0	0.23
12	0	1.08
mean	0.31	0.50

②Autumn

During the Autumn Voyage Survey, three of the 12 stations in the horizontal trawl captured fish eggs with a frequency of 25% . Larvae were caught in 1 position at a frequency of 8. 3% . The eggs of vertical trawlers were not collected . The larvae were collected only at station 10 . The frequency of occurrence was 8. 3% , the density was 0.222 ind/m³ and the average density of larvae was 0.019 ind/mm.

2. Swimming animals

(1) Species composition

In this study, 41 species of swimming animals were captured in spring and autumn in the sea area. Fourteen species of crustaceans, belonging to 2 orders, 8 families, 12 genera ; There are four species of cephalopod, belonging to three families and three genera (Table 7.2-17).

Table 7.2-17 List of swimming animals in spring and autumn

Species name		May	October	Latin name
Fish Class	Cynoglossus semilaevis		+	*Cynosus Joyneri*
	Tongue sole	+	+	*Cynosus Joyneri*
	Mackerel	+	+	*Clupanodon Pareatus*
	Blue scale		+	*Harengula Zunasi*
	Yellow crucian carp	+	+	*Setipinna Taty*
	Red nose	+	+	*Thrissa Kammalensis (Bleeker)*
	Silver pomfret		+	*Pampus Argenteus*
	Hairtail		+	*Trichiurus Muticus*
	Sea dragon	+		*Syngnathus acus Linnaeus*
	Pterospermopsis quadratus	+	+	*Enedrias Fangi*
	Wolf mackerel	+	+	*Odontamblypus Rubicundus (Hamilton)*
	Pterocarpus concavens	+	+	*CTenotrypaucchen Chinensis*
	Mackerel		+	*Scomber Japonicus (Houttuyn)*
	Call	+		*Johanius Belengerii*
	Tigery-tailed tiger	+	+	*Chaeturichthys Stigmatias*
	Pterosphaera	+	+	*Aconthogobius Hasta*
	Ctenosphaera nudus	+		*CTENOGOBIUS GYMNAUCHEN*
	Zhonghua tiger		+	*Trianoopogon Barbatus*
	Short fin	+	+	*Callionomus Kitaharae*
	Herringbone	+		*Callionomus Beniteguri Jordar & Snyder*
	Catfish		+	*Hexagrammos Otakii*
	Black sheep	+	+	*Platycephalus Indicus*
	Oil pan		+	*Sphyraena Pinguis Günther*
Onychia Shell Class	Shrimp cricket	+	+	*Oratosquilla Oratoria*
	Crayfish	+		*Leptochela Grcilis*
	Crayfish	+	+	*Palaemon Gravieri*
	White shrimp with spine		+	*Exopalamon Carincauda (Holthuis)*
	White Shrimp of South America		+	*Penaeus Vannamei*
	Japanese prawn		+	*Penaeus Japonicus*
	Eagle's claw shrimp		+	*Trachypenaeuscurvirostris*
	Japanese prawns	+	+	*Alphaeus Japonicus*
	Prawns with distinct features	+	+	*Alphaeus guguendus*
	Brown shrimp	+		*Crangon Crangon*
	Japanese mackerel	+	+	*Charybdis Japonica*
	Portunus trituberculatus	+	+	*Portunus tritumberculatus*
	Flagellated shrimp		+	*Lysmata Vitata Stimpson*
	Jellyfish shrimp	+		*Latreroutes Anoplonyx*
Head	Octopus	+	+	*Octopus Variabilis*

Foot Class	Cuttlebone	+	+	*Octopus Ocellatus*
	Scutellina bicornis	+		*Sepiola Birostrata*
	Japanese squid	+	+	*Loligo Japonica*

(2) Dominant species and dominance

①Spring

The three dominant species of swimming animals in spring were respectively crawfish (IRI = 6252.2), Japanese shrimp (IRI = 3240.3), and fish (IRI = 1690.1) . the nine important species are tongue sole (IRI = 969.1), prawns (IRI = 576.0), octopus (IRI = 496.7), mackerel (IRI = 390.9), squid (IRI = 232.1), brown shrimp (IRI = 184.7), shrimp (IRI = 178.7), crucian carp (IRI = 141.2), and mackerel (IRI = 115.2) see Table 7.2-18.

Table 7.2-18 Dominant species and dominance in spring

Species	Weight Percentage W	Mantissa Percent N	Occurrences	Frequency of occurrence	IRI	Advantage category
Shrimp cricket	46. 55%	28. 48%	10	83. 33%	6252.2	Dominant species
Japanese prawns	4. 03%	31. 32%	11	91. 67%	3240.3	Dominant species
Sautéed mackerel	11. 42%	8. 86%	10	83. 33%	1690.1	Dominant species
Tongue sole	5. 50%	6. 12%	10	83. 33%	969.1	Important species
Kudzu shrimp	1. 20%	5. 72%	10	83. 33%	576.0	Important species
Octopus	11. 02%	0. 90%	5	41. 67%	496.7	Important species
Mackerel	9. 29%	2. 44%	4	33. 33%	390.9	Important species
Japanese squid	1. 03%	2. 46%	8	66. 67%	232.1	Important species
Brown shrimp	0. 43%	3. 26%	6	50. 00%	184.7	Important species
Prawns with distinct features	0. 89%	1. 79%	8	66. 67%	178.7	Important species
Yellow crucian carp	2. 47%	0. 92%	5	41. 67%	141.2	Important species
Pterygodon concavens	0. 58%	2. 19%	5	41. 67%	115.2	Important species
Japanese mackerel	1. 15%	0. 41%	5	41. 67%	64.9	Common species
Jellyfish shrimp	0. 03%	1. 35%	3	25. 00%	34.7	Common species
Wolf mackerel	0. 64%	0. 64%	3	25. 00%	31.9	Common species
Pterosphaera	0. 55%	0. 47%	3	25. 00%	25.3	Common species
Cuttlebone	1. 36%	0. 17%	1	8. 33%	12.7	Common species
Crayfish	0. 02%	0. 72%	2	16. 67%	12.3	Common species
Red nose	0. 53%	0. 68%	1	8. 33%	10.1	Common

						species
Call	0. 15%	0. 14%	4	33. 33%	9.9	General species
Herringbone	0. 13%	0. 25%	2	16. 67%	6.4	General species
Portunus trituberculatus	0. 44%	0. 04%	1	8. 33%	4.0	General species
Black sheep	0. 33%	0. 04%	1	8. 33%	3.1	General species
Pterospermopsi s quadratus	0. 16%	0. 17%	1	8. 33%	2.8	General species
Scutellina bicornis	0. 02%	0. 25%	1	8. 33%	2.3	General species
Ctenosphaera nudus	0. 04%	0. 08%	2	16. 67%	2.1	General species
Short fin	0. 04%	0. 08%	2	16. 67%	2.0	General species
Sea dragon	0. 01%	0. 04%	1	8. 33%	0.4	Rare species

②Autumn

The dominant species of swimming animals in autumn are three species, namely the crawfish (IRI = 5662.7), the tiger (IRI = 5537.9), the squid (IRI = 3245.9), and the important species are 10, as shown in Table 7.2-19.

Table 7.2-19 Dominant Species and Superiority in Autumn

Species	Weight Percentage W	Mantissa Percent N	Occurrence s	Frequency of occurrence	*IRI*	Advantage category
Shrimp cricket	38. 29%	18. 34%	12	100. 00%	5662.7	Dominant species
Tigery-tailed tiger	20. 82%	34. 56%	12	100. 00%	5537.9	Dominant species
Japanese squid	14. 67%	20. 74%	11	91. 67%	3245.9	Dominant species
Cuttlebone	7. 01%	1. 11%	11	91. 67%	743.7	Important species
Crayfish	0. 98%	6. 33%	9	75. 00%	547.6	Important species
Japanese prawns	1. 01%	4. 69%	9	75. 00%	427.2	Important species
Japanese mackerel	3. 28%	0. 85%	11	91. 67%	378.1	Important species
Yellow crucian carp	1. 73%	3. 85%	8	66. 67%	371.5	Important species
Tongue sole	2. 21%	1. 47%	9	75. 00%	275.3	Important species
Pterosphaer a	3. 18%	0. 43%	9	75. 00%	270.9	Important species
Red nose	0. 71%	2. 41%	8	66. 67%	207.8	Important species
Pterocarpus concavens	0. 43%	2. 12%	8	66. 67%	169.9	Important species
Mackerel	1. 46%	0. 54%	6	50. 00%	100.4	Important species

Portunus trituberculatus	1. 06%	0. 10%	6	50. 00%	57.8	Common species
Octopus	0. 89%	0. 09%	6	50. 00%	49.0	Common species
Prawns with distinct features	0. 29%	1. 01%	3	25. 00%	32.4	Common species
Zhonghua tiger	0. 68%	0. 23%	3	25. 00%	22.7	Common species
Eagle's claw shrimp	0. 21%	0. 33%	5	41. 67%	22.6	Common species
White shrimp with spine	0. 16%	0. 39%	2	16. 67%	9.2	General species
Silver pomfret	0. 22%	0. 05%	2	16. 67%	4.5	General species
Oil pan	0. 15%	0. 03%	3	25. 00%	4.4	General species
Short fin	0. 08%	0. 18%	2	16. 67%	4.2	General species
Black sheep	0. 17%	0. 02%	2	16. 67%	3.0	General species
Hairtail	0. 06%	0. 03%	2	16. 67%	1.4	General species
Blue scale	0. 02%	0. 05%	2	16. 67%	1.1	General species
Wolf mackerel	0. 04%	0. 01%	2	16. 67%	0.9	Rare species
White Shrimp of South America	0. 07%	0. 01%	1	8. 33%	0.7	Rare species
Japanese prawn	0. 05%	0. 01%	1	8. 33%	0.6	Rare species
Cynoglossus semilaevis	0. 05%	0. 01%	1	8. 33%	0.5	Rare species
Catfish	0. 02%	0. 03%	1	8. 33%	0.4	Rare species
Mackerel	0. 02%	0. 01%	1	8. 33%	0.2	Rare species
Flagellated shrimp	0. 00%	0. 01%	2	16. 67%	0.1	Rare species
Pterospermopsis quadratus	0. 00%	0. 01%	1	8. 33%	0.1	Rare species

3. Status of fish resources

(1) Class composition

①Spring

In spring, 15 species of fish were captured, accounting for 53. 6% of the total number of swimming animals. Of the 15 species of fish captured, there are 7 species of warm-water fish, 7 species of warm-warm fish and 1 species of cold-warm fish ; There are 11 species of bottom fish and 4 species of pelagic fish, depending on the aquifer ; According to the wintering field, there are 9 species of local fish in Bohai Sea and 6 species of long distance migratory fish. According to economic value, there are 1 higher economic value, 5 general economic value, and 9 lower economic value (Table 7.2-20).

Table 7.2-20 Fish species composition in spring

Species	Economic value			Water layer		Temperature adaptability			Wintering field		
	Higher	General	Lower	Upper-middle class	Bottom layer	Warm water	Warm nature	Cold temperature property	Bohai Sea	Yellow Sea	East China Sea
Pterocarpus concavens			+		+	+			+		
Mackerel		+		+		+				+	
Red nose		+		+		+				+	
Short fin			+		+		+		+		
Pterospermopsis quadratus			+		+			+	+		
Herringbone			+		+		+		+		
Sea dragon			+	+		+			+		
Yellow crucian carp		+		+		+				+	
Tigery-tailed tiger			+		+		+		+		
Tongue sole		+			+		+		+		
Call		+			+	+				+	
Wolf mackerel			+		+		+			+	
Ctenosphaera nudus			+		+		+		+		
Pterosphaera			+		+		+		+		
Black sheep	+				+	+				+	
Total	1	5	9	4	11	7	7	1	9	6	0

②Autumn

A total of 19 species of fish were caught in the autumn survey, accounting for 57. 6% of the species of swimming animals. Of the 19 species of fish captured, there are 8 species of warm-water fish, 10 species of warm-warm fish and 1 species of cold-warm fish ; There are 13 species of bottom fish and 6 species of pelagic fish, depending on the aquifer ; According to the wintering field, there are 10 species of local fish in Bohai Sea and 9 species of long distance migratory fish. According to economic value, there are 5 kinds of higher economic value, 6 kinds of general economic value and 8 kinds of lower economic value (Table 7.2-21).

Table 7.2-21 The composition of fish species in the sea area in autumn

Species	Economic value			Water layer		Temperature adaptability			Wintering field		
	Higher	General	Lower	Upper-middle class	Bottom layer	Warm water	Warm nature	Cold temperature property	Bohai Sea	Yellow Sea	East China Sea
Cynoglossus semilaevis	+				+		+		+		

Tongue sole		+			+		+		+		
Mackerel		+		+		+				+	
Blue scale		+		+		+				+	
Yellow crucian carp		+		+		+				+	
Red nose		+		+		+				+	
Silver pomfret	+			+		+				+	
Hairtail			+		+		+			+	
Pterospermopsis quadratus			+		+			+	+		
Wolf mackerel			+		+		+		+		
Pterocarpus concavens			+		+	+			+		
Mackerel	+			+			+				+
Tigery-tailed tiger			+		+		+		+		
Pterosphaera			+		+		+		+		
Zhonghua tiger			+		+		+		+		
Short fin			+		+		+		+		
Catfish		+			+		+		+		
Black sheep	+				+	+				+	
Oil pan	+				+	+				+	
Total	5	6	8	6	13	8	10	1	10	8	1

(2) Biomass and biological density

①Spring

The changes of fish biomass in spring ranged from 0.26 to 5.28 kg/h, with an average value of 1.99 kg/h ; Fish biomass ranges from 27 to 274 tails/h, averaging 137 tails/h (Table 7.2-22).

Table 7.2-22 Composition and distribution of fish in spring

S.N	Biomasskg/h	%	BiodensityTail/h	%
1	0.70	2.93	30	1.83
2	5.28	22.10	174	10.62
3	0.69	2.89	27	1.65
4	2.54	10.63	118	7.20
5	4.89	20.47	274	16.72
6	0.68	2.85	126	7.69
7	2.46	10.30	255	15.56
8	1.43	5.99	141	8.60
9	3.15	13.19	248	15.13
10	0.61	2.55	66	4.03
11	1.20	5.02	150	9.15
12	0.26	1.09	30	1.83
mean	1.99		137	

According to the catch analysis, the fish tail number in spring was 16. 8% of the total mantissa of fish, the average density of fish was 23 tails/h, the biomass was 0.13 kg/h, and the average biomass of adult fish was 1.86 kg/h.

②Autumn

The changes of fish biomass in autumn ranged from 1.77 to 11.21 kg/h, with an average value of 4.97 kg/h ; Fish biomass ranges from 360 to 3664 tails/h, with an average of 1156 tails/h (Table 7.2-23).

Table 7.2-23 Composition and distribution of autumn fish

S.N	Biomasskg/h	%	BiodensityTail/h	%
1	5.25	8.80	832	6.00
2	4.23	7.09	644	4.64
3	5.55	9.30	408	2.94
4	11.21	18.79	3664	26.41
5	2.51	4.21	792	5.71
6	5.02	8.41	360	2.59
7	3.25	5.45	411	2.96
8	5.67	9.50	369	2.66
9	1.77	2.97	960	6.92
10	2.23	3.74	1436	10.35
11	7.68	12.87	2346	16.91
12	5.30	8.88	1652	11.91
mean	4.97		1156	

According to the catch analysis, the fish tail number in autumn was 19. 8% of the total fish fraction, the average density of fish was 229 tails/h, the biomass was 1.26 kg/h, and the average biomass of adult fish was 3.71 kg/h.

(3) Assessment of relative fish stocks

According to the sea sweeping area method, the average towing speed is 5.556 km/h, the net width is 23000000 and the sea sweeping area is 0.1278 km/h.

①Spring

The average fish resources in spring are 31.16 kg/km2 and the resource density is 2137 tails/km2 according to the method of sweeping sea area, among which the average fish adult resources is 29.18 kg/km2 and the average resource density of young fish is 359 tails/km2 (Table 7.2-24).

Table 7.2-24 Relative fish stocks by station in spring

Standing position	Amount of resources		Adult		Juvenile fish	
	Kg/km 2	Tail/km 2	Kg/km 2	Tail/km 2	Kg/km 2	Tail/km 2
1	10.95	469	10.52	391	0.43	79
2	82.63	2723	80.11	2266	2.52	457
3	10.80	423	10.41	352	0.39	71
4	39.75	1847	38.04	1536	1.71	310
5	76.53	4288	72.56	3568	3.96	720
6	10.64	1972	8.82	1641	1.82	331
7	38.50	3991	34.81	3320	3.69	670
8	22.38	2207	20.34	1836	2.04	371
9	49.30	3881	45.71	3229	3.59	652
10	9.55	1033	8.59	859	0.95	174
11	18.78	2347	16.61	1953	2.17	394
12	4.07	469	3.64	391	0.43	79
Average	31.16	2137	29.18	1778	1.98	359

②Autumn

The average fish resources in autumn are 77.82 kg/km2 and the resource density is 18093 tails/km2 according to the method of sweeping sea area, among which the average fish adult resources is 58.11 kg/km2 and the average resource density of young fish is 3582 tails/km2 (Table 7.2-25).

Table 7.2-25 Relative fish stocks by station in autumn

Standing position	Amount of resources		Adult		Juvenile fish	
	Kg/km 2	Tail/km 2	Kg/km 2	Tail/km 2	Kg/km 2	Tail/km 2
1	82.16	13020	67.98	10442	14.18	2578
2	66.20	10078	55.22	8083	10.98	1995
3	86.85	6385	79.90	5121	6.95	1264
4	175.43	57340	112.99	45986	62.44	11353
5	39.28	12394	25.78	9940	13.50	2454
6	78.56	5634	72.43	4518	6.14	1115
7	50.86	6432	43.86	5158	7.00	1274
8	88.73	5775	82.44	4631	6.29	1143
9	27.70	15023	11.34	12049	16.36	2975
10	34.90	22473	10.43	18023	24.47	4450
11	120.19	36714	80.21	29444	39.98	7269
12	82.94	25853	54.79	20734	28.15	5119
Average	77.82	18093	58.11	14511	19.70	3582

(4) Summary of fish resource assessment

According to the above calculation results, the average fish resource in spring and autumn is 54.49 kg/km2 and the average resource density is 10115 tails/km2. The fish adult resources averaged 43.65 kg/km2 in spring and autumn, and the average resource density was 8145 tails/km2. The spring and autumn resources of juvenile fish averaged 10.84 kg/km2, and the average resource density was 1970 tail/km2.

4.Cephalopods

（1）Class composition

①Spring

Four species of cephalopods were captured in the spring survey, accounting for 14. 3% of the total catches. The other three species (octopus, cuttlefish, Japanese cuttlefish) are of high economic value (Table 7.2-26).

Table 7.2-26 Species composition of cephalopod in spring

Species name	Economic value		
	Higher	Lower	Very low
Octopus	+		
Cuttlebone	+		
Japanese squid	+		
Scutellina bicornis		+	

②Autumn

Three species of cephalopods were captured in the autumn survey, accounting for 9. 1% of the total catches. The economic value of octopuses, octopuses and cuttlefish captured in Japan is high (Table 7.2-27).

Table 7.2-27 Species composition of cephalopod in autumn

Species name	Economic value		
	Higher	Lower	Very low
Octopus	+		
Cuttlebone	+		
Japanese squid	+		

(2) Biomass and biological density

①Spring

The changes of cephalopod biomass ranged from 0 to 3.64 kg/h in spring, and the mean value was 0.84 kg/h. The densities of cephalopods ranged from 0 to 72 tails/h, with an average of 22 tails/h (Table 7.2-28).

According to the catch analysis, the mantissa of cephalopod larvae accounted for 12. 4% of the total mantissa in spring, the average density of larvae was 3 ind/h, the biomass was 0.012 kg/h, and the average biomass of cephalopod adults was 0.83 kg/h.

Table 7.2-28 Quantitative composition and distribution of cephalopod in spring

Standing position	Biomass kg/h	Percent %	Density tail/h	Percent %
1	0.01	0.10	6	2.24
2	0.17	1.69	9	3.36
3	0.01	0.10	3	1.12
4	2.19	21.75	16	5.97
5	1.47	14.60	12	4.48
6	0.02	0.20	6	2.24
7	0.06	0.60	18	6.72
8	1.21	12.02	39	14.55
9	3.64	36.15	72	26.87
10	0.26	2.58	57	21.27
11	1.03	10.23	30	11.19
12	0	0	0	0
Average	0.84		22	

②Autumn

The changes of cephalopod biomass in autumn ranged from 0.26 to 13.01 kg/h, and the mean value was 3.50 kg/h. The densities of cephalopods ranged from 20 to 2832 tails/h, with an average of 551 tails/h (Table 7.2-29).

According to the catch analysis, the mantissa of cephalopod larvae accounted for 22. 5% of the total mantissa, the average density of larvae was 124 tail/h, the biomass was 0.32 kg/h, and the average biomass of cephalopod adults was 3.18 kg/h.

Table 7.2-29 Quantitative composition and distribution of cephalopod in autumn

Standing position	Biomass kg/h	Percent %	Density tail/h	Percent %
1	4.21	10.02	936	14.15
2	3.53	8.40	102	1.54
3	2.09	4.97	56	0.85
4	2.31	5.50	718	10.85
5	0.26	0.62	20	0.30
6	2.73	6.50	64	0.97
7	5.83	13.87	438	6.62
8	0.52	1.24	21	0.32
9	2.84	6.76	472	7.14
10	3.58	8.52	728	11.01
11	13.01	30.95	2832	42.81
12	1.12	2.66	228	3.45
Average	3.50		551	

(3) Assessment of the relative resources of cephalopod

①Spring

The average resource of cephalopod in spring is 13.13 kg/km2 and the resource density is 349 kg/km2 . The average resource of cephalopod adults is 12.96 kg/km2 and the average resource density of larvae is 43 kg/km2 (Table 7.2-30).

Table 7.2-30 Relative resources of cephalopods in each station in spring

S.N	Resources		Adult		Larval	
	kg/km^2	Tail/km^2	kg/km^2	Tail/km^2	kg/km^2	Tail/km^2
1	0.16	94	0.11	82	0.05	12
2	2.66	141	2.59	123	0.07	17
3	0.16	47	0.13	41	0.02	6
4	34.27	250	34.15	219	0.12	31
5	23.00	188	22.91	165	0.09	23
6	0.31	94	0.27	82	0.05	12
7	0.94	282	0.80	247	0.14	35
8	18.94	610	18.63	535	0.30	76
9	56.96	1127	56.41	987	0.56	140
10	4.07	892	3.63	781	0.44	111
11	16.12	469	15.89	411	0.23	58
12	0.00	0	0.00	0	0.00	0
mean	13.13	349	12.96	306	0.17	43

②Autumn

The average resource of cephalopod in autumn is 54.77 kg/km2 and the resource density is 8623 kg/km2 . The average resource of cephalopod adults is 49.73 kg/km2 and the average resource density of larvae is 1940 kg/km2 (Table 7.2-31).

Table 7.2-31 Relative resources of cephalopods in each station in autumn

S.N	Resources		Adult		Larval	
	kg/km^2	Tail/km^2	kg/km^2	Tail/km^2	kg/km^2	Tail/km^2
1	0.16	94	0.11	82	0.05	12
2	2.66	141	2.59	123	0.07	17
3	0.16	47	0.13	41	0.02	6
4	34.27	250	34.15	219	0.12	31
5	23.00	188	22.91	165	0.09	23
6	0.31	94	0.27	82	0.05	12
7	0.94	282	0.80	247	0.14	35
8	18.94	610	18.63	535	0.30	76
9	56.96	1127	56.41	987	0.56	140
10	4.07	892	3.63	781	0.44	111
11	16.12	469	15.89	411	0.23	58
12	0.00	0	0.00	0	0.00	0
mean	13.13	349	12.96	306	0.17	43

(4) Summary of assessment of cephalopod resources

According to the above calculation results, the average resource of cephalopod in spring and autumn is 33.95 kg/km2, and the average resource density is 4486 tails/km2. The resource of cephalopod is 31.35 kg/km2 in spring and autumn, and the average resource density is 3495 tail/km2. The resources of cephalopod larvae averaged 2.61 kg/km2 in spring and autumn, and the average resource density was 991 tails/km2.

5.Crustaceans

(1) Class composition

①Spring

In spring, 9 species of crustaceans were captured, accounting for 32. 1% of the total catches, 7 species of shrimps and 2 species of crabs. There are three higher economic values, four lower ones and two lower ones (Table 7.2-32).

Table 7.2-32 The species composition of crustaceans in the sea area in spring

Species name	Economic value		
	Higher	Lower	Very low
Crayfish		+	
Jellyfish shrimp			+
Brown shrimp		+	
Shrimp cricket	+		
Japanese prawns		+	
Crayfish			+
Prawns with distinct features		+	
Portunus trituberculatus	+		
Japanese mackerel	+		

②Autumn

Eleven species of crustaceans were captured in the autumn survey, accounting for 33. 3% of the total catches. There are 9 kinds of shrimp and 2 kinds of crab. The economic value of the higher six, the lower four, the very low one are shown in Table 7.2-33)

Table 7.2-33 The species composition of crustaceans in the sea area in autumn

Species name	Economic value		
	Higher	Lower	Very low
Flagellated shrimp			+
Crayfish		+	
White shrimp with spine		+	
Shrimp cricket	+		
White Shrimp of South America	+		
Japanese prawn	+		
Japanese prawns		+	
Prawns with distinct features		+	
Eagle's claw shrimp	+		
Portunus trituberculatus	+		
Japanese mackerel	+		

(2) Biomass and biological density

①Spring

In spring, the changes of crustacean biomass ranged from 0.02 to 14.45 kg/h, with an average value of 3.42 kg/h. The densities of crustaceans ranged from 6 to 1094 tails/h, averaging 432 tails/h. The variation range of shrimp biomass was 0.01-14.26 kg/h, and the mean value was 3.38 kg/h. The biological density ranges from 6 to 1075 tails/h, mean 427 tails/h, crab biomass ranges from 0 to 0.19 kg/h, mean 0.04 kg/h. Biological density ranges from 0 to 17 tails/h, with an average of 5 tails/h, as shown in the following table.

According to the analysis of catches, the mantissa of shrimp larvae accounts for 16. 41% of the total mantissa of shrimp, the average density of shrimp larvae is 70 tails/h, the biomass is 0.11 kg/h, the average biomass is 357 tails/h and the average biomass is 3.27 kg/h ; The average biomass was 0.04 kg/h and the average density was 5 tails/h.

Table 7.2-34 Quantitative composition and distribution of crustaceans in spring

Standing position	Biological density (tail/h)		Percentage (%)		Biomass (kg/h)		Percentage (%)	
	Shrimp	Crab	Shrimp	Crab	Shrimp	Crab	Shrimp	Crab
1	86	1	1.68	1.72	0.93	0.01	2.30	1.59
2	12	0	0.23	0	0.02	0	0.05	0
3	6	0	0.12	0	0.01	0	0.02	0
4	487	5	9.52	8.62	14.26	0.19	35.19	34.65
5	1075	17	21.00	29.31	4.93	0.06	12.17	11.33
6	523	5	10.21	8.62	2.51	0.03	6.20	7.54
7	582	6	11.37	10.34	3.85	0.05	9.49	9.43
8	276	3	5.40	5.17	3.07	0.04	7.57	7.55
9	483	5	9.44	8.62	4.95	0.07	12.20	13.11
10	187	2	3.66	3.45	0.67	0.01	1.64	1.59
11	618	6	12.07	10.34	2.93	0.04	7.24	7.55
12	784	8	15.32	13.79	2.40	0.03	5.93	5.66
Average	427	5			3.38	0.04		

②Autumn

The variation range of crustacean biomass in autumn was 2.09-13.18 kg/h, and the mean value was 7.04 kg/h. The densities of crustaceans ranged from 429 to 1522 tails/h, with an average of 806 tails/h. The variation range of shrimp biomass was 2.09-10.26 kg/h, and the mean value was 5.94 kg/h. The biological density range is 385-1522 tail/h, the mean value is 759 tail/h, the crab biomass range is 0-3.10 kg/h, the mean value is 1.10 kg/h. Biological density ranges from 0 to 84 tails/h, with an average of 47 tails/h, as shown in the following table.

According to the catch analysis, the mantissa of shrimp larvae accounted for 21. 97% of the total mantissa of shrimp in the autumn survey, with an average density of 167 tails/h, an average biomass of 0.23 kg/h, an average biomass of 592 tails/h and an average biomass of 5.71 kg/h ; The mantissa of crab larvae accounts for 18. 18% of the total mantissa of crab, with an average density of 9 tails/h, an average biomass of 0.11 kg/h, an average density of 38 tails/h and an average biomass of 0.99 kg/h.

Table 7.2-35 Quantitative composition and distribution of crustaceans in autumn

Standing position	Biological density (tail/h)		Percentage (%)		Biomass (kg/h)		Percentage (%)	
	Shrimp	Crab	Shrimp	Crab	Shrimp	Crab	Shrimp	Crab
1	537	47	5.90	8.25	5.83	0.63	8.17	4.79
2	721	0	7.92	0	2.09	0	2.93	0
3	916	80	10.07	14.08	5.07	0.64	7.10	4.87
4	394	0	4.33	0	3.50	0	4.90	0
5	972	84	10.67	14.93	9.73	3.10	13.64	23.57
6	495	49	5.44	8.66	5.03	1.04	7.05	7.91
7	385	44	4.23	7.77	5.51	1.06	7.72	8.06
8	560	49	6.15	8.62	3.66	1.04	5.13	7.91
9	1522	0	16.72	0	8.16	0	11.43	0
10	1177	91	12.93	16.08	10.26	2.92	14.38	22.21
11	541	47	5.94	8.36	3.41	1.24	4.78	9.43

12	884	75	9.71	13.25	9.11	1.48	12.77	11.25
Average	759	47			5.94	1.10		

(3) Evaluation of relative resources of crustaceans

① Spring

a) Shrimp

The average biomass of shrimp in spring was 3.38 kg/h ; The average biomass density was 427 tails/h, and the average biomass was 71 tails/h, 0.11 kg/h, 361 tails/h and 3.27 kg/h. According to the method of sweeping sea area, the average resource of shrimp is 52.90 kg/km2 and the resource density is 6682 tails/km2, among which, the resource amount of shrimp adult is 51.18 kg/km2 and the resource density is 5586 tails/km2. The average resource of shrimp larvae was 1.72 kg/km2 and the resource density was 1096 tails/km2 (Table 7.2-36).

Table 7.2-36 Shrimp Relative Resources in Each Station in Spring

S.N	Resources		Adult		Larval	
	kg/km^2	Tail/km^2	kg/km^2	Tail/km^2	kg/km^2	Tail/km^2
1	14.55	1346	14.21	1125	0.35	221
2	0.31	188	0.26	157	0.05	31
3	0.16	94	0.13	78	0.02	15
4	223.16	7621	221.20	6371	1.96	1251
5	77.15	16823	72.82	14062	4.33	2761
6	39.28	8185	37.17	6842	2.11	1343
7	60.25	9108	57.90	7613	2.35	1495
8	48.04	4319	46.93	3610	1.11	709
9	77.46	7559	75.52	6318	1.95	1240
10	10.49	2926	9.73	2446	0.75	480
11	45.85	9671	43.36	8084	2.49	1587
12	37.56	12269	34.40	10256	3.16	2013
mean	52.90	6682	51.18	5586	1.72	1096

b) Crab

The crabs are all adult in spring. The average biomass of crab in spring was 0.04 kg/h ; The mean biomass density was 5 tails/h, and the mean resource of crab was 0.63 kg/km2 in spring and 78 tails/km2 in spring according to the method of sweeping sea area (Table 7.2-37).

Table 7.2-37 Spring Station Crab Relative Resources

S.N	Resources（kg/km^2）	Resource density（Tail/km^2）
1	0.16	16
2	0.00	0
3	0.00	0
4	2.97	78
5	0.94	266
6	0.47	78
7	0.78	94
8	0.63	47
9	1.10	78
10	0.16	31
11	0.63	94
12	0.47	125
mean	0.63	78

②Autumn

a) Shrimp

The average biomass of shrimp was 5.94 kg/h in autumn. The average biomass density was 759 tails/h, and the average biomass was 167 tails/h, 0.23 kg/h, 592 tails/h and 5.71 kg/h. According to the method of sweeping sea area, the average resource density of shrimp in autumn is 11878 tails/km2, and the average resource density of shrimp is 89.36 kg/km2, and the average resource density is 9265 tails/km2. The average resource of shrimp larvae was 3.60 kg/km2 and the resource density was 2613 tails/km2 (Table 7.2-38).

Table 7.2-38 Autumn Station Shrimp Relative Resources

S.N	Resources		Adult		Larval	
	kg/km^2	Tail/km^2	kg/km^2	Tail/km^2	kg/km^2	Tail/km^2
1	91.24	8404	88.69	6557	2.55	1846
2	32.71	11283	29.29	8804	3.42	2479
3	79.34	14335	75.00	11186	4.35	3149
4	54.77	6166	52.90	4811	1.87	1355
5	152.27	15211	147.66	11869	4.61	3342
6	78.72	7746	76.37	6045	2.35	1702
7	86.23	6025	84.40	4701	1.83	1324
8	57.28	8764	54.62	6838	2.66	1925
9	127.70	23818	120.48	18586	7.22	5233
10	160.56	18419	154.98	14373	5.58	4047
11	53.36	8466	50.80	6606	2.57	1860
12	142.57	13834	138.37	10795	4.19	3039
mean	92.96	11878	89.36	9265	3.60	2613

b) Crab

The average biomass of crab was 1.10 kg/h in autumn. The average biological density was 47 tails/h, and the average biological density of crab larvae was 9 tails/h, 0.11 kg/h, 38 tails/h and 0.99 kg/h respectively. According to the method of sweeping sea area, the average resource of shrimp in autumn is 17.21 kg/km2, and the average resource density is 736 tails/km2, among which, the average resource density of crab is 15.57 kg/km2 and 602 tails/km2. The average resource of crab larvae was 1.64 kg/km2, and the resource density was 134 tails/km2 (Table 7.2-39).

Table 7.2-39 Relative resources of crabs in each station in autumn

S.N	Resources		Adult		Larval	
	kg/km^2	Tail/km^2	kg/km^2	Tail/km^2	kg/km^2	Tail/km^2
1	9.86	736	8.23	602	1.63	134
2	0	0	0	0	0	0
3	10.02	1252	7.23	1024	2.78	228
4	0	0	0	0	0	0
5	48.51	1315	45.59	1076	2.92	239
6	16.28	767	14.57	627	1.70	139
7	16.59	689	15.06	563	1.53	125
8	16.28	767	14.57	627	1.70	139
9	0	0	0	0	0	0
10	45.70	1424	42.53	1165	3.16	259
11	19.41	736	17.77	602	1.63	134

12	23.16	1174	20.55	960	2.61	213
mean	17.21	736	15.57	602	1.64	134

(4) Summary of resource assessment for crustaceans

According to the above calculation results, the average resource of shrimp in spring and autumn is 72.93 kg/km2 and the average resource density is 9280 tail/km2. In spring and autumn, the average resource density of shrimp was 70.27 kg/km2 and 7426 tail/km2. In spring and autumn, the average resource and density of shrimp larvae were 2.66 kg/km2 and 1854 tail/km2.

The average resources in spring and autumn were 8.92 kg/km2, and the average resource density was 407 tails/km2. The average resource density of crab is 340 tails/km2, and the average resource density is 8.10 kg/km2 in spring and autumn. The average spring and autumn resources of crab larvae were 0.82 kg/km2, and the average resource density was 67 tails/km2.

7.2.3.4 Total resource assessment

The change range of fishing catch rate in spring was (0.71-19.18) kg/h, with an average of 6.25 kg/h ; The range of catch per unit time ranged from 36 to 1378 tails/h, averaging 590 tails/h. The weight density (11.12-300.15) kg/km2 of fishery resources in the investigated sea area was 97.8 kg/km2. Resource mantissa density (564-21565) tail/km2, average 9238 tail/km2. The weight density of larval fishery resources (0.43-8.38) kg/km2, the average value is 3.87 kg/km2 ; Resource mantissa density (92-3504) tail/km2, average 1498 tail/km2. Details of the spring survey of fisheries resource catch rates are shown in table 7.2-40.

Table 7.2-40 Spring Survey of Swimming Biological Resources

Standing position	Weight catch Kg/h	Amount of resources Kg/km2	Mantissa catch Tail/h	Resource density Tail/km2	Larva resource Kg/km2	Larva resource density Tail/km2
1	1.65	25.82	123	1925	0.83	312
2	5.47	85.6	195	3052	2.64	505
3	0.71	11.12	36	564	0.43	92
4	19.18	300.15	626	9796	3.79	1592
5	11.35	177.62	1378	21565	8.38	3504
6	3.24	50.7	660	10329	3.98	1686
7	6.42	100.47	861	13475	6.18	2200
8	5.75	89.99	459	7183	3.45	1156
9	11.81	184.82	808	12645	6.1	2032
10	1.55	24.27	312	4882	2.14	765
11	5.2	81.38	804	12581	4.89	2039
12	2.69	42.1	822	12863	3.59	2092

The range of changes in the total catch rate of fishery resources investigated in autumn was (9.85-25.34) kg/h, with an average of 15.5 kg/h ; The range of catch per unit time ranged from (968-5766) tail/h to an average of 2513 tail/h. The weight density (154.15-396.56) kg/km2 of fishery resources in the investigated sea area was 242.8 kg/km2. Resource mantissa density (15149-90235) tail/km2, average 39331 tail/km2. The weight density of larval fishery resources (10.78-70.88) kg/km2, the average value is 29.99 kg/km2 ; Resource mantissa density (3181-19235) tail/km2, average 8266 tail/km2. Details of the autumn survey of fisheries resource catch rates are provided in table 7.2-41.

Table 7.2-41 Inventory of Biologic Resources in Swimming in Autumn

Standing position	Weight catch Kg/h	Amount of resources Kg/km2	Mantissa catch Tail/h	Resource density Tail/km2	Larva resource Kg/km2	Larva resource density Tail/km2

1	15.92	249.14	2352	36808	26.93	7854
2	9.85	154.15	1467	22957	15.33	4833
3	13.35	208.92	1460	22848	14.59	4838
4	17.02	266.35	4776	74742	70.88	15236
5	15.6	244.13	1868	29233	21.21	6105
6	13.82	216.28	968	15149	10.78	3181
7	15.65	244.92	1278	20000	14.37	4265
8	10.89	170.43	999	15635	10.84	3281
9	12.77	199.84	2954	46228	27.9	9870
10	18.99	297.19	3432	53709	39.87	11319
11	25.34	396.56	5766	90235	70.11	19235
12	17.01	266.2	2839	44429	37.04	9174

7.2.4 Trend of marine ecological change

7.2.4.1 Trend Analysis of Interannual Change of Marine Ecology

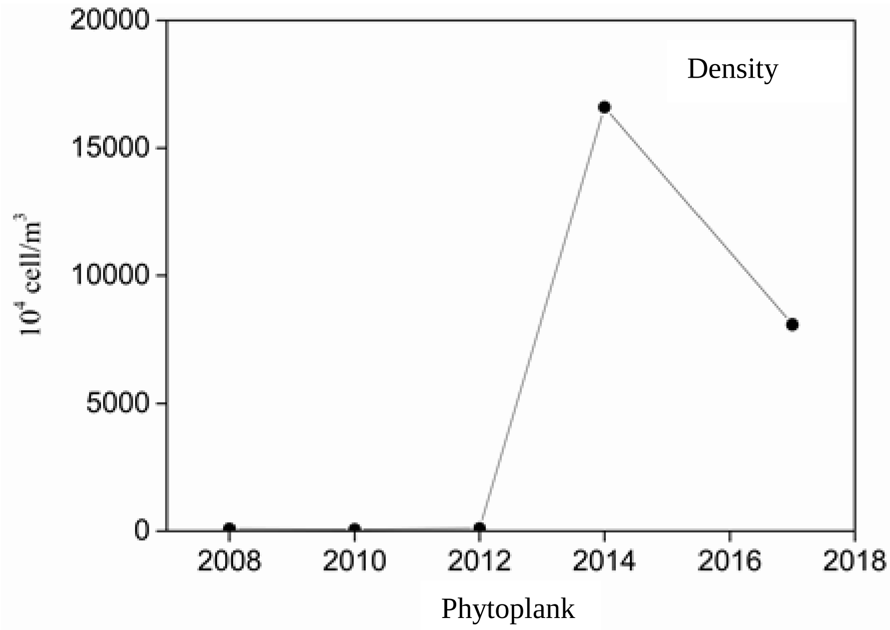
The interannual trend analysis of marine ecology selected indicators of total and diversity of phytoplankton, zooplankton and benthos and examined trends over five years in 2008 (November), 2010 (October), 2012 (October), 2014 (November) and 2017 (September).

(1) Phytoplankton

As can be seen from Table 7.2-42 and Figure 7.2-3, the total and diversity of phytoplankton can be seen that the density of phytoplankton remained basically stable from 2008 to 2012, with a significant increase in 2014, followed by a decrease in 2017 ; The diversity index, dominance and evenness remained stable except for 2014 .

Table 7.2-42 Assessment of phytoplankton in the sea areas, 2008, 2010, 2012, 2014 and 2017 Monitoring data and evaluation index statistics

Investigate Time	Category number	Dominant species	Individual density (104 /M3)	Diversity index	Dominance	Uniformity	Abundance
Autumn 2008	26	Mesocostata mediana, Virostris, noctilucent algae, Trichosanthes cylindrica, Rhabdosphaera rigida, Rhombodinia spinosa and Rugosa	93.2	2.04	0.73	0.58	
Autumn 2010	28	Rhomboid spinocephalus, Mesocosta, noctilucent algae, Raurocerus and Vibrio vulnificus	69.78	1.90	0.76	0.56	0.76
Autumn 2012	34	Rhomboidina spinifera, Rugosa rotunda, Raurocera	105.3	3.23	0.43	0.77	1.90
Autumn 2014	17	Rhizoctonia longipennis	1.66 x 104	0.06	1.00	0.02	0.42
Autumn 2017	32	Trichophora spiralis	199.68	2.49	0.59	0.74	1.44



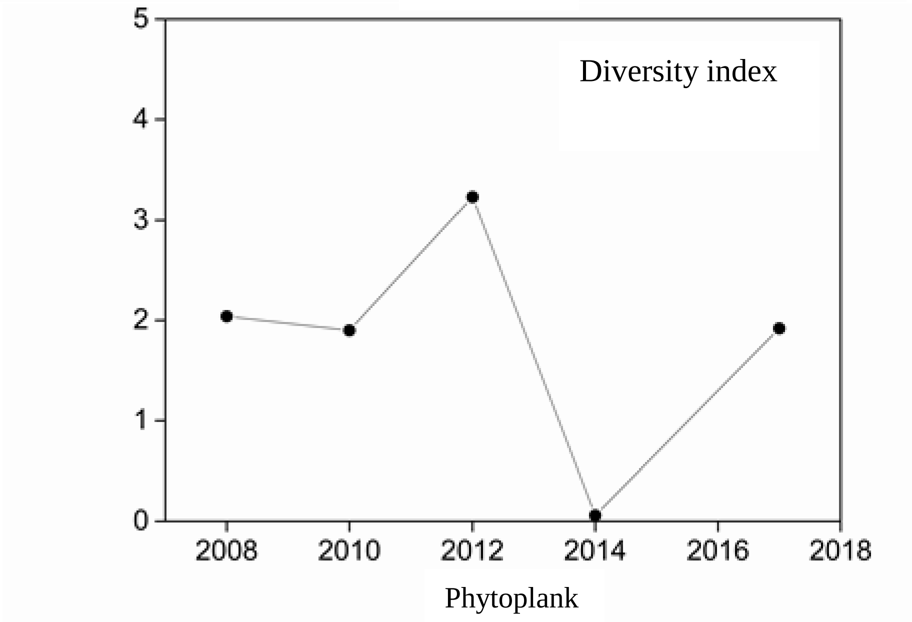


Figure 7.2-3 phytoplankton density and diversity index

(2）Zooplankton

As can be seen from Table 7.2-43 and Figure 7.2-4, the total amount and diversity of zooplankton can be seen. The diversity index declined in 2014 and remained largely stable in other years ; The level of dominance, uniformity and abundance remained stable.

Table 7.2-43 Assessment of zooplankton in the sea areas, 2008, 2010, 2012, 2014 and 2017

Survey Time	Category number	Dominant species	Individual density (s/m3)	Diversit y index	Domin ance	Unifor mity	Abun danc e
Autumn 2008	14	Daphnia minor	251.7	1.56	0.85	0.64	
Autumn 2010	20	Strongylidae	101.9	1.26	0.86	0.48	0.89
Autumn 2012	9	The Strongly Arrowworm, the	61.0	1.07	0.89	0.58	0.56

		Echinocheilus, and the Pacific Daphnia spinosus					
Autumn 2014	10	Strongylus	57.54	0.46	0.97	0.36	0.32
Autumn 2017	23	Strongylus sagittarius and Daphnia dorsalis	35.30	1.89	0.70	0.85	1.08

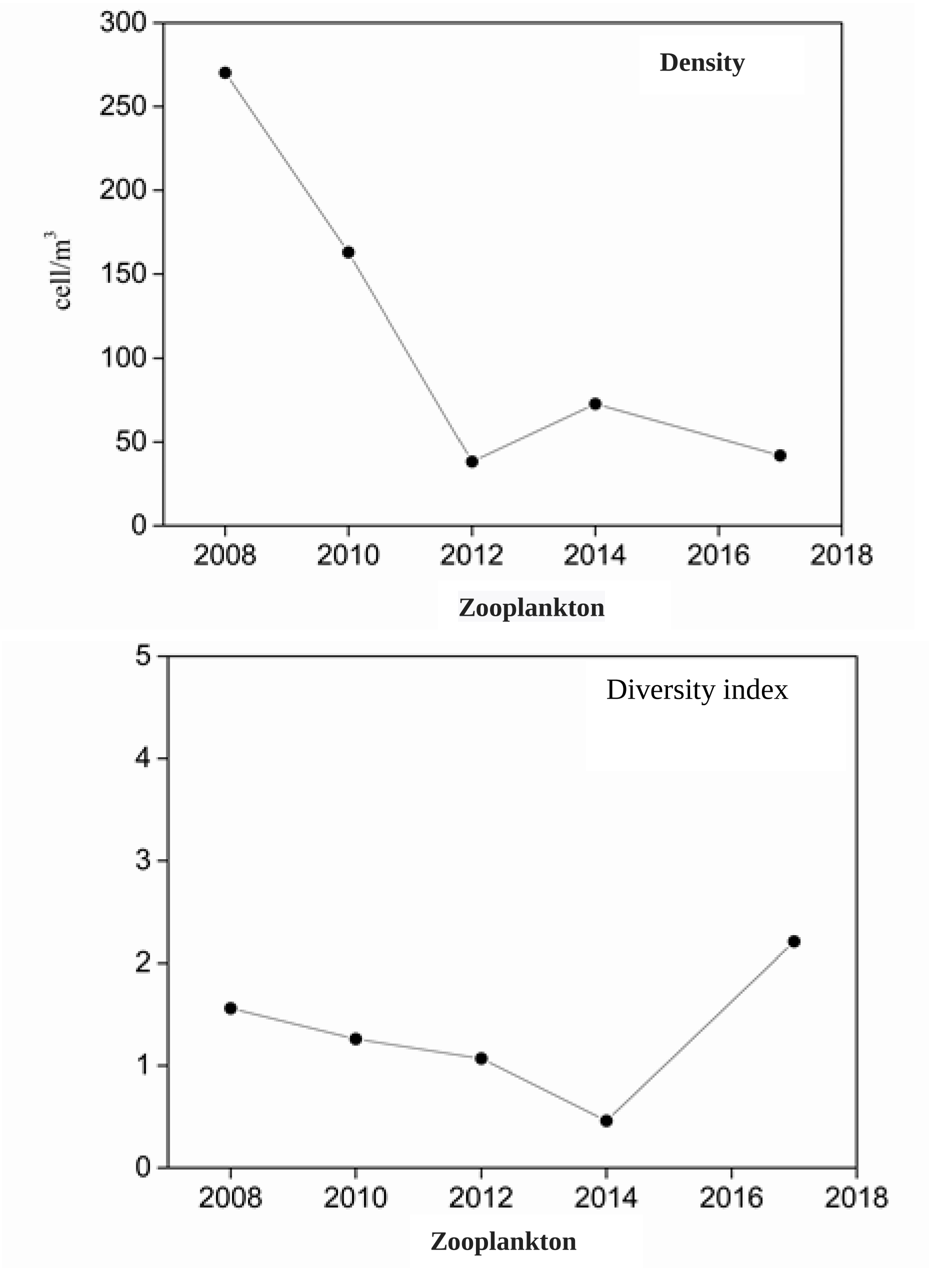


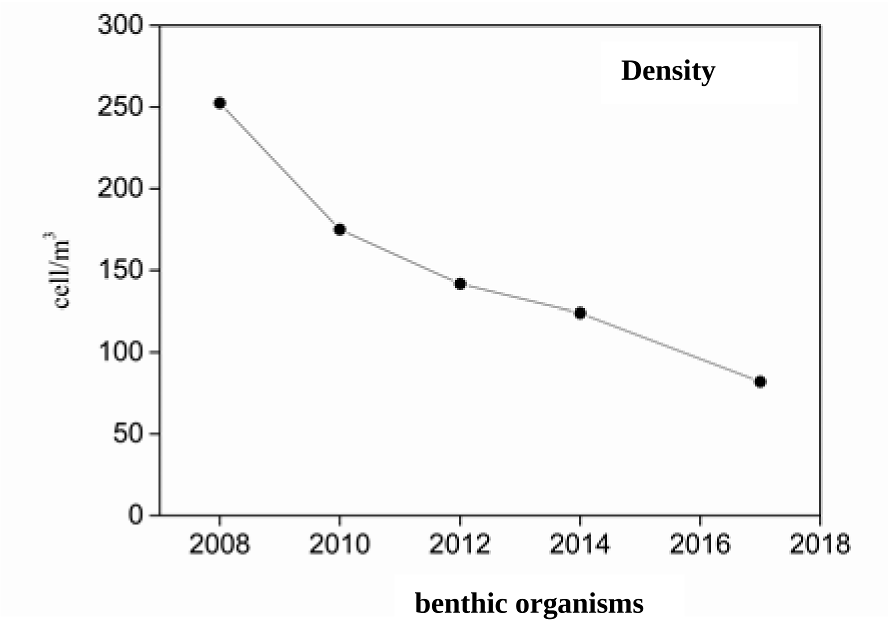
Figure 7.2-4 the density and diversity of zooplankton

(3) Benthos

As can be seen from Table 6.2-44 and Figure 6.2-5, the total amount and diversity of benthos can be seen that the total zooplankton biomass decreased from 2008 to 2017. The indexes such as diversity, dominance, uniformity and abundance remained stable.

Table 7.2-44 Evaluation of phytoplankton in the sea in 2008, 2010, 2012, 2014, 2017 Monitoring data and evaluation index statistics

Survey Time	Category number	Dominant species	Individual density (s/m3)	Diversity index	Dominance	Uniformity
2008 autumn	26	252.5	1.79	0.71	0.84	
2010 autumn	39	175	2.48	0.54	0.85	0.98
2012 autumn	39	141.7	2.39	0.56	0.90	1.65
2014 autumn	63	123.96	2.55	0.53	0.85	1.21
2017 autumn	37	76.5	1.94	0.65	0.93	1.32



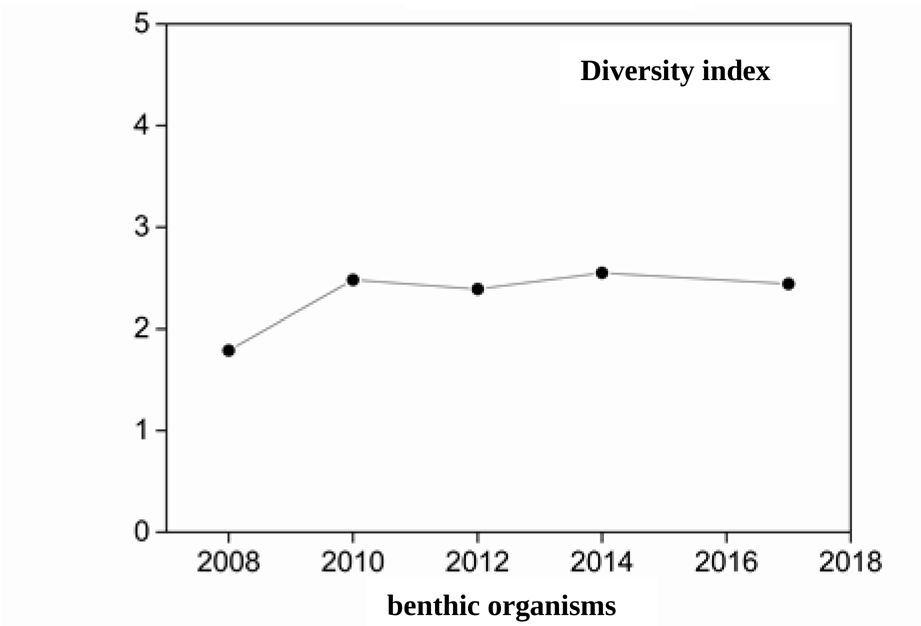


Figure 7.2-5 The density and diversity of benthic organisms

7.2.4.2 Summary

Based on the analysis of marine ecological trends in the coastal waters around the dock area, the density of phytoplankton increased significantly in 2014, then decreased in 2017, the density or biomass of zooplankton and benthos decreased, and the diversity index remained stable.

7.3 Investigation and Evaluation of Atmospheric Environmental Quality

7.3.1 Regional ambient air quality conditions

In accordance with the relevant provisions of the Technical Guidelines for Environmental Impact Assessment-Atmospheric Environment (HJ 2.2-2018), this evaluation uses the monitoring data and conclusions of the 2017 Tianjin Environmental Status Bulletin to determine the environmental air quality standards in the administrative areas of the project.

(1) Ambient air quality conditions

According to the State of Tianjin Environment Bulletin 2017, the environmental air quality of Tianjin city is as follows: the average annual concentration of sulfur dioxide (SO2) is 16 ug/m3, which is lower than the national average concentration standard (60 ug/m3) ; The average annual concentration of nitrogen dioxide (NO2) is 50 μg/m3, 0.25 times higher than the national average concentration standard (40 μg/m3) ; The average annual concentration of inhalable particulate matter (PM10) is 94 ug/m3, 0.34 times higher than the national average concentration standard (70 ug/m3) ; The average annual concentration of fine particles (PM 2.5) is 62 ug/m3, 0.77 times higher than the national average concentration standard (35 ug/m3) ; The average concentration of carbon monoxide (CO) at 24 hours was 2.8 mg/m3, which was below the 24-hour average concentration standard (4 mg/m3) ; The maximum 8-hour mean concentration of ozone (O3) at 90 percent was 192 ug/m3, 0.20 times higher than the maximum 8-hour average concentration (160 ug/m3) per day.

This project passes through the Wuqing District, Binhai New Area, Xiqing District and Jinghai District in Tianjin, and the environmental air quality is shown in the following table.

Table 7.3-1 Air quality monitoring results of various districts in Tianjin involved in this project

District	Contaminant concentration					
	$PM_{2.5}$	PM_{10}	SO_2	NO_2	CO	O_3
Wuqing	61	88	19	48	2.8	202
Binhai New aera	63	92	16	49	2.6	189
Xiqing	63	94	15	51	3.1	166
Jinghai	70	105	16	46	2.6	191
standard value	35	70	60	40	4	160
Compliance	Excess	Excess	Reach	Excess	Reach	Excess
Highest surpassing time	1	0.5	-	0.28	-	0.26

Note: The four pollutants of SO 2, NO 2, PM 10 and PM 2.5 are the mean concentration, CO is the 95 percentiles of average concentration at 24 hours and O3 is the 90 percentiles of average concentration at 8 hours. Except for CO units of mg/m3, other pollutant units are micrograms/m3.

The statistics show that the average annual concentration of fine particles (PM 2.5) is 61-70 μg/m3, and each district exceeds the national average concentration standard (35 μg/m3). The average annual concentration of inhalable particulate matter (PM10) is 88-105 ug/m3, with each region exceeding the national average concentration standard (70 ug/m3) ; The average annual concentration of sulfur dioxide (SO2) is 15-19 ug/m3, with each region falling below the national average (60 ug/m3) ; The average annual concentration of nitrogen dioxide (NO2) is 46-51 μg/m3, with each region exceeding the national average concentration standard (40 μg/m3) ; The average concentration of carbon monoxide (CO) at 24 hours was 2.6-3.1 mg/m3 in the 95 percentiles and was below the 24-hour average concentration standard in all regions (4 mg/m3) ; The maximum 8-hour average concentration of ozone (O3) was 166-202 ug/m3 at 90 percentiles, and each region exceeded the daily maximum 8-hour average concentration standard (160 ug/m3) by 0.20 times.

(2) Assessment of the project area's attainment

In accordance with the relevant provisions of the Technical Guidelines for Environmental Impact Assessment-Atmospheric Environment (HJ 2.2-2018) 6.4.1.2 , " All six pollutants for the assessment indicators of urban environmental air quality compliance are those that meet the urban environmental air quality standards . " In the districts and counties where this project passes, except the corresponding concentration of sulfur dioxide (SO2) and carbon monoxide (CO) meets the requirements of Grade II Standard of " Environmental Air Quality Standard " (GB 3095-2012), the other basic factors are above the standard, so the ambient air quality of Tianjin in 2017 is not up to standard.

7.3.2 Monitoring and evaluation of atmospheric environment near receiving station

The investigation of the atmospheric environment near the Receiving terminal is the field survey data of Hebei Pu'an Testing Technology Ltd. from September 12 to September 18, 2018 in and around the port area. The monitoring location, monitoring items and frequency are shown in Table 7.3-2. The single factor index method is used for the evaluation . The monitoring points are located in the second functional area of environmental air quality . The results of monitoring and evaluation are shown in Table 7.3-3.

The results showed that the monitoring concentrations of non-methane total hydrocarbons, VOCs, O3, SO2, NO2 and PM10 in the monitoring position of the port and adjacent areas were lower than the secondary standard limits of " ambient air quality " (3095-2012). The particle and PM 2.5 are all over the standard. Among them, the overproof rate of the primary value of particles near the project site was 39. 28% , 46. 43% , 50. 00% , 35. 71% , 46. 43% and 46. 43% , and the overproof times were 0.10 , 0.11 , 0.12 , 0.14 , 0.14 and 0.15 respectively. The average overproof rate of PM 2.5 was 42. 86% , 42. 86% , 42. 86% , 42. 86% , 28. 75% and 42. 86% , and the overproof times were 0.31 , 0.36 , 0.33 , 0.32 , 0.36 and 0.32 , respectively.

Table 7.3-2 Monitoring location, monitoring items and monitoring frequency

Monitoring position	Monitoring project	Monitoring frequency
Mapengkou Village, Antai Small Area, Oil Production Small Area, Unity Lane, Nangang Administrative Committee, Near Project Location	Non-methane total hydrocarbons, VOCs, particulate matter, O3, SO 2 , NO 2	Monitoring 7 days, 4 times a day
Mapengkou Village, Antai Small Area, Oil Production Small Area, Unity Lane, Nangang Administrative Committee, Near Project Location	PM 2.5 , PM 10	Monitoring for 7 days, 1 monitoring per day

Table 7.3-3 Monitoring and evaluation results of atmospheric environmental quality

Point position	Categories		Non-methane total hydrocarbon	VOCS	Particulate matter	SO 2	NO 2	O 3	PM 2.5	PM 10
Shi Men Kou Cun	Primary value	Checkout range	From 0.79 to 1.08	From 0.009 to 0.049	From 0.17 to 0.22	From 0.008 to 0.024	From 0.012 to 0.071	From 0.012 to 0.189	/	/
		Maximum value	1.08	0.049	0.22	0.024	0.071	0.189	/	/
		Standard limit	2	2	0.2	0.5	0.2	0.2	/	/
		Overproof %	0	0	39.28	0	0	0	/	/
		Overproof multiple	0	0	0.10	0	0	0	/	/
	Average daily value	Checkout range	/	/	/	/	/	/	From 0.026 to 0.098	From 0.09 to 0.129
		Maximum value	/	/	/	/	/	/	0.098	0.129
		Standard limit	/	/	/	/	/	/	0.075	0.15
		Overproof %	/	/	/	/	/	/	42.86	0
		Overproof multiple	/	/	/	/	/	/	0.31	0
Antai District	Primary value	Checkout range	From 0.73 to 1.08	From 0.008 to 0.037	From 0.173 to 0.223	From 0.008 to 0.023	From 0.010 to 0.072	From 0.012 to 0.188	/	/
		Maximum value	1.08	0.037	0.223	0.023	0.072	0.188	/	/
		Standard limit	2	2	0.2	0.5	0.2	0.2	/	/
		Overproof %	0	0	46.43	0	0	0	/	/
		Overproof multiple	0	0	0.11	0	0	0	/	/
	Average daily value	Checkout range	/	/	/	/	/	/	From 0.024 to 0.102	From 0.092 to 0.127

		Maximum value	/	/	/	/	/	/	0.102	0.127
		Standard limit	/	/	/	/	/	/	0.075	0.15
		Overproof %	/	/	/	/	/	/	42.86	0
		Overproof multiple	/	/	/	/	/	/	0.36	0
Oil production district	Primary value	Checkout range	From 0.70 to 1.09	From 0.009 to 0.046	From 0.170 to 0.225	From 0.008 to 0.022	From 0.011 to 0.072	From 0.012 to 0.185	/	/
		Maximum value	1.09	0.046	0.225	0.022	0.072	0.185	/	/
		Standard limit	2	2	0.2	0.5	0.2	0.2	/	/
		Overproof %	0	0	50	0	0	0	/	/
		Overproof multiple	0	0	0.12	0	0	0	/	/
	Average daily value	Checkout range	/	/	/	/	/	/	From 0.025 to 0.100	From 0.088 to 0.125
		Maximum value	/	/	/	/	/	/	0.100	0.125
		Standard limit	/	/	/	/	/	/	0.075	0.15
		Overproof %	/	/	/	/	/	/	42.86	0
		Overproof multiple	/	/	/	/	/	/	0.33	0
Unite	Primary value	Checkout range	From 0.76 to 1.14	From 0.005 to 0.046	From 0.172 to 0.227	From 0.080 to 0.022	From 0.009 to 0.071	From 0.012 to 0.192	/	/
		Maximum value	1.14	0.046	0.227	0.022	0.071	0.192	/	/
		Standard limit	2	2	0.2	0.5	0.2	0.2	/	/
		Overproof %	0	0	35.71	0	0	0	/	/
		Overproof multiple	0	0	0.14	0	0	0	/	/
	Average daily value	Checkout range	/	/	/	/	/	/	From 0.026 to 0.099	From 0.095 to 0.123
		Maximum value	/	/	/	/	/	/	0.099	0.123
		Standard limit	/	/	/	/	/	/	0.075	0.15
		Overproof %	/	/	/	/	/	/	42.86	0

		Overproof multiple	/	/	/	/	/	/	0.32	0
South Harbour Administrative Committee	Primary value	Checkout range	From 0.76 to 1.13	From 0.008 to 0.043	From 0.170 to 0.227	From 0.008 to 0.023	From 0.011 to 0.073	From 0.013 to 0.181	/	/
		Maximum value	1.13	0.043	0.227	0.023	0.073	0.181	/	/
		Standard limit	2	2	0.2	0.5	0.2	0.2	/	/
		Overproof %	0	0	46.43	0	0	0	/	/
		Overproof multiple	0	0	0.14	0	0	0	/	/
	Average daily value	Checkout range	/	/	/	/	/	/	From 0.027 to 0.102	From 0.09 to 0.125
		Maximum value	/	/	/	/	/	/	0.102	0.125
		Standard limit	/	/	/	/	/	/	0.075	0.15
		Overproof %	/	/	/	/	/	/	28.75	0
		Overproof multiple	/	/	/	/	/	/	0.36	0
Near engineering location	Primary value	Checkout range	From 0.77 to 1.09	From 0.007 to 0.042	From 0.175 to 0.230	From 0.008 to 0.021	From 0.011 to 0.073	From 0.012 to 0.184	/	/
		Maximum value	1.09	0.042	0.230	0.021	0.073	0.184	/	/
		Standard limit	2	2	0.2	0.5	0.2	0.2	/	/
		Overproof %	0	0	46.43	0	0	0	/	/
		Overproof multiple	0	0	0.15	0	0	0	/	/
	Average daily value	Checkout range	/	/	/	/	/	/	From 0.024 to 0.099	From 0.089 to 0.124
		Maximum value	/	/	/	/	/	/	0.099	0.124
		Standard limit	/	/	/	/	/	/	0.075	0.15
		Overproof %	/	/	/	/	/	/	42.86	0
		Overproof multiple	/	/	/	/	/	/	0.32	0

7.4 Monitoring and evaluation of acoustic environment

Four monitoring stations are set up according to the monitoring of the current LNG operation area from 16 March to 18 March 2018. From the monitoring results, it can be seen that the ambient noise in the present area is 50.6-56.1 dB in daylight and 48.4-52.4 dB (A) in night, and the noise in the acoustic environment area can meet the three standard limit requirements in the Standard for Environmental Noise Emission from Industrial Enterprises (GB 12348-2008).

Table 7.4-1 Noise monitoring data statistics [unit: dB(A)]

Monitoring date	Survey Sation.No	Day time	Night
2018.03.16	1	52.6-53.3	48.4
	2	50.8-54	50.1
	3	54.6-55.1	52.2
	4	52.9-53.7	51.2
2018.03.17	1	51.2-52.1	48.8-49.3
	2	53.4-54.2	50.3-50.5
	3	55.6-56.1	51.9-52.4
	4	50.6-53.3	50.3-51.7
2018.03.18	1	-	48.4
	2	-	51.3
	3	-	53.1
	4	-	50.3
Standard limit		65	55
Whether it meets the standard		Yes	Yes

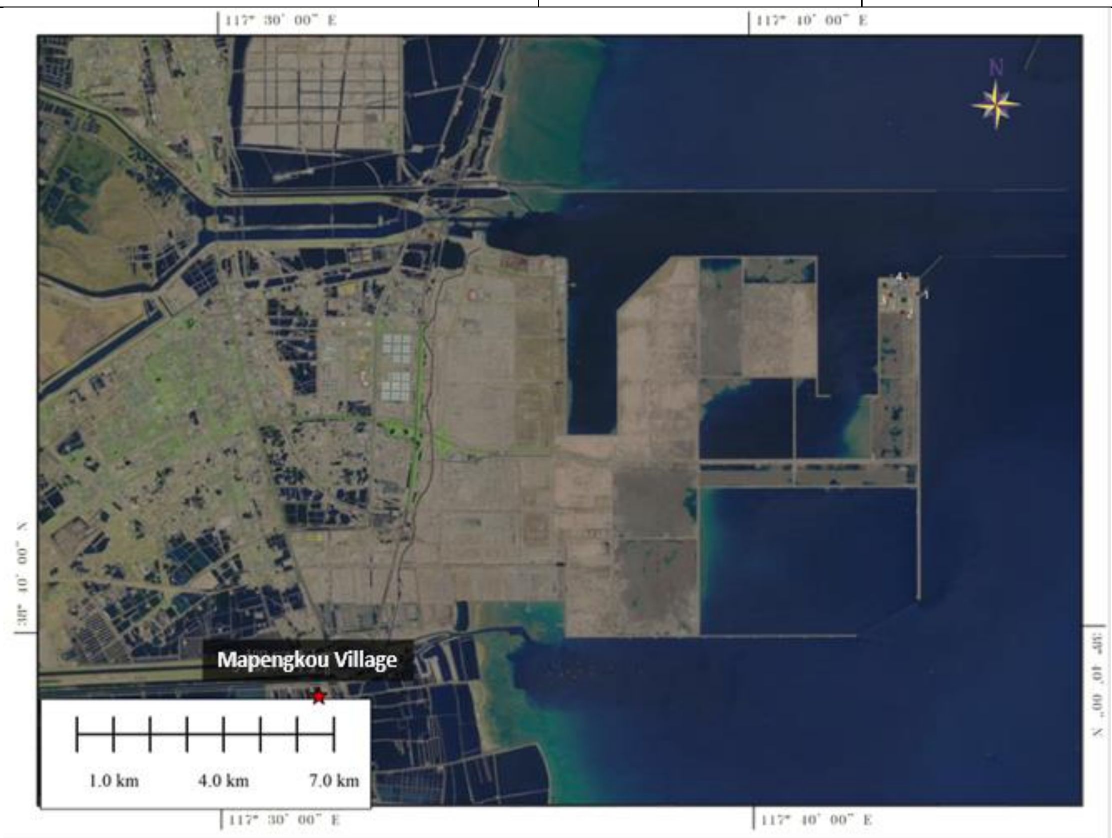


Figure 7.4-1 Layout of Noise Monitoring Station

7.5 Monitoring of groundwater environmental quality at the receiving station

The relevant data in the “Preliminary Report on Water and Soil Site Environmental Assessment of Beijing Gas Tianjin Nangang LNG Emergency Reserve Project” written by Tianjin Prospecting Institute in October 2018 was adopted, and the adopt time was in September 2018.

7.5.1 Monitoring locations and items

The elevation system of this test uses hypothetical elevation, and we assume that the elevation point is measured from the west side of the site, J1 (coordinate X = 257884, Y = 144295), assuming an elevation of 10.000 m; the coordinate system uses the 1990 Tianjin arbitrary rectangular coordinate system. The coordinates and elevation are both measured using GNSS (i80 mobile station).

Table 7.5-1 Information of locations of groundwater sampling

<table>
<tr><th>No.</th><th>X coordination (m)</th><th>Y coordination (m)</th><th>Depth of monitoring well (m)</th><th>Test items</th></tr>
<tr><td>TQ1</td><td>257792</td><td>144675</td><td>6.0</td><td rowspan="3">pH, total petroleum hydrocarbons, heavy metals, VOC, SVOC</td></tr>
<tr><td>TQ3</td><td>257275</td><td>144891</td><td>7.0</td></tr>
<tr><td>TQ5</td><td>256604</td><td>144970</td><td>7.0</td></tr>
</table>

Figure 7.5-1 The location of soil and groundwater sampling

7.5.2 The test items and analysis method of groundwater

The items considered in laboratory tests for groundwater samples are pH, total petroleum hydrocarbons (C10~C40), heavy metals (7 items), VOC (27 items), SVOC (11 items in total). The methods for test and analysis and detection limits of methods (the lowest value of a test item needs to achieve to exceed its required standard) are shown in Table 6.7-7.

Table 7.5-2 Table 6.7-7 Methods of water quality test and analysis and detection limits of methods

Name of pollutants	Methods	unit	Detection limit
Heavy metals			
As	HJ700-2014	μg/L	50
Ge	HJ700-2014	μg/L	1
Cu	HJ700-2014	μg/L	10
Pb	HJ700-2014	μg/L	10
Ni	HJ700-2014	μg/L	10
Total Hg	HJ 694-2014	μg/L	0.1
Cr^{6+}	GB/T 7467-1987	mg/L	0.004
Volatile organic compounds		-	-
CCl_4	HJ639-2012	μg/L	0.5
$CHCl_3$	HJ639-2012	μg/L	0.5

Name of pollutants	Methods	unit	Detection limit
CH_3Cl	HJ639-2012	μg/L	0.5
1,1-$C_2H_4Cl_2$	HJ639-2012	μg/L	0.5
1,2- $C_2H_4Cl_2$	HJ639-2012	μg/L	0.5
1,1- $C_2H_2Cl_2$	HJ639-2012	μg/L	0.5
cis-1,2- $C_2H_2Cl_2$	HJ639-2012	μg/L	0.5
trans-1,2- $C_2H_2Cl_2$	HJ639-2012	μg/L	0.5
CH_2Cl_2	HJ639-2012	μg/L	5
1,2-$C_3H_6Cl_2$	HJ639-2012	μg/L	0.5
1,1,1,2-$C_2H_2Cl_4$	HJ639-2012	μg/L	0.5
1,1,2,2- $C_2H_2Cl_4$	HJ639-2012	μg/L	0.5
C_2Cl_4	HJ639-2012	μg/L	0.5
1,1,1- $C_2H_3Cl_3$	HJ639-2012	μg/L	0.5
1,1,2- $C_2H_3Cl_3$	HJ639-2012	μg/L	0.5
C_2HCl_3	HJ639-2012	μg/L	0.5
1,2,3- $C_3H_5Cl_3$	HJ639-2012	μg/L	0.5
C_2H_3Cl	HJ639-2012	μg/L	0.5
C_6H_6	HJ639-2012	μg/L	0.5
1,2- $C_6H_4Cl_2$	HJ639-2012	μg/L	0.5
1,4- $C_6H_4Cl_2$	HJ639-2012	μg/L	0.5
C_8H_{10} (Xylene)	HJ639-2012	μg/L	0.5
C_8H_8	HJ639-2012	μg/L	0.5
C_7H_8	HJ639-2012	μg/L	0.5
C_8H_{10} (m/para-Xylene)	HJ639-2012	μg/L	0.5
C_8H_{10} (ortho-xylene)	HJ639-2012	μg/L	0.5
$C_{10}H_8$	HJ639-2012	μg/L	0.5
semi-volatile organic compounds		-	-
$C_6H_5NO_2$	USEPA 8270E-2017	μg/L	0.5
2- ClC_6H_4OH	USEPA 8270E-2017	μg/L	0.5
$C_{18}H_{12}$ (a)	USEPA 8270E-2017	μg/L	0.2
$C_{20}H_{12}$ (a)	USEPA 8270E-2017	μg/L	0.05
$C_{20}H_{12}$ (b)	USEPA 8270E-2017	μg/L	0.05
$C_{20}H_{12}$ (k)	USEPA 8270E-2017	μg/L	0.05
$C_{18}H_{12}$	USEPA 8270E-2017	μg/L	0.2
$C_{22}H_{14}$ (a,h)	USEPA 8270E-2017	μg/L	0.2
$C_{22}H_{12}$ (1,2,3-cd)	USEPA 8270E-2017	μg/L	0.05
C_6H_7N	USEPA 8270E-2017	μg/L	2.5
Total petroleum hydrocarbon		-	-
TPH>C_{10}-C_{40}	USEPA 8015C-2007	μg/L	400

7.5.3 Analysis to the groundwater monitoring data

The statistical analysis results of the groundwater sample by laboratory test are shown in Table 6.7-8. Among the three groundwater samples, the concentration of heavy metals such as Cr6+, As, Ni, Hg and Ge were lower than their detection limits. The detecting rate of Cu was 100%, and that of Pb was 33.3%. The concentration of organic matter (27 items) and semi-volatile organic compounds (11 items) were lower than detection limits of each methods; that of total petroleum hydrocarbons (C10~C40) were lower than the method detection limit. All test pollutants in groundwater samples did not exceed the IV type standard limits which required in <Groundwater Quality Standard> (GB/T 14848-2017).

Table 7.5-3 The laboratory test results of the groundwater samples

Pollutants	No. of samples	No. of samples exceed threshold values	rate	IV type standard value (mg/L)	Ultra-screening sample number	Exceed rate	Exceed times	Max (mg/L)	Min (mg/L)	Mean (mg/L)	Sample standard deviation
Cu	3	3	100.0	1.5	0	0.0%	/	0.026	0.020	0.0227	0.0031
Pb	3	1	33.3	0.1	0	0.0%	/	0.045	0.045	0.045	/

8 Prediction and assessment of environment impacts during construction

8.1 Prediction and assessment of marine environment impacts

8.1.1 Prediction and analysis of hydrodynamics

8.1.1.1 Introduction of the hydrodynamic numerical model

The computation of tidal currents is performed using flow model (FM) with unstructured grids based on the software of MIKE series. The software is developed by Danish Hydraulic Institute (DHI)，can be used for 2D/3D hydrodynamic computation in ocean, sea and estuary. The unstructured grids of the FM module are quite powerful in dealing with boundaries of tide and complex hydraulic structure, and are widely applied in engineering and research projects around the world.

The FM is the core module of this software, and the flow governing equation is 2D shallow water equation as below:

$$\frac{\partial h}{\partial t}+\frac{\partial h\bar{u}}{\partial x}+\frac{\partial h\bar{v}}{\partial y}=hS \tag{1}$$

$$\frac{\partial h\bar{u}}{\partial t}+\frac{\partial h\bar{u}^2}{\partial x}+\frac{\partial h\bar{v}\bar{u}}{\partial y}= f\bar{v}h-gh\frac{\partial \eta}{\partial x}-\frac{gh^2}{2\rho_0}\frac{\partial \rho}{\partial x}+\frac{\tau_{sx}}{\rho_0}-\frac{\tau_{bx}}{\rho_0}+\frac{\partial}{\partial x}\left(hT_{xx}\right)+\frac{\partial}{\partial y}\left(hT_{xy}\right)+hu_sS \tag{2}$$

$$\frac{\partial h\bar{v}}{\partial t}+\frac{\partial h\bar{v}\bar{u}}{\partial x}+\frac{\partial h\bar{v}^2}{\partial y}= -f\bar{u}h-gh\frac{\partial \eta}{\partial y}-\frac{gh^2}{2\rho_0}\frac{\partial \rho}{\partial y}+\frac{\tau_{sy}}{\rho_0}-\frac{\tau_{by}}{\rho_0}+\frac{\partial}{\partial x}\left(hT_{xy}\right)+\frac{\partial}{\partial y}\left(hT_{yy}\right)+hv_sS \tag{3}$$

where $h=\eta+d$， η and d are elevation of water surface and still water depth respectively, x and y denote coordinates along horizontal and vertical axes respectively, t is time, g is gravity acceleration, $\bar{u}$ and $\bar{v}$ are depth-averaged velocity in x- and y-direction respectively, f is Coriolis coefficient, ρ is fluid density, ρ_0 is reference density, S is source discharge, u_s and v_s are velocities of the source discharge, T_{ij} represents stress terms，including viscous stress, turbulent stress, advection and etc., which are calculated based on gradient of the depth-averaged velocity.

The bottom shear stress $\overrightarrow{\tau_b}=\left(\tau_{bx},\tau_{by}\right)$ is calculated by the equation below,

$$\frac{\overrightarrow{\tau_b}}{\rho_0}=c_f\overrightarrow{u_b}\left|\overrightarrow{u_b}\right| \tag{4}$$

in which, c_f is drag coefficient, $\overrightarrow{u_b} = (u_b, v_b)$ is depth-averaged velocity. The drag coefficient can be calculated by Chezy coefficient C or Manning coefficient M.

$$c_f = \frac{g}{C^2} \tag{5}$$

$$c_f = \frac{g}{\left(Mh^{1/6}\right)^2} \tag{6}$$

Manning coefficient can be calculated by bottom roughness.

The wind stress $\overrightarrow{\tau_s} = (\tau_{sx}, \tau_{sy})$ is computed as

$$\tau_s = \rho_a c_d |u_w| \overrightarrow{u_w} \tag{7}$$

where ρ_a is air density， c_d is air drag coefficient, $\overrightarrow{u_w} = (u_w, v_w)$ is wind speed at 10m above the sea surface.

The governing equation is solved by discretization using finite volume method based on the unstructured grids; the time integral is carried out with explicit Euler scheme; and tidal flats are considered with the dry/wet grid method.

8.1.1.2 Model domain and mesh

In order to avoid numerical error rising from the model boundary, the model domain has to be sufficiently large。In this study, there are two models which are nested for hydrodynamic computation. The large model covers the whole Bohai Sea, and provides boundary conditions to the small model which only covers the Bohai Bay. The computational domains of the two models are shown in Figure 8.1-1. The open boundary of the large model is driven by tides, and the tidal information is obtained from ChinaTide， which predicts the tidal elevation by superposition of harmonic constants from 8 tidal components.

In the model domains, the unstructured meshes can closely fit the complex coastline and structure boundary， and be easily refined in any local area for the port structure and navigation channel. The computational meshes and bathymetries of the two models are given in Figure 8.1-2 and Figure 8.1-3 respectively. The large mother model has 54189 computational nodes, and its time step is adapt automatically between 0.0s and 5.0s. The small local model has 53069 computational nodes with spatial resolution between 2m and 5000m, and its time step is adapt automatically between 0.01s and 0.5s.

The horizontal eddy viscosity coefficient in the local model is computed by the Smagorinsky sub-grid scale model, and the formation of various vortices can be well represented. The eddy viscosity coefficient is calculated as

$$A = c_s^2 l^2 \sqrt{2S_{ij}S_{ij}} \tag{8}$$

where the constant c_s is set equal to 0.28， the upper and lower limits of the eddy viscosity coefficient are set at 1.0e+10m^2/s and 1.8e-006m^2/s respectively, S_{ij} is deformation rate, and correlated with velocity gradient as below

$$S_{ij} = \frac{1}{2}\left(\frac{\partial u_i}{\partial x_j} + \frac{\partial u_j}{\partial x_i}\right), (i, j = 1, 2) \tag{9}$$

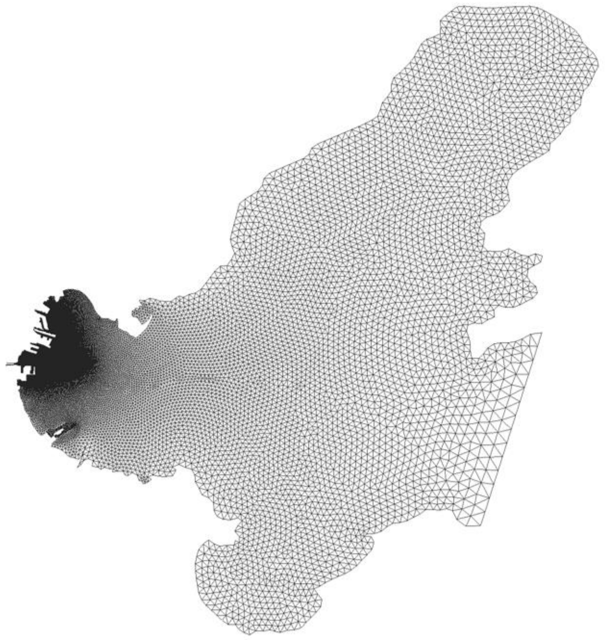
The bottom friction in the local model is calculated using the Chezy coefficient which is set equal to $45m^{1/3}/s$. The Coriolis force is taken into account in both the mother and local models.

Since high piled beam-slab and high-pile pier structure are applied in this project, the effects of pile piers on the hydrodynamics cannot be neglected. In the hydrodynamic model, such effects are considered by simulation of the flow-induced drag on each pile pier. The effective drag can be computed by:

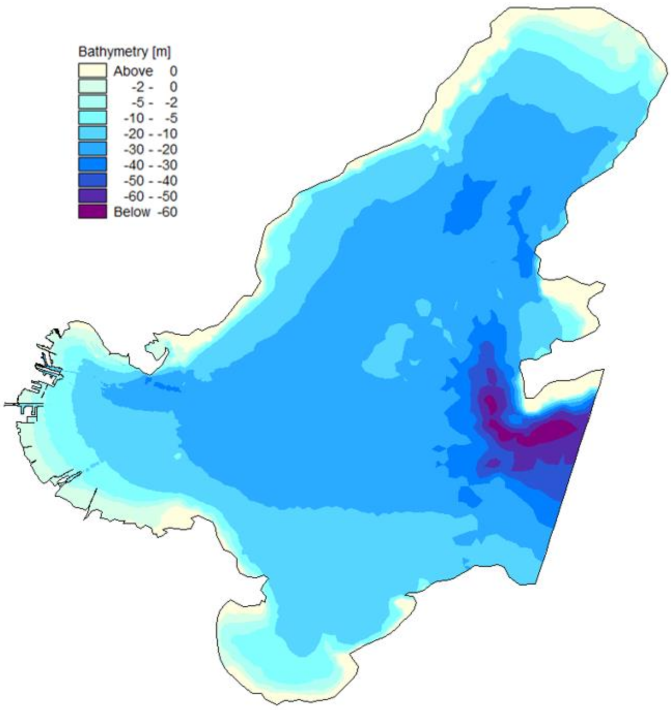
$$F = \frac{1}{2}\rho_w \gamma C_D A_e V^2 \quad (10)$$

in which ρ_w is seawater density; γ is streamlined coefficient which is set equal to 1.02, C_D is drag coefficient, A_e is effective wet cross sectional area, V is value of velocity.

Figure 8.1-1 Computational domains of large and small models

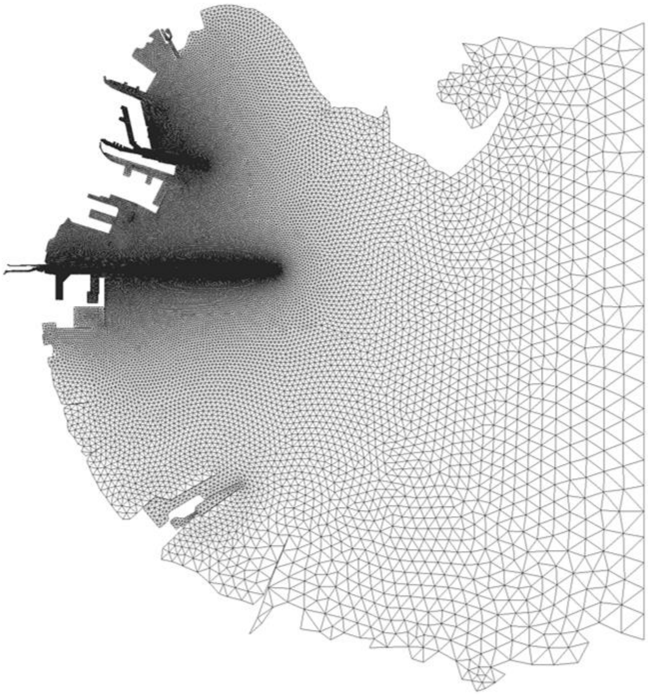


Model mesh

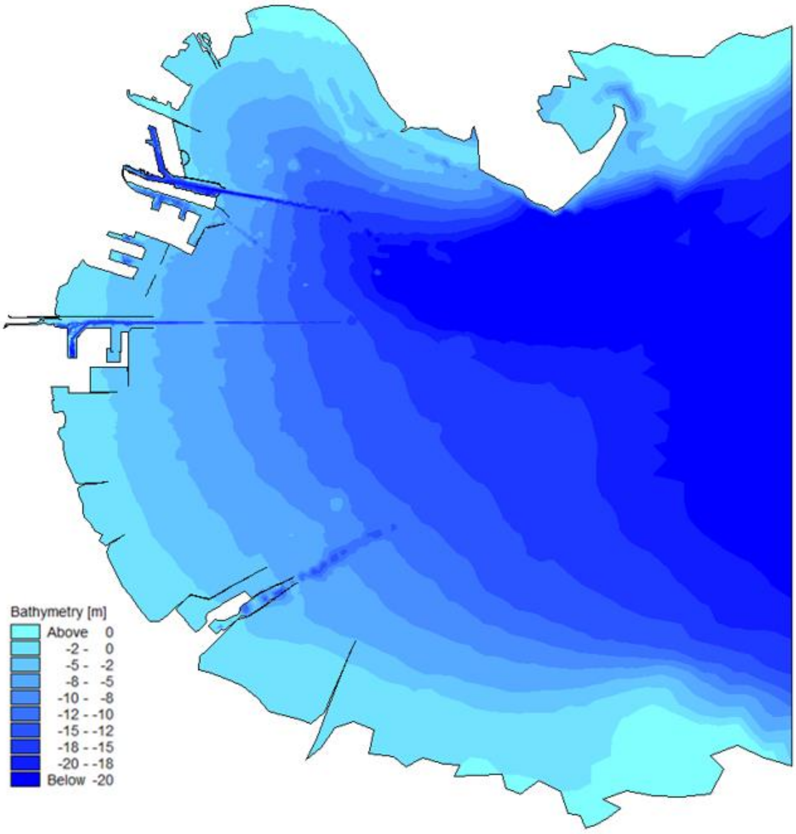


Model bathymetry

Figure 8.1-2 Computational domain and bathymetry of the large model



Model mesh



Model bathymetry

Figure 8.1-3 Computational domain and bathymetry of the small model

8.1.1.3 Hydrodynamic validation

(1) Validation of tidal level

The tidal level is sampled at Nanbao station (W1), Dagang station (W2) and a temporary station in the Dakou Estuary (W3).

The model is validated against the measured tidal level. A good agreement could be observed between the modelled and measured ones. The variation of the tidal level is well captured by the model.

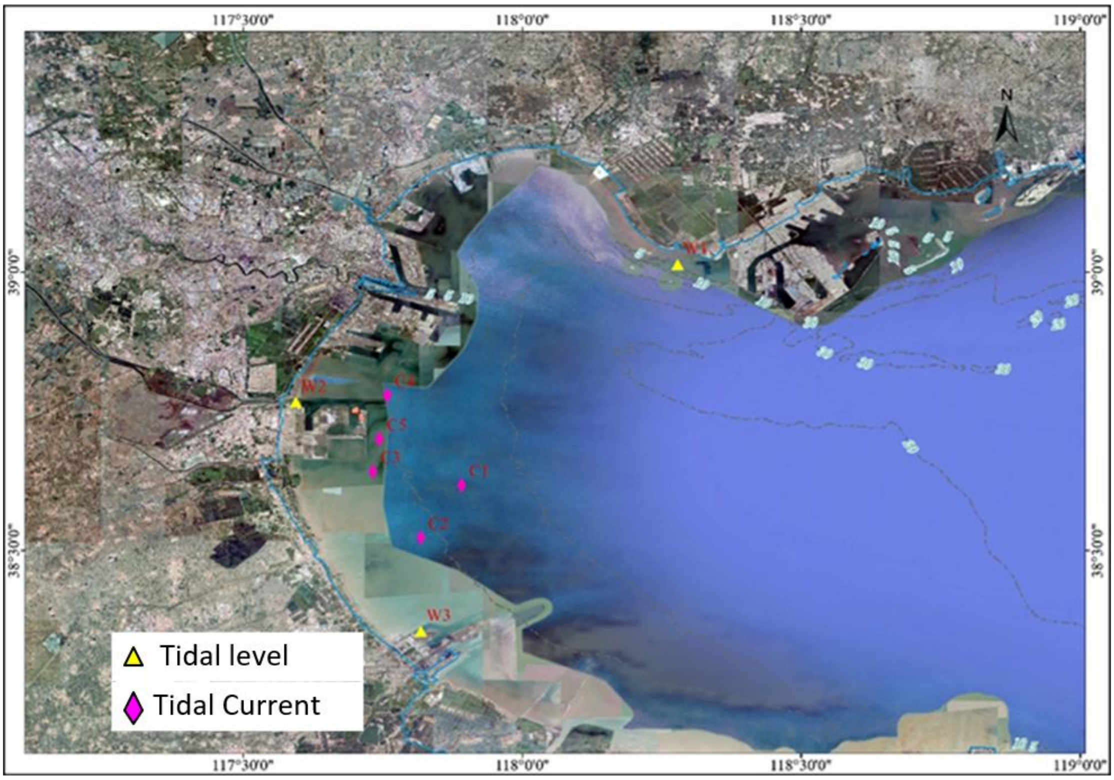


Figure 8.1-4 Location of measurement stations

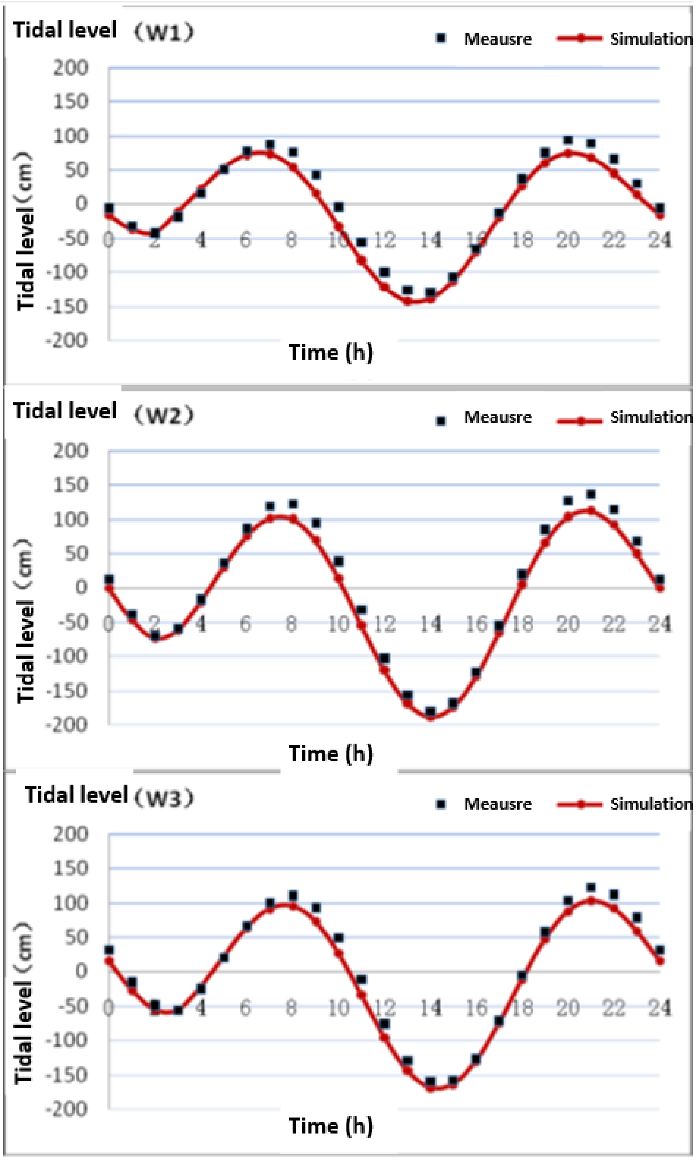


Figure 8.1-5 Modelled and measured tidal level

(2）Validation of tidal current

The model is validated against tidal current measured at 5 stations around the project site during a spring tide in January of 2018. The location of the 5 measurement stations is shown in Figure 8.1-4, and the comparison of tidal current between measurement and model is displayed in Figure 8.1-6.

The comparison shows that the tidal current velocity and direction are both reproduced well by the model.

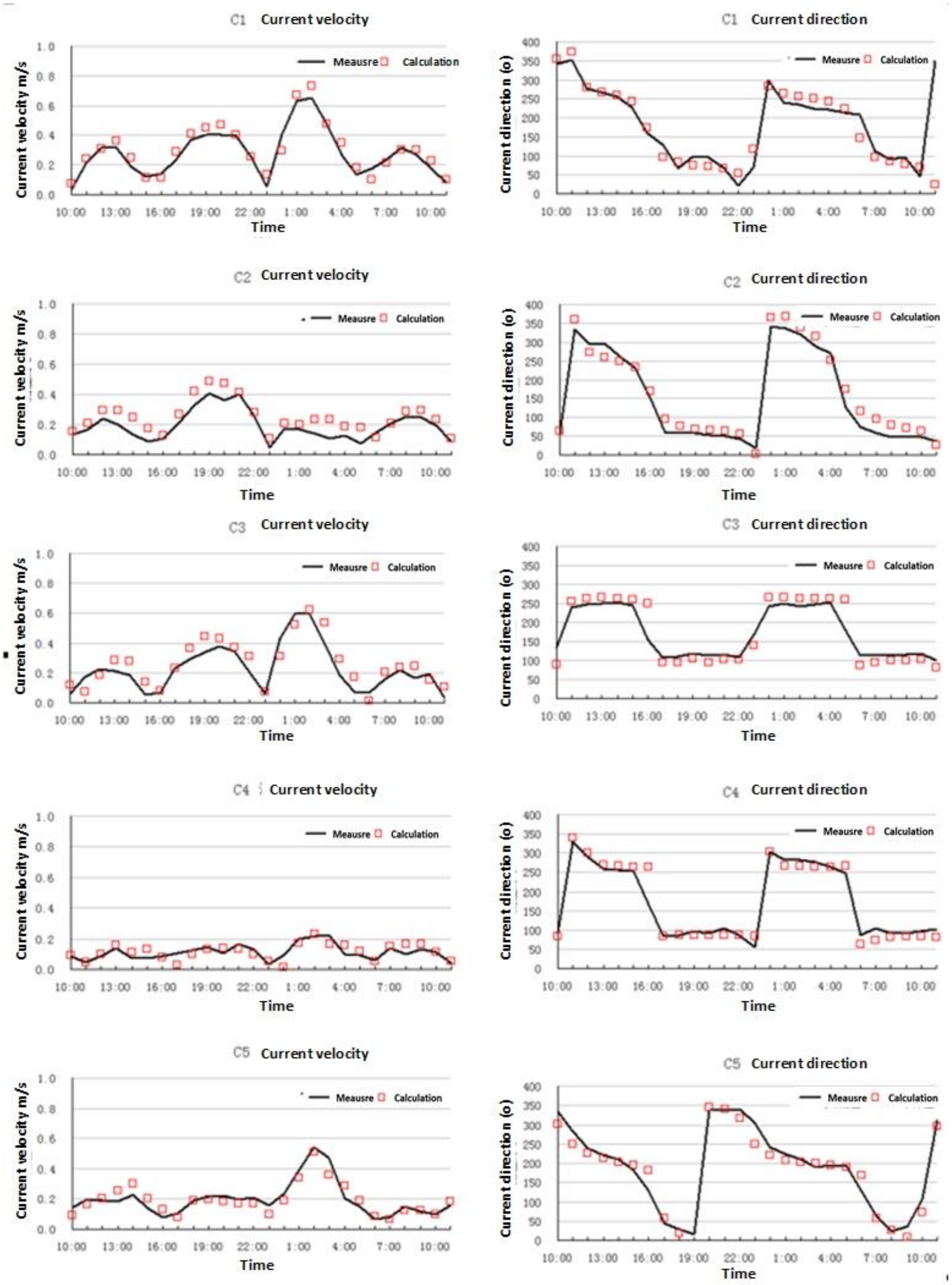


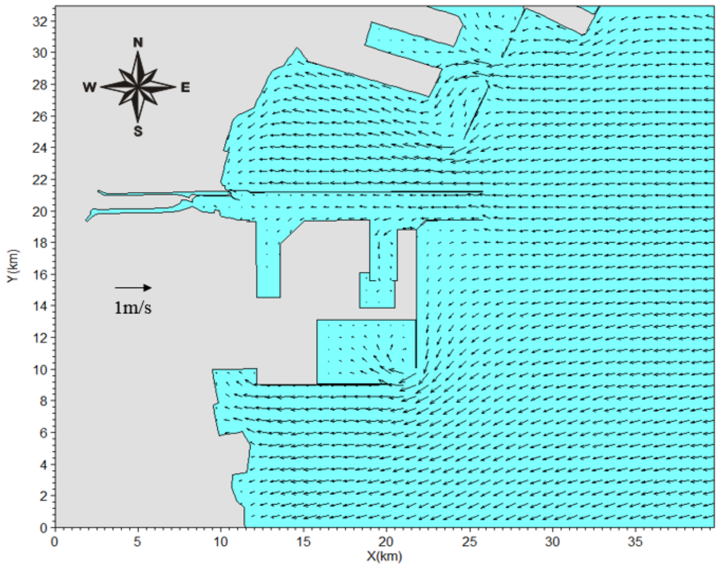
Figure 8.1-6 Analysis of modelled tidal currents

Figure 8.1-7 and Figure 8.1-8 display the flow fields in the large domain at the peak flood and ebb before and after this project is constructed. Figure 8.1-9 and Figure 8.1-10 show the local flow fields in the area of interest at the peak flood and ebb before and after this project is constructed. It could be observed that from the comparison with the flow fields before the project is constructed, the flow fields at the peak flood and ebb are not affected in the area of interest after the project is constructed, because the change of hydrodynamics is mainly caused by the change of bathymetry due to the dredge during the construction, and the land boundary is not affected.

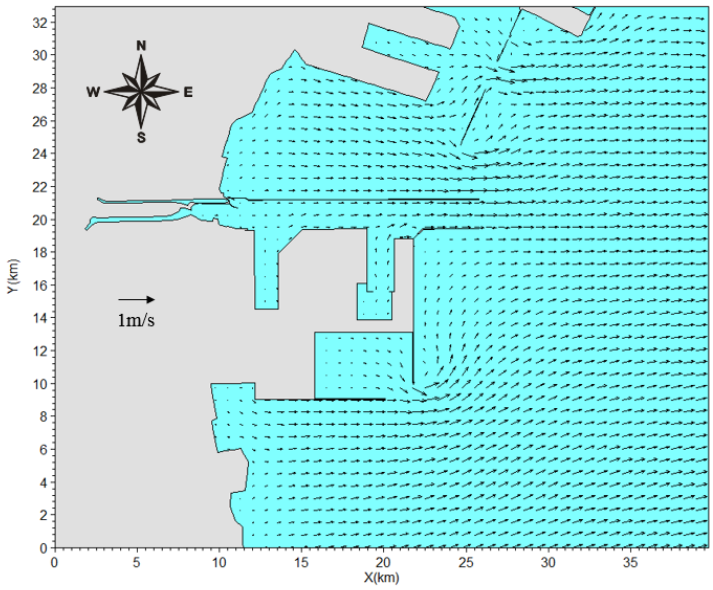
Figure 8.1-11 and Figure 8.1-12 give the contour maps of current velocity before and after the project is constructed. It could be found that the current velocity only changes within the dredging area of the harbor, and does not change in the other areas.

Figure 8.1-13 shows the influence range of the project for the current velocity. The red zone (>0) indicates that the velocity is increased, while the blue zone (<0) indicates that the velocity is decreased. It has been shown that the flow field is not changed for the large domain, and only changed a little within the local area of the project. The impact weakens gradually with the distance away from the project. The statistical analysis shows the maximum increase of the velocity is 0.07m/s and the maximum decrease of that is After the project is constructed, 0.16m/s after the project is constructed.

The analysis for the change of flow pattern and velocity due to construction of this project, suggests that the flow velocity is relatively low in the eastern harbor of the Nangang Industrial Zone. The dredging and deepening have relatively small and local impacts on flow pattern and velocity, and does not influence the ambient hydrodynamics strongly.

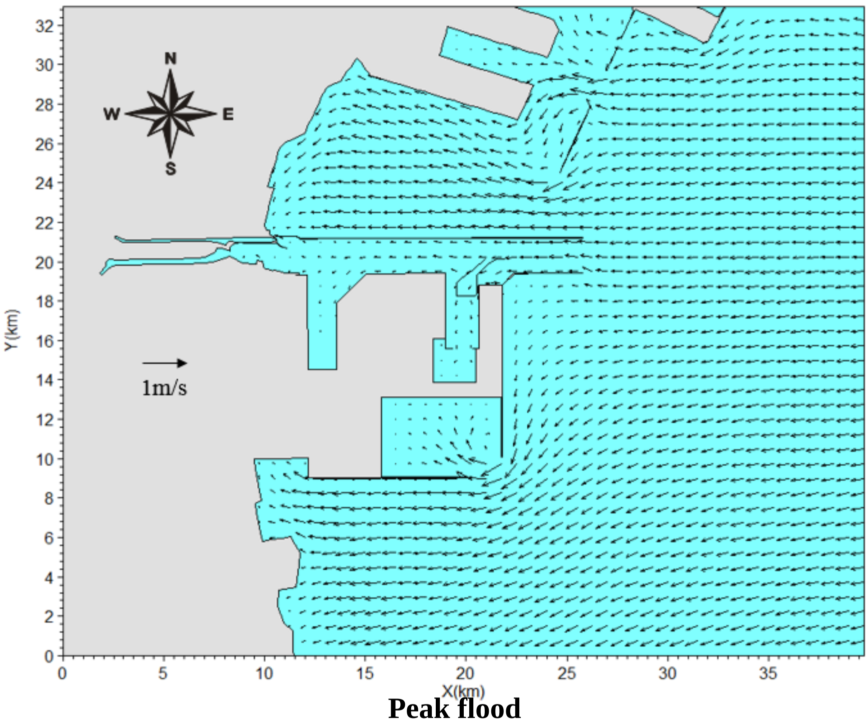


Peak ebb

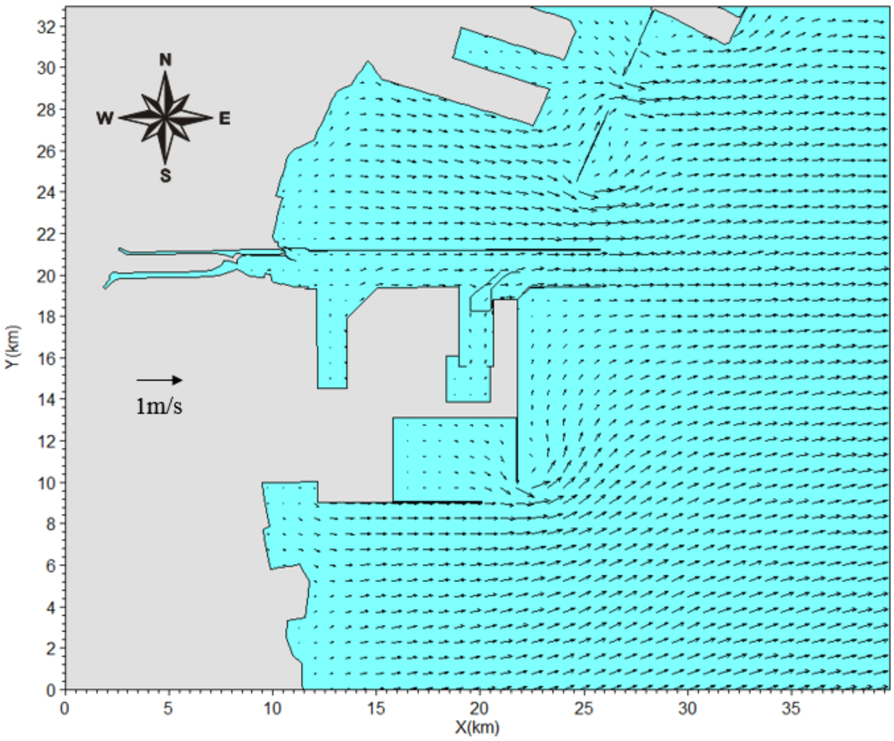


Peak flood

Figure 8.1-7 Flow field in project area (before project, large domain)

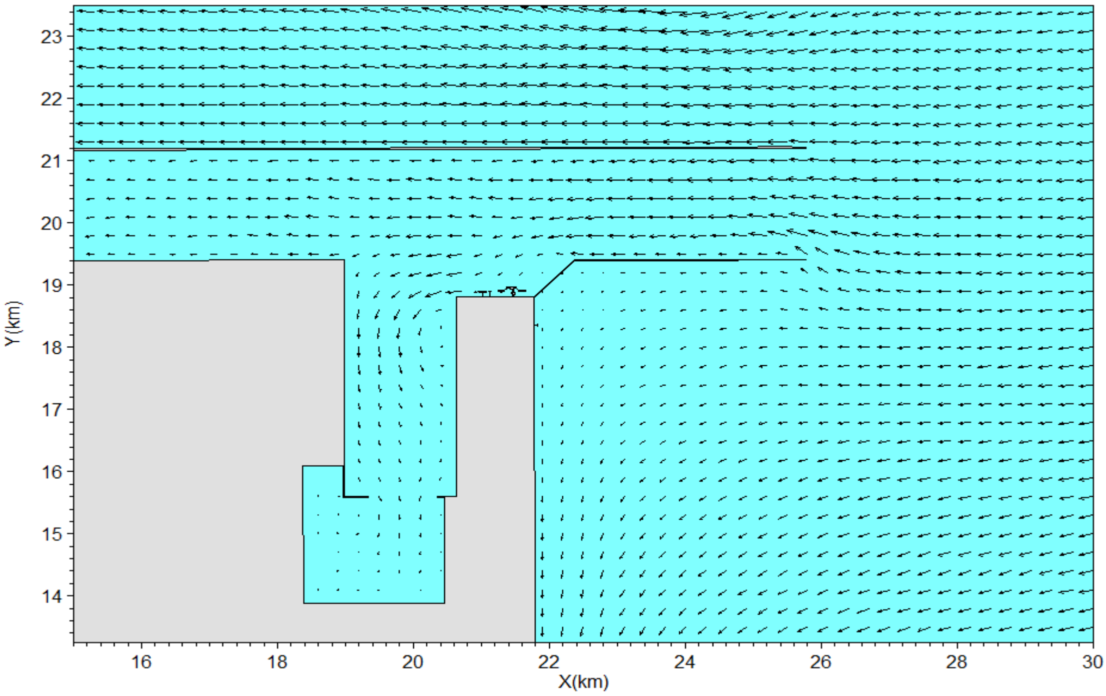


Peak flood

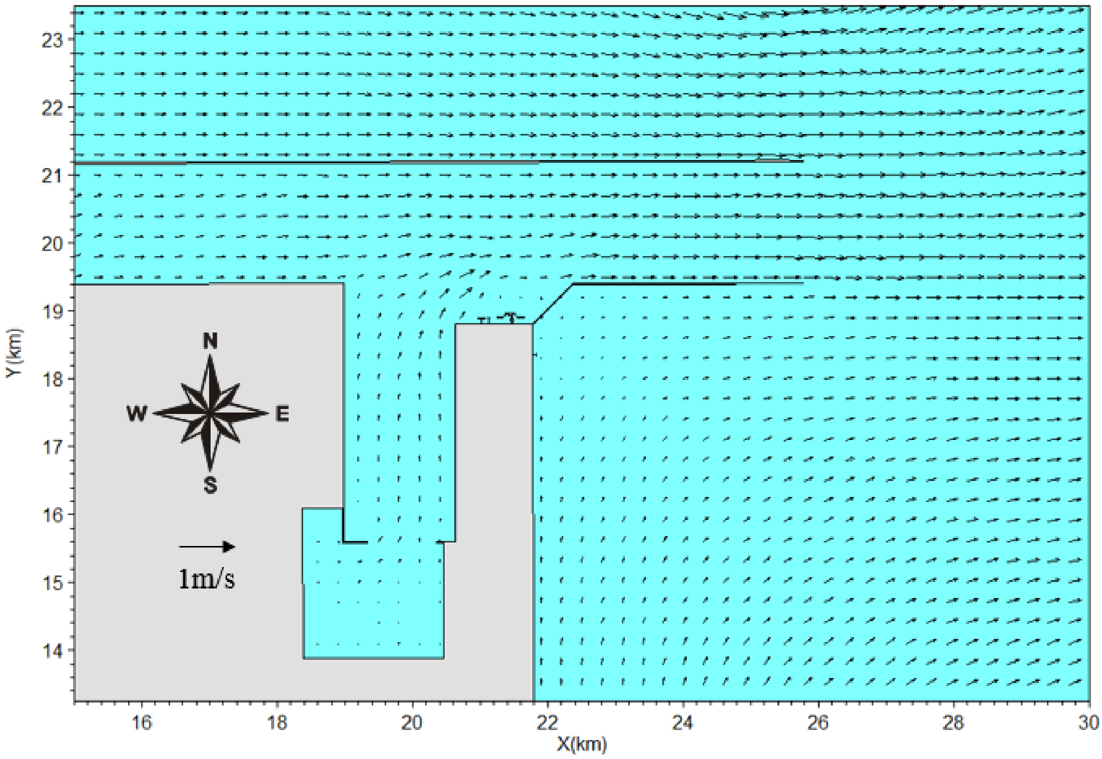


Peak ebb

Figure 8.1-8 Flow field in project area (after project, large domain)

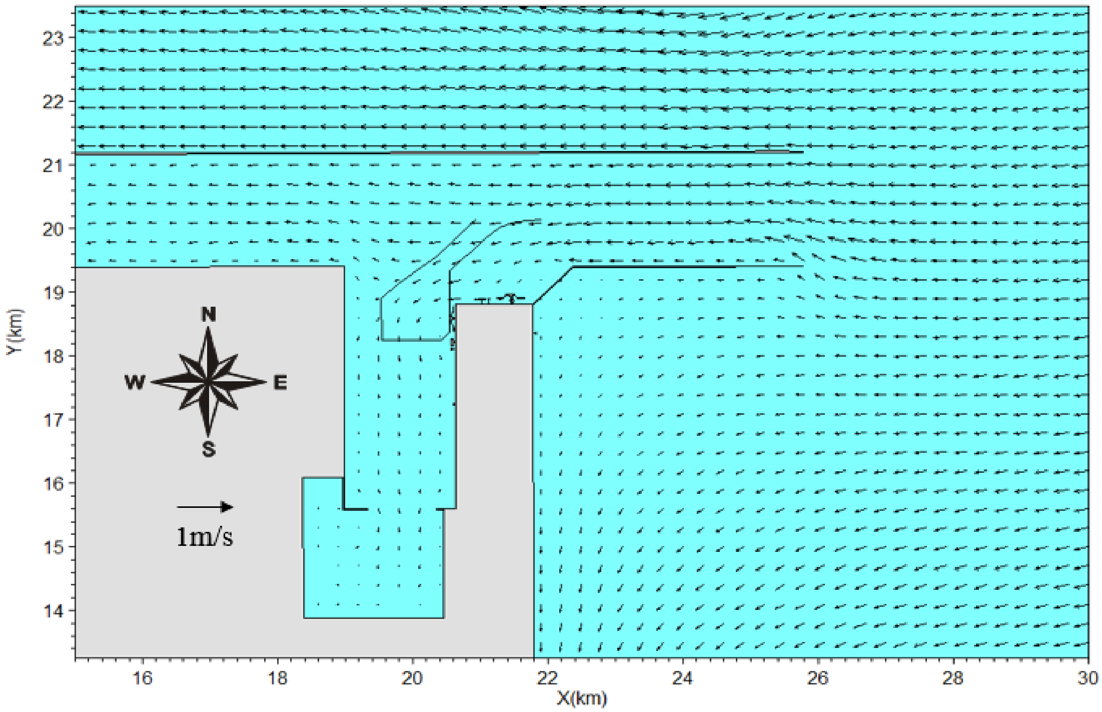


Peak flood

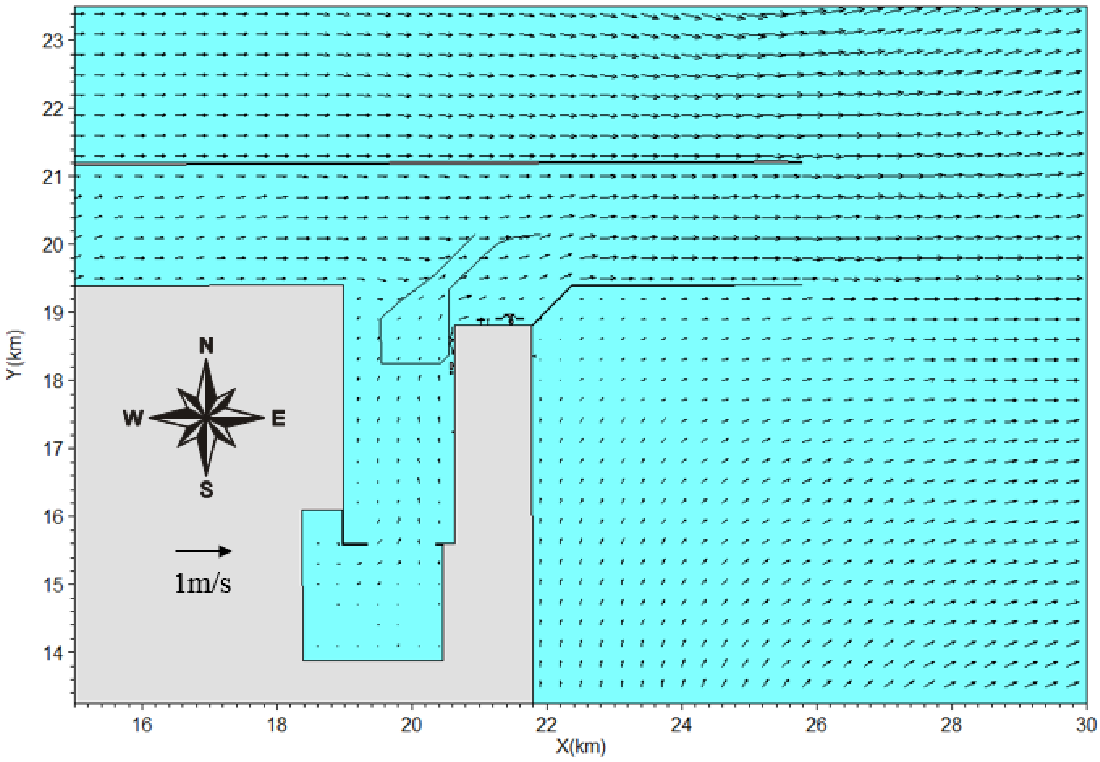


Peak ebb

Figure 8.1-9 Flow field in project area (before project, local domain)

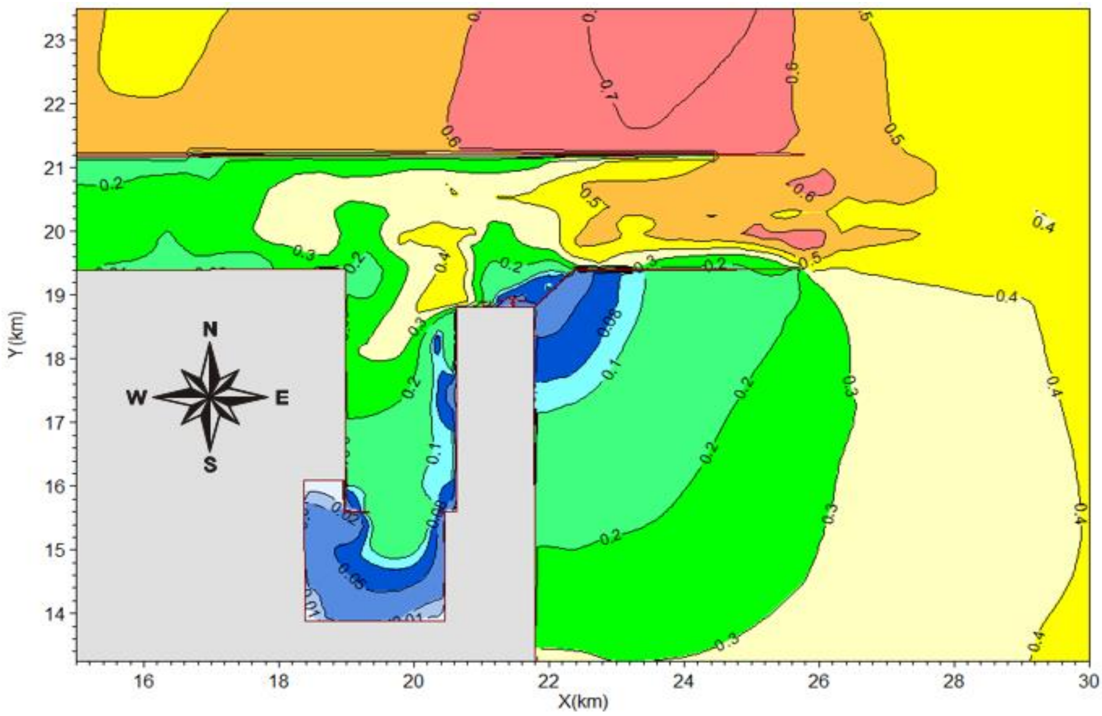


Peak flood

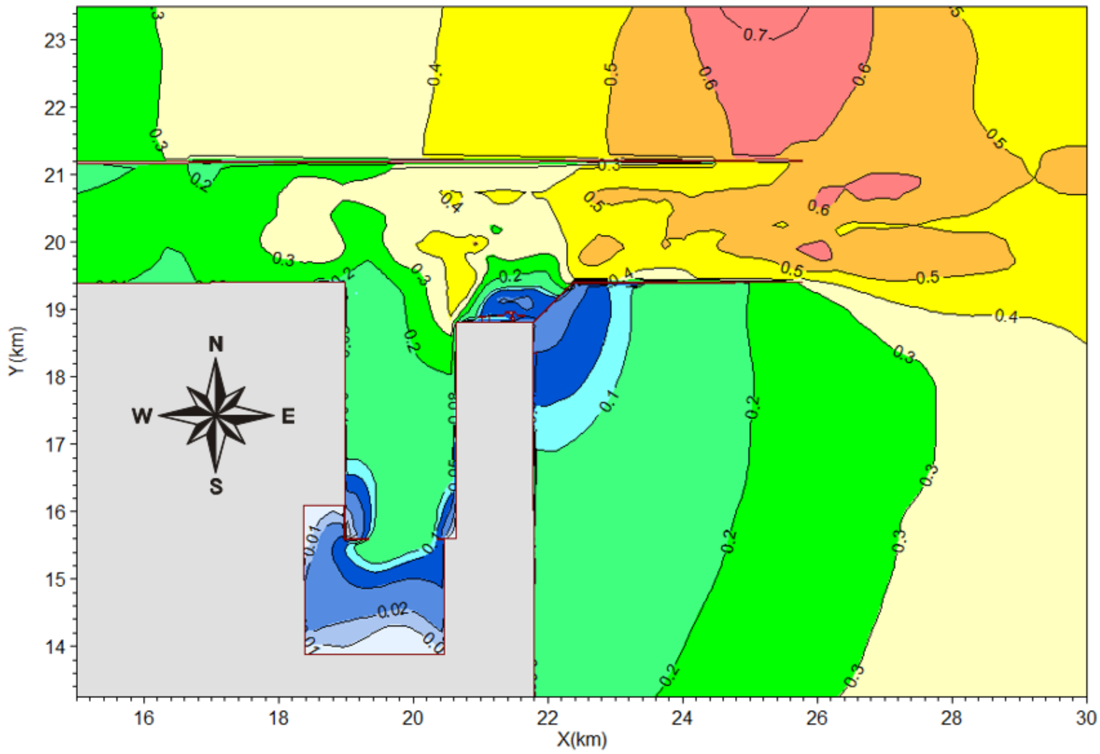


Peak ebb

Figure 8.1-10 Flow field in project area (after project, local domain)

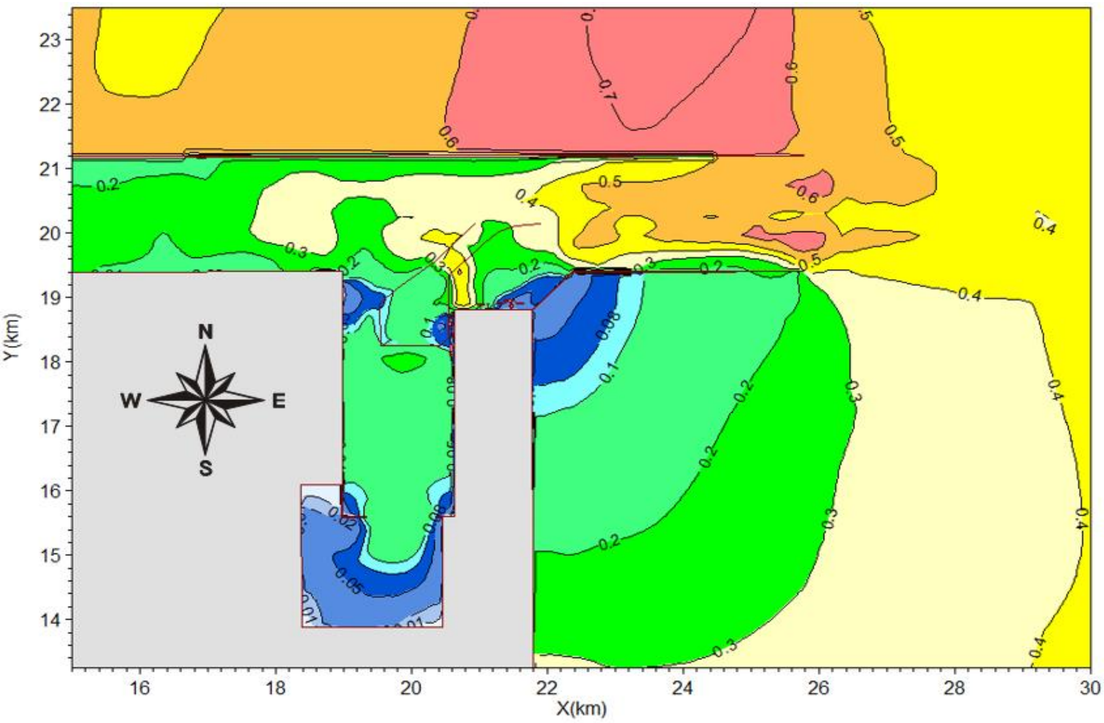


Peak flood

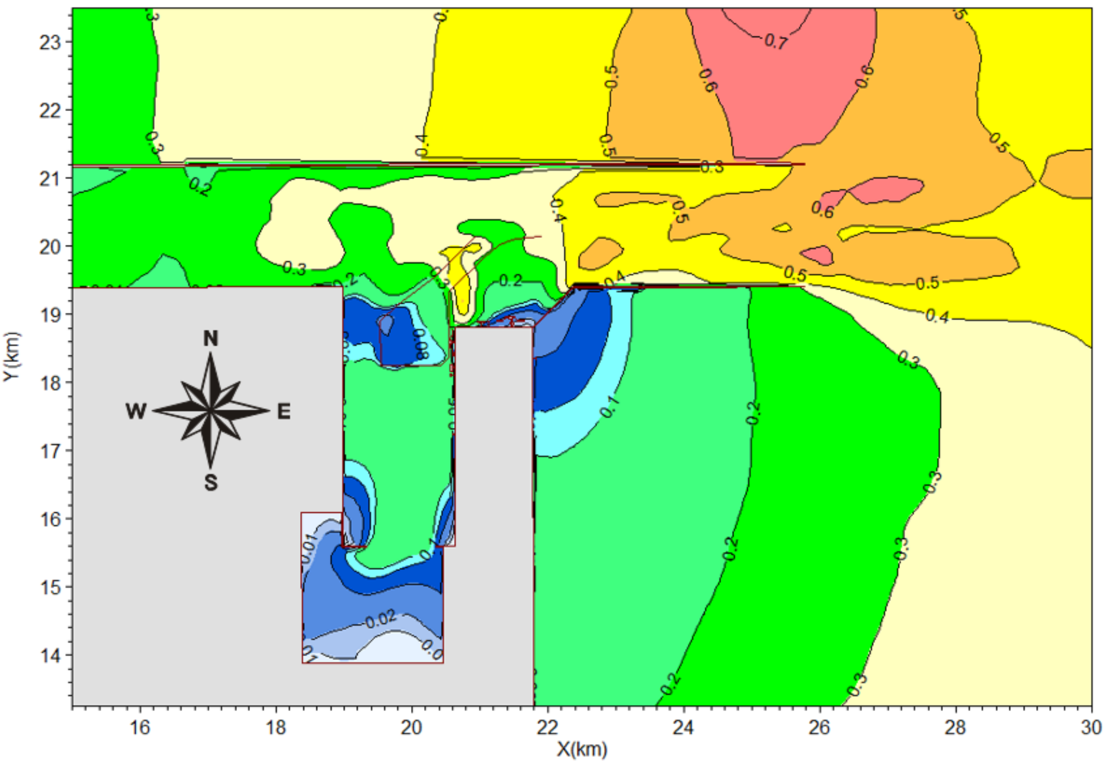


Peak ebb

Figure 8.1-11 Velocity contours in project area (before project， local domain)



Peak flood



Peak ebb

Figure 8.1-12 Velocity contours in project area (before project， local domain)

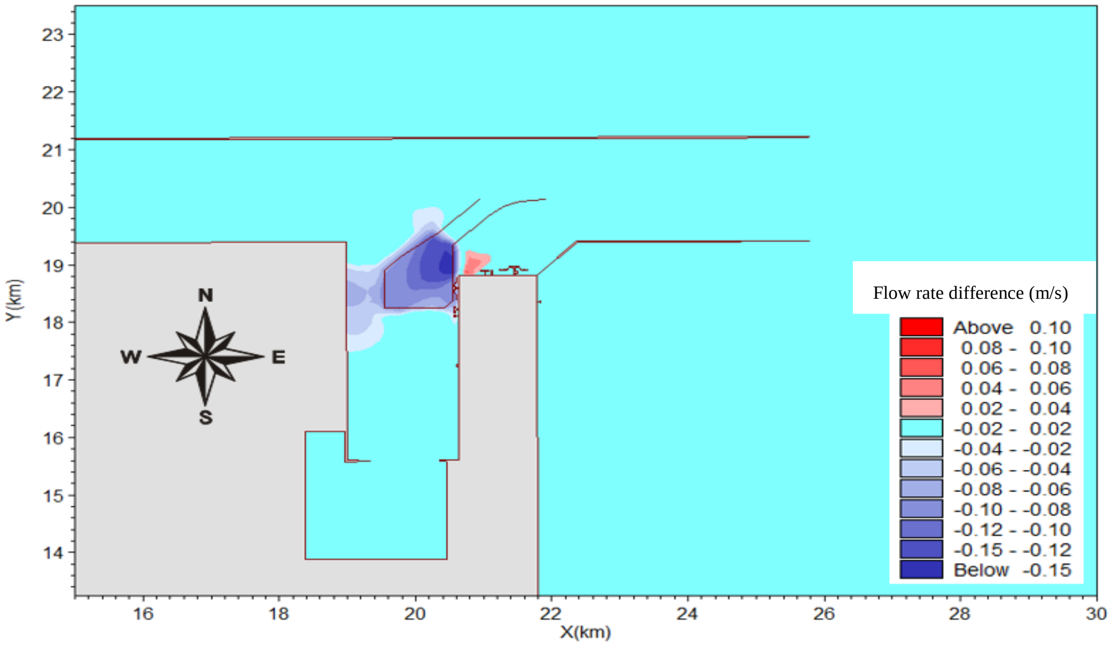


Figure 8.1-13 Influence range of project for current velocity (after project – before project)

8.1.2 Prediction and analysis of sedimentation in harbor and navigation channel

This section is copied from the report "Numerical hydrodynamic modelling for the LNG emergency storage project of Beijing Gas Group in Tianjin Nangang " (Nanjing Hydraulic Research Institute, November 2018).

The sediment transport model is driven by both tidal and wave forces. The calibration and validation of the model are undertaken by computation of the sedimentation/erosion distribution in the 150000-DWT navigation channel of the Tianjin Port under the normal representative tide and wave. Furthermore, the sedimentation/erosion in the Dagang and LNG harbors is computed, and the annual mean sedimentation volume in different zones is analyzed.

In order to be consistent with results of the study "Research on sedimentation in the 100000-DWT navigation channel of the Dagang harbor in the Tianjin Port" (Nanjing Hydraulic Institute, November 2013), the mesh of the sediment transport model in this study is only refined locally around Nangang Industrial Zone, the boundary conditions and relevant sediment parameters are kept as identical as before.

Figure 8.1-14 shows the annual mean sedimentation/erosion in the Tianjin Port. It could be observed that the morphological changes are quite significant in the area near the Lingang Economic Zone, at the entrance of the Nangang Industrial Zone, and in the area near the structure in the southeastern corner of the Nangang Industrial Zone. The sedimentation takes place in the areas with low currents or sheltered from waves, while the erosion takes place at the entrance, and the tip of the structure due to strong currents and unprotection from waves.

Figure 8.1-15 displays the annual mean sedimentation/erosion around the entrance of the Nangang Industrial Zone and LNG harbor. Due to the large current and unprotection from waves at the entrance, the erosion is very strong in the shoal area especially at the northern side of the navigation channel. In general, the sedimentation takes place along the entire channel. The largest sedimentation in the main channel is located at the junction of the eastern harbor, and the sedimentation decreases gradually along the channel axis of the eastern harbor.

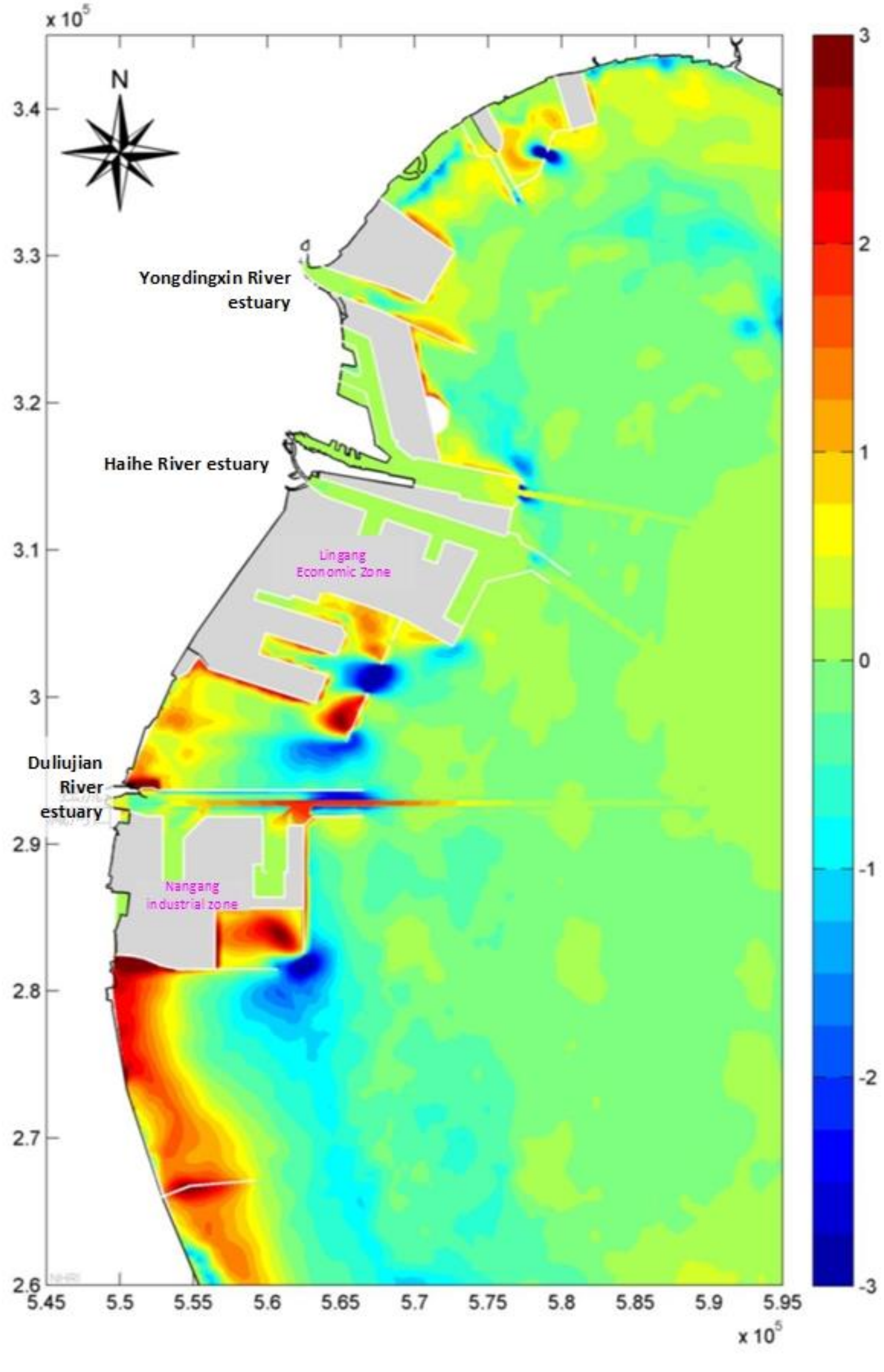


Figure 8.1-14 Annual mean sedimentation/erosion in the area of the Tianjin Port

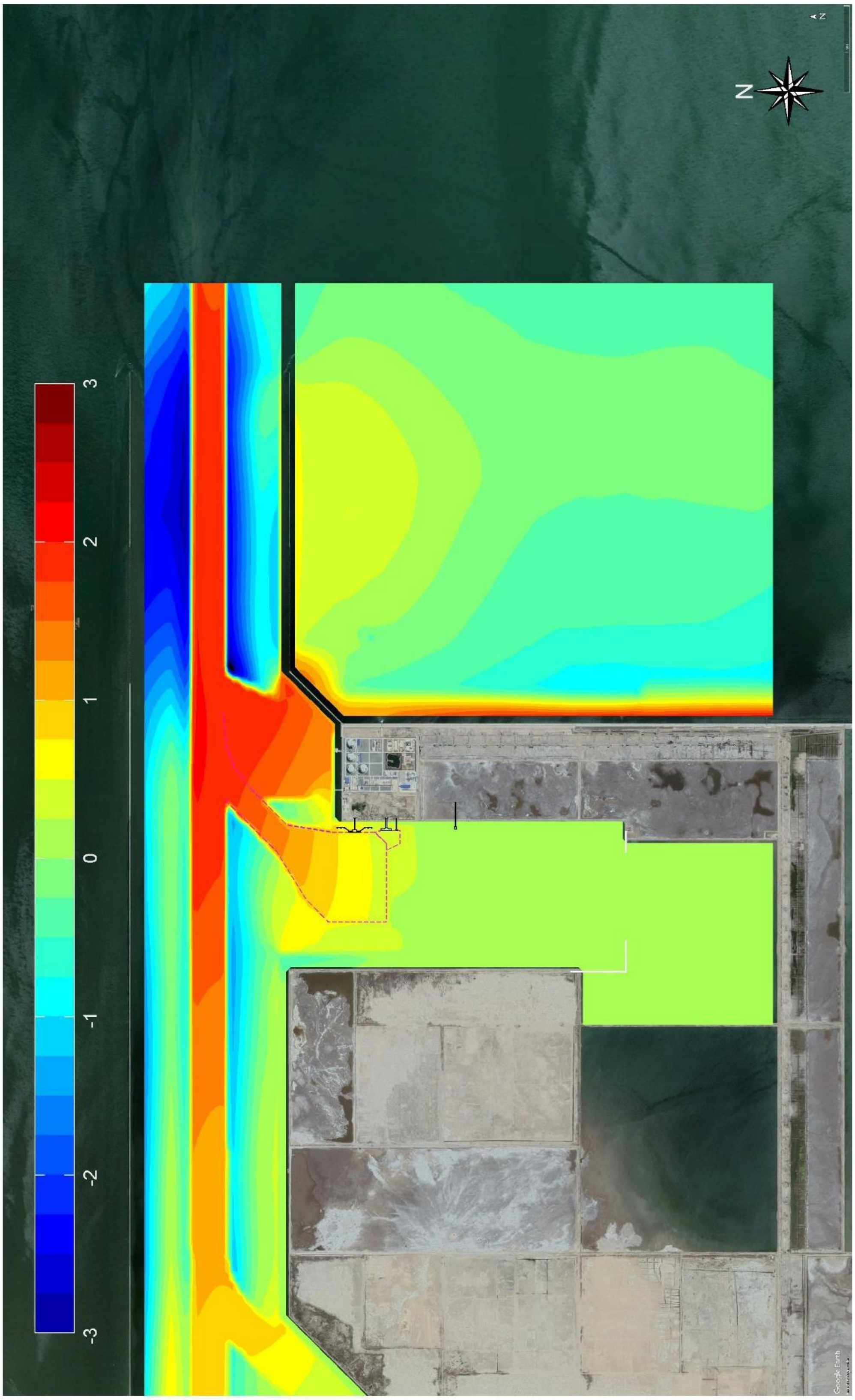


Figure 8.1-15 Annual mean sedimentation/erosion around the entrance of the Nangang Industrial Zone and the harbor of the LNG

8.1.3 Prediction and analysis of impacts of suspended sediment on environment during construction

8.1.3.1 Prediction of the model

The tidal current is the main force for dilution and transportation of contaminants in seas. On basis of the reliable flow field which is obtained from the hydrodynamic model, the water quality modelling can be achieved by coupling with a 2D module for simulation of unsteady horizontal advection-diffusion.

(1）2D governing equation for advection-diffusion of water quality:

$$\frac{\partial}{\partial t}(hc)+\frac{\partial}{\partial x}(uhc)+\frac{\partial}{\partial y}(vhc)=\frac{\partial}{\partial x}\left(h\cdot D_x\cdot\frac{\partial c}{\partial x}\right)+\frac{\partial}{\partial y}\left(h\cdot D_y\cdot\frac{\partial c}{\partial y}\right)-F\cdot h\cdot c+s$$

where DX and DY are diffusion coefficient in x and y direction respectively, the diffusion coefficient $D_l=K_l\frac{\Delta x^2}{\Delta t}$, Δx is space step (20m~562m)， Δt is time step (0.8s~120s), kl is a coefficient that ranges between 0.003 and 0.075. In the simulation, the space step and time step are very different from one grid cell to another for the unstructured grids, thus the diffusion coefficients are also very different, and computed automatically according to the space and time step defined by user. In addition, c is suspended sediment concentration (SSC), F is decay coefficient. In the equation F=p·ws， p is percentage for settling, and assigned between 0.1 and 0.5 in the area of interest， ws is settling velocity. According to the grain size distribution on site, the settling velocity is set equal to 0.0005m/s/. s is discharge flux of the suspended sediment. In the equation s=QSCS, QS is discharge， CS is SSC of the discharge.

(2）Boundary conditions

Closed boundary: zero flux

Open boundary:

Inflow: $C|\Gamma=P0$, where Γ is flow boundary, P0 is concentration at the boundary. Since only the impacts of increased SSC are considered in model, P0=0。

Outflow: $\frac{\partial C}{\partial t}+U_n\frac{\partial C}{\partial n^w}=0$, where Un is normal velocity at the boundary, and n is normal vector.

(3）Initial conditions

$$C(x,y)\big|_{t=0}=0$$
。

8.1.3.2 Setup of model parameters

(1）location of suspended sediment sources

In this project, the main sources to produce suspended sediment are from pile driving, dredge in harbor and riprap at outlet.

Following the plan and methodology of the construction, a few representative sources are used in the model for prediction and analysis. The location of the sources could be found in Figure 8.1-16.

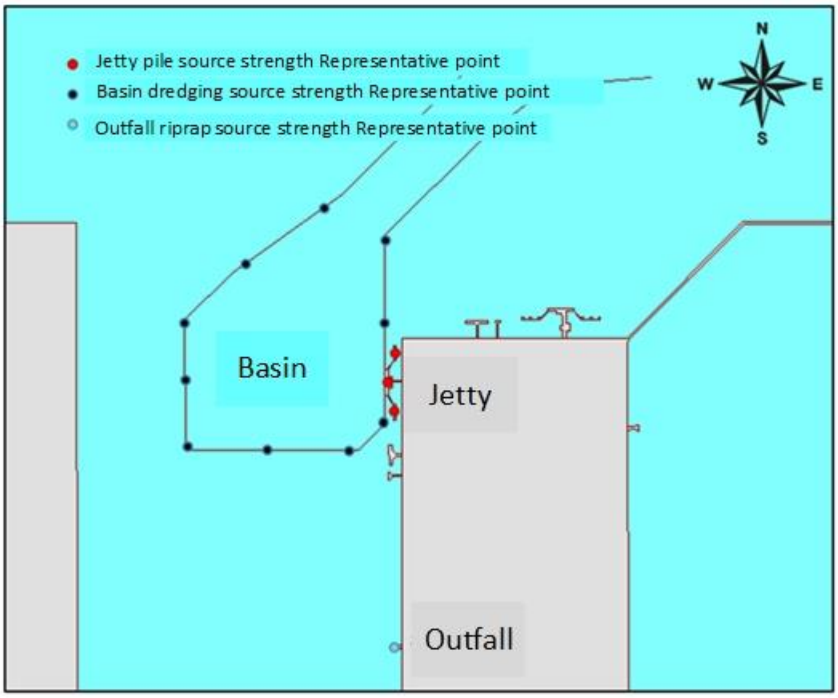


Figure 8.1-16 The location of the sediment sources

(2) Flux of the sources

During construction of the project, the suspended sediment is mainly produced from pile driving, dredge in harbor and riprap at outlet, the flux of which can achieve 1.0kg/s, 9.72kg/s and 3.80kg/s respectively.

In order to know the largest influence range of the suspended sediment, the governing points for prediction are selected at edge of the construction zone. The contour maps are generated based on the maximum diffusion of each governing point. The increased SSC on each point is the highest instantaneous SSC during the whole construction, and the contour maps of increased SSC are plot.

(3) settling velocity of sediment

With reference to "Coastal Engineering and Environment" (Chang), the settling velocity of fine sediment (D<0.1mm) is calculated by the Stokes' law:

$$\omega = \frac{1}{18}\frac{\rho_s - \rho}{\rho} g \frac{D^2}{\upsilon}$$

in which, ρ_s —— density of sediment, 2650kg/m^3;

ρ —— density of water, 1000 kg/m^3;

g—— gravity acceleration, 9.81m/s^2;

D—— grain size;

υ —— viscosity coefficient, $\upsilon = 1.792 \times 10^{-6} \exp(-0.042\mathrm{T}^{0.87})$, water temperature T =21.9℃.

Group-mean settling velocity of sediment:

$$\omega = \frac{1}{100}\sum_{i=1}^{N} \Delta P_i \cdot \omega_i$$

in which, ω—— group-mean settling velocity of sediment;

ω_i—— settling velocity of the particle with grain size Di;

ΔP_i—— weight percentage of the sediment with grain size Di.

The sample analysis indicates that the sediment in this area is mainly composed of clayey silt. The clay content reaches 38.6% of the sample. The median grain size D50 is relatively fine, and varies between 0.0041 and 0.0206mm. The range of the variation is very small. With computation of the formula above, the settling velocity of the sediment is 0.0005m/s for modelling of dredge in harbor and overflow during backfilling.

8.1.3.3 Analysis for impacts of suspended sediment diffusion on water quality

(1) pile driving

The contour map of SSC due to pile driving could be found inFigure 8.1-17. Table 8.1-1 and Table 8.1-2 summarize the statistical results for the Largest influence distance and range of suspended sediment due to pile driving. It is shown that the influence of suspended sediment due to pile driving is quite local, and limited to a small area around the pile foundation. The increased SSC 10mg/L reaches 650m at farthest, and 0.288km^2 at widest; the increased SSC 100mg/L reaches 450m at farthest, and 0.065km^2 at widest; The increased SSC 150mg/L reaches 400m at farthest, and 0.028km^2 at widest.

(2) dredge in harbor

The contour map of SSC due to dredge in harbor could be found in Figure 8.1-18. Table 8.1-3 and 8.1-4 summarize the statistical results for the Largest influence distance and range of suspended sediment due to dredge in harbor. It is shown that the dredge in harbor influences a large part of the eastern harbor of Nangang as well as a small section of the approach channel. The increased SSC 10mg/L reaches 8100m at farthest, and 9.283km^2 at widest; the increased SSC 100mg/L reaches 2400m at farthest, and 2.208km^2 at widest; The increased SSC 150mg/L reaches 1650m at farthest, and 0.933km^2 at widest.

(3) riprap at outlet

The contour map of SSC due riprap at outlet could be found in Figure 8.1-19. Table 8.1-5 and Table 8.1-6 summarize the statistical results for the Largest influence distance and range of suspended sediment due to riprap at outlet. Since the main flow direction at the outlet is southward during the flood and northward during the ebb, the diffusion of the suspended sediment is narrow and long from south to north with the strong effects of flood and ebb currents. The increased SSC 10mg/L reaches 3150m at farthest, and 0.375km^2 at widest; the increased SSC 100mg/L reaches 1050m at farthest, and 0.098km^2 at widest; The increased SSC 150mg/L reaches 750m at farthest, and 0.045km^2 at widest.

The contour map of SSC due to all activities during the construction could be found inFigure 8.1-20. Table 8.1-7 and Table 8.1-8 summarize the statistical results for the Largest influence distance and rang of suspended sediment due to all activities during the construction. The increased SSC 10mg/L reaches 8100m at farthest, and 9.473km^2 at widest; the increased

SSC 100mg/L reaches 3400m at farthest, and 2.328km^2 at widest; The increased SSC 150mg/L reaches 2650m at farthest, and 1.005km^2 at widest.

In summary, the dredge in harbor can produce much stronger diffusion of suspended sediment than the pile driving and riprap at outlet during the construction. The diffusion of the suspended sediment is mostly centralized in the eastern harbor of Nangang and nearby, and does not reach outside the entrance of the harbor of Nangang. Therefore, the construction of this project will not influence the environmental protection targets in the open sea.

Table 8.1-1 Largest influence distance of suspended sediment due to pile driving (m)

increase of SSC	10mg/L	50mg/L	100mg/L	150mg/L
largest influence distance	650	550	450	400

Table 8.1-2 Largest influence range of suspended sediment due to pile driving (km2)

increase of SSC	10mg/L	50mg/L	100mg/L	150mg/L
largest influence range	0.288	0.125	0.065	0.028

Table 8.1-3 Largest influence distance of SSC due to dredge in harbor (m)

increase of SSC	10mg/L	50mg/L	100mg/L	150mg/L
largest influence distance	8100	3000	2400	1650

Table 8.1-4 Largest influence range of suspended sediment due to dredge in harbor (km2)

increase of SSC	10mg/L	50mg/L	100mg/L	150mg/L
largest influence range	9.283	4.358	2.208	0.933

Table 8.1-5 Largest influence distance of suspended sediment due to riprap at outlet (m)

increase of SSC	10mg/L	50mg/L	100mg/L	150mg/L
largest influence distance	3150	1700	1050	750

Table 8.1-6 Largest influence range of suspended sediment due to riprap at outlet (km2)

increase of SSC	10mg/L	50mg/L	100mg/L	150mg/L
largest influence range	0.375	0.165	0.098	0.045

Table 8.1-7 Largest influence distance of suspended sediment due to all activities during construction (m)

increase of SSC	10mg/L	50mg/L	100mg/L	150mg/L
largest influence distance	8100	3950	3400	2650

Table 8.1-8 Largest influence range of suspended sediment due to all activities during construction (km2)

increase of SSC	10mg/L	50mg/L	100mg/L	150mg/L
largest influence range	9.473	4.538	2.328	1.005

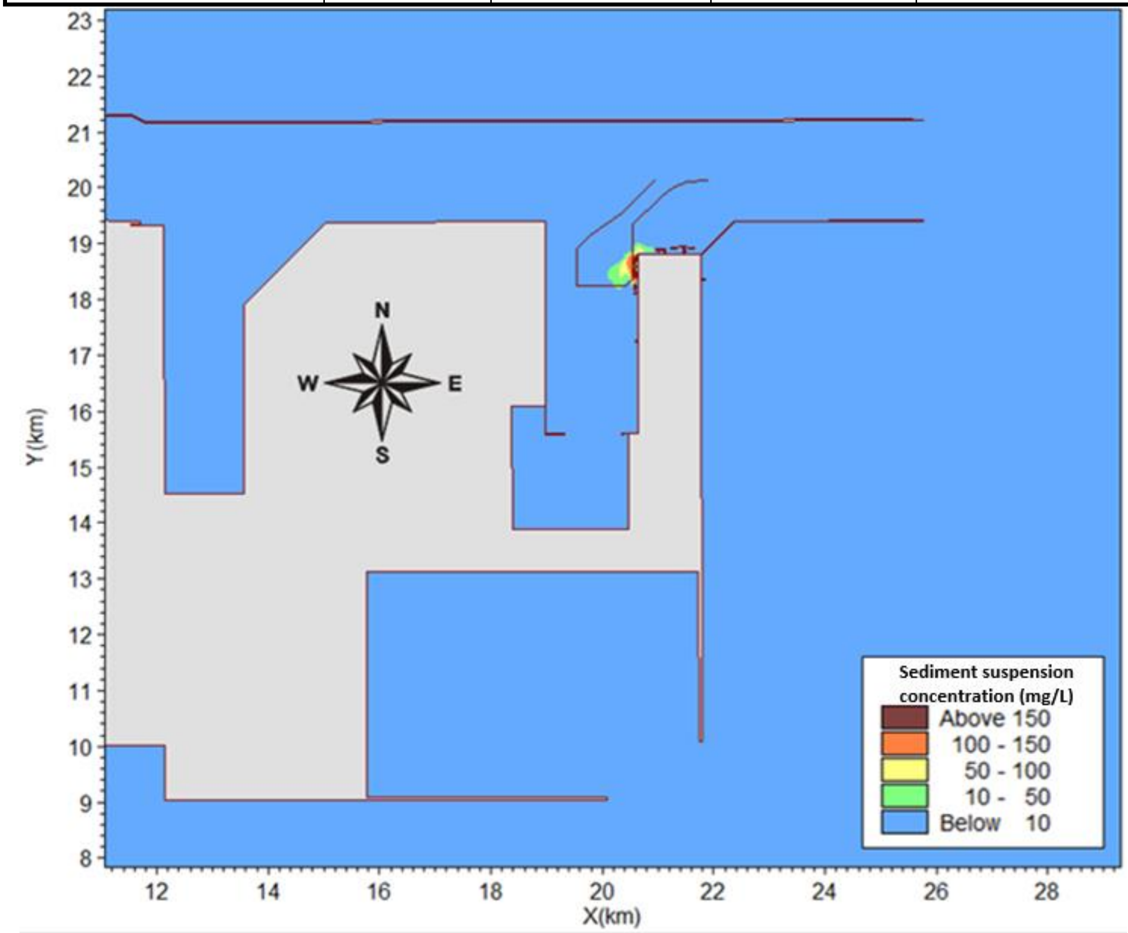


Figure 8.1-17 Contour map of SSC due to pile driving

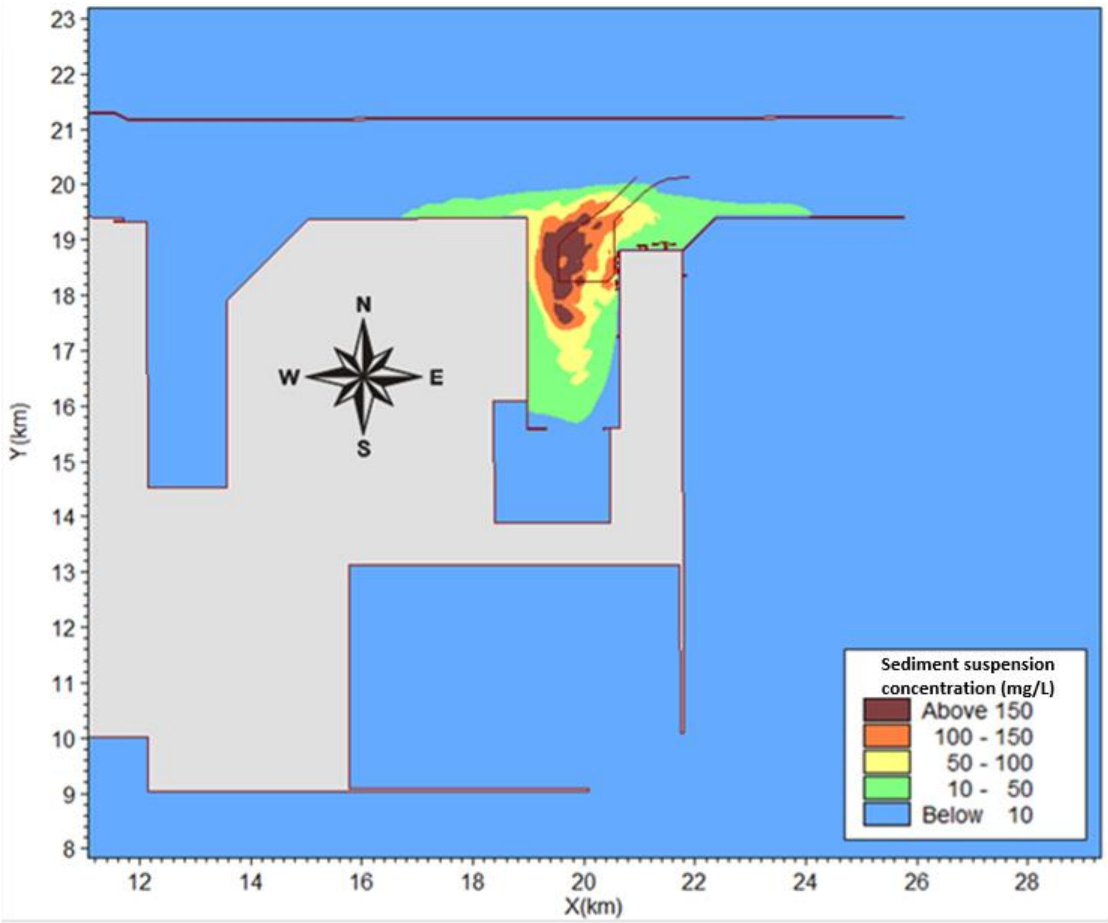


Figure 8.1-18 Contour map of SSC due to dredge in harbor

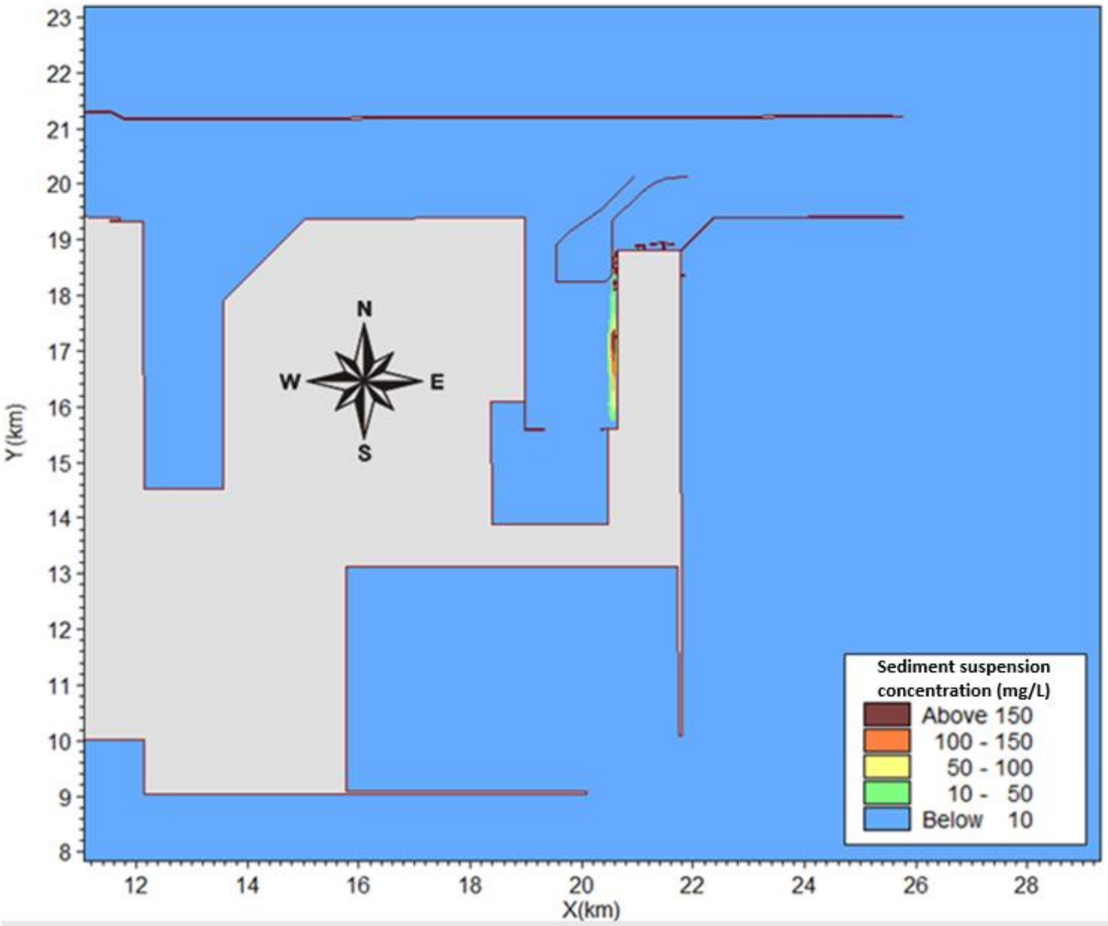


Figure 8.1-19 Contour map of SSC due to riprap at outlet

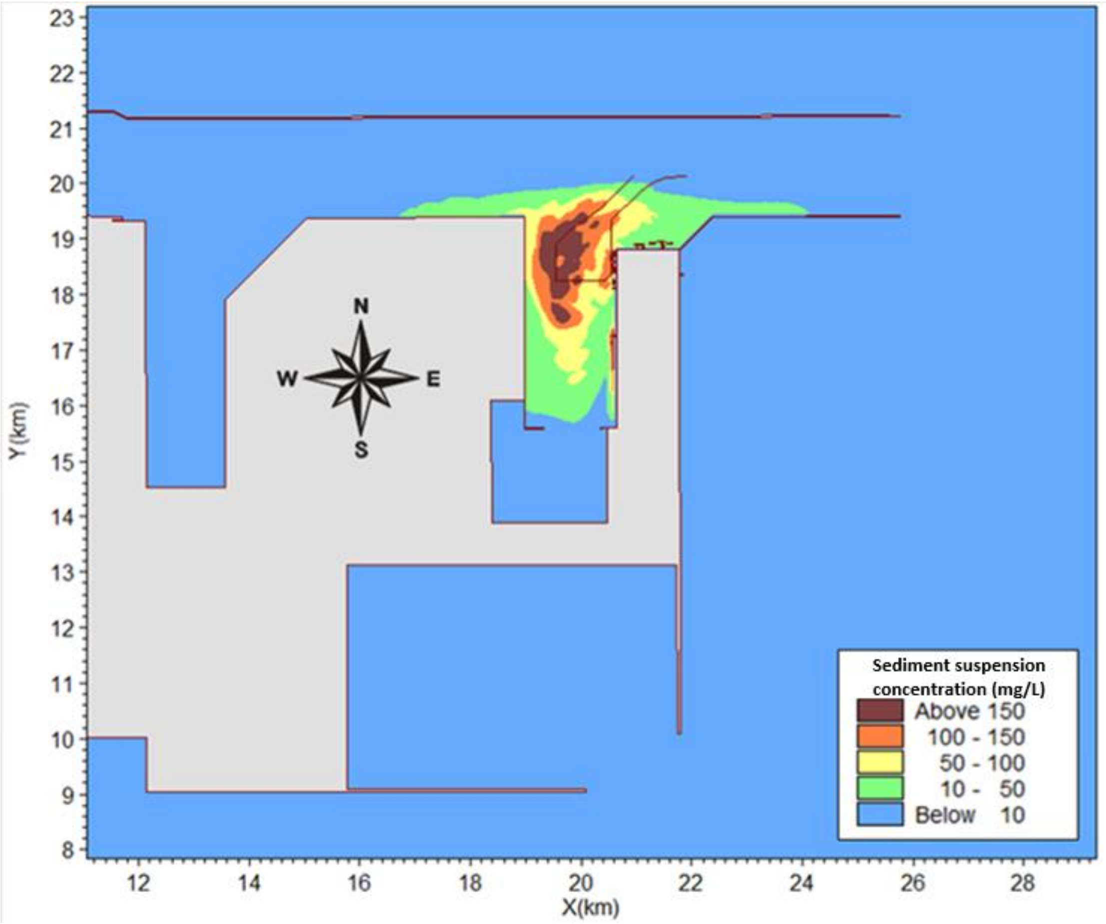


Figure 8.1-20 Contour map of SSC during construction

8.1.4 Analysis for environmental impacts of other waste water during the construction

During the construction, the domestic wastewater from the ship will be firstly collected by the land and afterward transported to the Nangang Wastewater Treatment Plant. The oily wastewater from the ship engine-room will be collected and processed by the qualified organization. The wastewater from the construction vessel will be separately treated according to water quality, and not be directly released to the sea. The impacts on seawater quality will be limited.

8.1.5 Analysis for environmental impacts of solid waste from construction vessel

The solid waste will be collected and processed by the qualified organization, and not dumped freely. The impacts on ambient environment will be limited.

8.1.6 Analysis for marine ecological environmental impacts during the construction

The impacts of the construction on the marine ecological environment are mainly from the diffusion of suspended sediments during the construction, resulting in a decline in water quality and adverse effects on the biological ecology.

8.1.6.1 Impacts on plankton

The main effect of suspended sediment on plankton is the suspended sediment generated during the construction, which is responsible for an increase of the water turbidity. The reproduction and growth of phytoplankton are inhibited. Besides, the growth rate and feeding rate of zooplankton are also affected. The toxic effect of dredged suspended sediment on the aquatic system in the Yangtze Estuary has been tested. The test result indicates that the survival rate of zooplankton and photosynthesis of phytoplankton are affected when the suspended sediment concentration reaches 9 mg/L. In the work for the environmental assessment of the Shengsi Yangshan Deepwater Port, the Donghai Aquatic Products Research Institute has conducted experiments to investigate the effects of the dredged sediment on the marine ecosystem. The experimental results show that the zooplankton and phytoplankton biomass can be reduced by the dredged sediment although the marine ecosystem is not significantly affected. The Donghai Aquatic Products Research Institute has a performed statistical regression analysis for the effects of dynamic suspended sediment (which is from the dredging work in the Yangtze Estuary) on the growth of N. oculata and CMuellen with different exposure moments. Their results suggest that the increase of suspended sediment concentration can significantly inhibit the growth of phytoplankton. The relative loss rate of zooplankton during construction is about 5% in the period between January and March, even reaches over 20% in April which is their active period, and stays around between 8 and 13% in the other months. The monthly average loss rate is 12%. Meanwhile, the reduction of water transparency affects the photosynthesis of phytoplankton, and leads to the decline of primary productivity. A large amount of suspended solids appears in local waters, and may block the sputum of larvae and cause their death due to suffocation. In the natural environment, the increase of suspended sediments affects the abundance of zooplankton feeding on phytoplankton, indirectly affects the feeding rate of zoea and megalopa, and ultimately affect their normal growth.

The suspended sediment generated during the construction of this project will increase the concentration of suspended solids in the surrounding seawater, reduce its transparency, and decrease the photosynthesis of phytoplankton. The phytoplankton is inevitably affected and damaged to a certain extent. However, since the suspended sediment is discharged during a relatively short period, its impact will be reduced gradually when the construction is finished and accordingly the discharge of suspended sediment is also stopped.

8.1.6.2 Impacts on nekton

The increase of suspended solids also affects the distribution of nekton. The nekton is a large group of marine organisms. Marine fishes are representatives of this group. They usually have strong motion organs and excellent athletic ability, and are able to escape from the contamination. Indoor ecological experiments suggest that the fish can only survive for 3~4 weeks when the suspended matter content is 300mg/L and a short-time stirring is carried out on daily basis. The suspended matter content below 200mg/L does not directly lead to the death of the fish. In this project, the construction will not produce areas with high concentration of suspended solids, the adult fish will not be killed, and marine organisms like fish, shrimp and crab with strong swimming ability will escape on one's own initiative. Their escape can lead to a reduction of biomass in the area where they used to live, thus the species composition and quantity distribution of the biomes in the area are affected. With completion of the construction, the species and quantities of nekton will gradually recover. Therefore, suspended solids generated during construction will not affect the nekton largely.

8.1.6.3 Impacts on benthos

The construction includes foundation trench excavation, riprap and etc., which can increase the suspended solid content, thereby the living environment of the benthos is affected. When the covering thickness of the suspended matter above the benthos is larger than 2cm, the benthos can be damaged fatally. The shellfishes can be killed by the deposition of suspended matter, which may block the mantle cavity and siphon of the shellfishes. The deposition of suspended solids mainly affects the benthic communities in the area near the project site. These benthic communities will be gradually replaced by new ones after completion of the construction.

8.2 Prediction and assessment of atmospheric environmental impacts

8.2.1 Analysis of atmospheric environmental impact during construction period

Construction air pollution is mainly from servarl sources including ground excavation, soil and stone stacking, concrete mixing and other construction vehicles driving dust (dust); Welding dust and dust generated during welding construction of Receiving terminal project; Volatile organic compounds produced during spray painting; The main pollutants in the exhaust gas from construction machinery, ships and transport vehicles are nitrogen oxides, carbon monoxide, non-methane hydrocarbon. These pollutants will cause a certain degree of pollution to the environment air, but this pollution is short-term. After the project is finished, all will disappear. This evaluation uses the construction experience and monitoring results of similar projects to analyze the influence of the construction period on the ambient air environment.

8.2.1.1 Analysis on the Influence of Ground Source Dust in Construction Field

Dust pollution of construction site mainly depends on construction operation mode, material stacking and wind power. Among them, the wind power are the biggest the influence factors. Under general meteorological conditions, the average wind speed is 2.5 m/s, and the TSP concentration in the construction site is 2-2.5 times the control point of the upper wind direction, and the influence range of dust in construction can reach 150 m. And the average TSP concentration in the affected area can reach 0.49 mg/m^3. When a barrier construction fence is erected, the impact distance can be reduced by 40 percent under the same conditions.When the wind speed is more than 5 m/s, the TSP concentration in the construction site and downwind part area will exceed the air quality standard, and with the increase of wind speed, the pollution degree will exceed the standard range of construction dust. The maximum radius of influence will be about 500m. The distance between the proposed project and the recently proposed atmospheric environment sensitive protection target exceeds the maximum radius of 500 m, and the ground source dust of the construction site has little effect on the surrounding sensitive protection target.

8.2.1.2 Analysis of Dust Impact on Transport Vehicles

In the process of automobile transportation during construction, dust pollution will be produced. The amount of dust and particle size are related to many factors, such as road condition, vehicle speed, load capacity, weather condition, etc. Wind speed, wind direction and other weather conditions directly affect the direction and distance of dust transmission. Due to the short time of dust, the fast arrival of dust, and the influence range mainly concentrated on the two sides of the transportation road. The influence on the 30 m range of the roadside is larger, and the linear pollution, the TSP concentration of the roadside can reach 10 mg/m^3. The concentration decreases gradually with the increase of distance. The main transport line of the proposed project is the main urban trunk road or the port area sparse port road . The distance between the proposed project and the sensitive protection target is more than 30 meters. The road passing by the vehicle of this project is hardened, and the influence of the transportation dust on the ambient air can be greatly reduced under the condition that the road is regularly sprinkled with water and dust, the vehicle is not overloaded, and the sealing or covering measures are taken.

8.2.1.3 Analysis on Atmospheric Environment of Welding Dust

The welding wire and flux used in the proposed project are less ,and the amount of welding smoke produced is less, because of the duration is short. Therefore, the welding dust has little effect on the surrounding environment during construction.

8.2.1.4 Analysis of atmospheric environmental impact of volatile organic compounds

The amount of paint used for the proposed due to that project is small, the duration is short, and the project area is the easternmost part of the port area. Therefore, the volatile organic compounds produced by spray painting during construction have little effect on the surrounding environment.

8.2.1.5 Analysis of Atmospheric Environmental Effects of Tail Gas from Construction Machinery, Ships and Transport Vehicles

In the process of construction, construction machinery, ships and transport vehicles as sources of mobile pollution will produce a small amount of combustion tail gas. The main pollutants include nitrogen oxides, carbon monoxide, non-methane hydrocarbon, etc. Because the amount of waste gas is small and the construction site is in the open area with less population distribution, it is conducive to the diffusion of air, and the source of waste gas pollution is intermittent and mobile. Thus, the environmental impact on the local area is less. The proposed project is far from the recent target of sensitive protection of atmospheric environment, so the exhaust gas from construction machinery, ships and transport vehicles has little influence on the sensitive protection target.

In a word, the dust, welding dust, spray paint and volatile organic compounds produced during the construction of the terminal and Receiving terminal of the proposed project can be accepted by the environment.

8.3 Acoustic Environmental Impact Assessment during Construction Period

The noise source during construction of the terminal and Receiving terminal of the proposed project mainly comes from construction machinery, equipment, vehicles and ships, whose strength is 68-106 dB (A).

The main construction machinery and equipment noise sources of the proposed project are detailed inTable 8.3-1.

Table 8.3-1 List of main construction machinery noise sources

No.	Pollution source	Maximum sound level dB (A)	Distance between measuring point and sound source (m)
1	Construction ship	68～75	10～20
2	Pipe hanger	88	2
3	Dump truck	88	7.5
4	Concrete mixer	95	10
5	Concrete dumper	90	12
6	Concrete vibrator	106	12
7	Pile driver	82	30
8	Electric welder	85	60
9	Excavator	92	10
10	Dozer	90	5
11	Loader	90	5
12	Cutting machine	95	8
13	Handling machinery	89	3

For the construction machinery can be regarded as the point sound source, regardless of the influence of shielding, air absorption and other factors. According to the attenuation model of point source recommended by the *Technical Guidelines for Environmental Impact Assessment-Sound Environment* (HJ 2.4-2009), the noise values in sensitive areas at different distances from the source can be estimated. The prediction formula is as follows :

$$LA(r)=LA(r0)-20\lg(r/r0)$$

where：LA (r), LA (r0)—— Sound level A from sound source r, r0，dB (A)；

r, r0—— Distance from point source (m)；

The environmental impact of some high noise construction machinery noise calculated from the above model is shown in Table 7.3-2. Table 7.3-2 shows that the noise generated by each construction machine, equipment, vehicle and ship can meet the requirements of the daytime standard of *Environmental Noise Emission Standard of Construction Yard* (GB 12523-2011) outside the 100 m construction site and the night standard *Environmental Noise Emission Standard of Construction Yard* (GB 12523-2011) for construction site boundary can be met at 400 m.

Table 8.3-2 List of main construction machinery noise impact areas

Type of machinery	Noise values at different distances (m) from the source dB (A)								
	10	20	50	100	150	200	300	400	500
Excavator	72	65.98	58.02	52	48.48	45.98	42.46	39.96	38.02
Pipe hanger	68	61.98	54.02	48	44.48	41.98	38.46	35.96	34.02
Electric welder	65	58.98	51.02	45	41.48	38.98	35.46	32.96	31.02
Dozer	70	63.98	57.02	50	47.48	43.98	40.46	37.96	37.02
Cutting machine	75	68.98	61.02	55	51.48	48.98	45.46	42.96	41.02

The proposed project and the recent acoustic environment sensitive protection targets are 500m away, and the construction noise is mostly discontinuous. So its impact is temporary. With the end of construction operations it will be eliminated. Therefore, the construction period of the proposed project will have little effect on the surrounding sound environment and can be accepted by the environment.

8.4 Effect Analysis of Solid Waste during Construction Period

Table 8.4-1 Summary of Solid Waste Generation and Disposal During Construction Period

Categories	Pollution source	Generating situation	Main contaminants	Disposal measures
Solid waste	Building waste	5.0t/d	Spoil	Pile up to designated temporary stacking point and make comprehensive use of it after unified planning
	Terrestrial domestic refuse	100kg/d	Domestic garbage	Unified treatment by municipal sanitation department
	Waste welding rod and slag	100kg/d	Lead-free waste welding rod and slag	Factory recovery and utilization
	Marine domestic garbage	100kg/d	Marine domestic garbage	Processing received by qualified units
	Ship maintenance refuse	100kg/d	Marine domestic garbage	
	Machine repair oil cotton yarn	10kg/d	Hazardous Waste, Hazardous Waste Number HW 49	For hazardous wastes included in *the list of management exemptions*, which will be integrated into domestic wastes in accordance with the conditions for exemption, will be handled uniformly by municipal sanitation authorities
	Paint dreg	10kg/d	Hazardous Waste, Hazardous Waste Number HW 12	It shall be temporarily stored in the temporary storage room of hazardous waste at the construction

	Waste oil	5kg/d	Hazardous Waste, Hazardous Waste Number HW 08	site, and shall be periodically entrusted to the competent units for receiving and processing
	Waste engine oil	10kg/d	Hazardous Waste, Hazardous Waste Number HW 08	

8.4.1 Environmental Impact Analysis of General Solid Waste

The general solid waste in the construction period of the terminal and Receiving terminal of the proposed project will not be discharged. They will be comprehensively utilized and will be collected by municipal sanitation department and recycled by the factory. Thus, it has less impact on the surrounding environment.

8.4.2 Environmental Impact Analysis of Hazardous Wastes

(1) Collection, storage and transport of hazardous wastes

① The workshop where hazardous waste is produced must have dedicated hazardous waste collection containers. Hazardous wastes produced must be placed in containers at any time. In accordance with the agreements signed with the Hazardous Waste Disposal Centre, hazardous wastes are periodically handed over to qualified units for safe disposal.

② The collection and storage of hazardous solid waste shall be stored in corrosion resistant, non-perishable, deformed and aged containers in accordance with the national standard according to the composition of hazardous solid waste, and shall be labeled on the storage dangerous solid waste containers in accordance with the provisions, specifying the name, weight, composition, characteristics of the hazardous solid waste and emergency measures and remedies in case of leakage and diffusion pollution accidents.

③ The storage facilities for hazardous solid waste meet the requirements of *the Storage Pollution Control Standard for Hazardous Wastes* (GB 18597-2001) issued after the revision in 2013. The storage facilities for dangerous solid waste shall be constructed with leak-proof skirts. Its ground and skirting feet shall be constructed with strong anti-seepage materials, and the corresponding isolation facilities, warning devices and windproof, sun-proof and rainproof facilities shall be constructed with 2 mm high-density polyethylene material for the foundation anti-seepage layer. The surface of the storage facilities is hardened with corrosion resistant material and the lining is provided with leachate collection and removal system, runoff export system and rainwater collection tank.

④ The monthly report of hazardous waste types, production, temporary storage time, disposal time and etc. should be handed to the local environmental protection department.

⑤ The transfer of hazardous wastes shall comply with the requirements of the *Measures for the Management of Transfer of Hazardous Wastes* and other relevant provisions and shall prohibit the discharge of hazardous wastes into the environment during the transfer process. The construction unit may, together with the hazardous waste disposal unit, study the transport of hazardous waste, ensure the safety and reliability of the transport of hazardous waste, reduce or avoid secondary pollution in the transport process and possible environmental risks.

(2) Impact analysis

The collection, storage and transportation of hazardous waste during the construction period of the proposed project shall be carried out in accordance with the relevant requirements, with little impact on the surrounding environment.

At least 40 cm thick surface soil is guaranteed to be the original soil. According to relevant rules, original landscape conditions should be restored.

In summary, the solid waste generated during the construction period of the proposed project will be treated separately and will not be discharged. In the case of strict implementation of the above measures, solid waste will not have adverse effects on the environment during construction period.

9 Prediction and evaluation of environmental impact during operation period

9.1 Forecast and analysis of atmospheric environmental impact during operation period

9.1.1 Meteorological characteristics of pollution in the assessment area

(1) Representative analysis of meteorological data

The surface meteorological data used in this project are derived from the statistical results of major meteorological data of the Tianjin Dagang District Meteorological Station in recent years. Dagang Meteorological Station is a national general meteorological observatory with geographical coordinates of 117°28′ E, 38°51′ N, and an altitude of 2.2m. The distance between the station and the project is about 24km. The station is close to the site, and its terrain and underlying surface conditions are similar to the site. Hence, the meteorological data has a good representative.

(2) Statistics of long-term meteorological factors of Dagang station

① Climatic characteristics

Tianjin is an area with warm temperate semi-humid continental monsoon climate with four distinct seasons, windy springs with drought and less rain; hot summers with concentrated rainwater; cool autumn with moderate warm and cold; cold winter, with dry and less snow.

② Statistics of long-term meteorological element

The statistics of long-term meteorological elements are shown in the table below.

Table 9.1-1 Statistics results of long-term main meteorological elements of Dagang Meteorological Station

Items	Value
Annual average wind speed (m/s)	2.3
Maximum wind speed (m/s)	11.7
Annual average temperature (℃)	13.4
Extreme maximum temperature (℃)	39.4 (Time of appearance: 5/7/2010)
Extreme minimum temperature (℃)	-15.2 (Time of appearance: 5/1/2010)
Annual average relative humidity (%)	59
Annual average precipitation (mm)	590.4
Annual average sunshine hours (h)	2346.6

(3) Frequency statistics of long-term wind

According to the long-term meteorological data, the dominant wind direction of the evaluation area is E-ESE-SE wind, and the sum of occurrence frequency of the three wind directions is 39.6%. The evaluation zone has a static wind frequency of 10.6%.

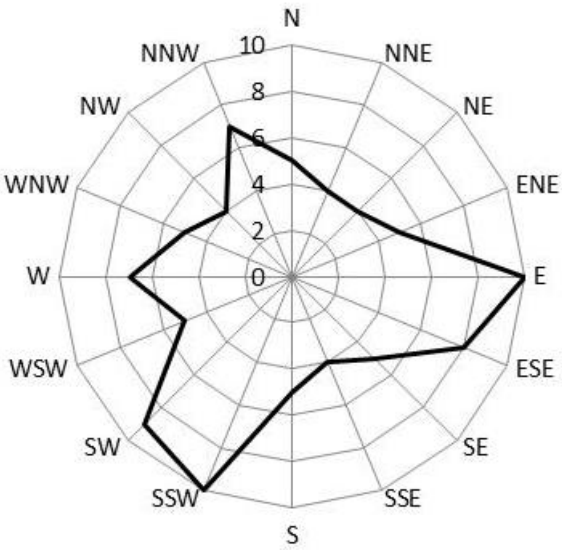


Figure 9.1-1 Rose map of long-term annual average wind frequency of Dagang Station

9.1.2 Pollution source parameters

According to the engineering analysis, the exhaust gas pollution source of the Receiving terminal under normal working conditions is SCV (submerged Combustion vaporizer) combustion exhaust gas, flare long-light combustion exhaust gas, boiler fuel waste gas and non-methane total hydrocarbons discharged from the station. The emission parameters of the pollution source are shown in the table below.

Table 9.1-2 The atmospheric pollution source parameters of the project under normal working conditions

Source of pollution		Altitude of exhaust tube bottom (m)	Height of exhaust tube (m)	Outlet diameter of exhaust tube (m)	Outlet temperature °C	Exhaust emissions (Nm3/h)	Annual emission hours (h)	Emissions condition	Pollutant emission rate (kg/h)		
									NOx	Smoke	SO2
G1~11	SCV	0	25	1.0	220	45271	See details in Table 4.2-8	Normal	3.1690	0.4527	0.3884
G12	Boiler	0	15	0.6	200	3496	2880	Normal	0.2447	0.0350	0.0300
G13 ~14	Flare stacks 1	0	30	9	＜800	141.75	8760	Normal	0.0238	0.0019	0.00054
Anci Sub-transmission Station		0	15	0.6	220	1478	8400	Normal	0.1035	0.0148	0.0042
Chengnan Last Station		0	15	0.6	220	3124	2160	Normal	0.0937	0.0156	0.0089

Table 9.1-3 Non-point air pollution source parameters of the project

Source of pollution		Altitude of exhaust tube bottom (m)	Length of surface source (m)	width of surface source (m)	Effective emission height of surface source (m)	Annual emission hours (h)	Emissions condition	Pollutant emission rate (kg/h)
NO.	Name							Non-methane total hydrocarbon

9.1.3 Choice of atmospheric diffusion mode

The atmospheric evaluation level of this project is second level, and the atmospheric diffusion mode can be analyzed by the prediction result of the estimation model (AERSCREEN) recommended by the Environmental Impact Assessment Technical Guidelines (HJ2.2-2018). No further evaluation and prediction are needed.

9.1.4 Main parameters and options of the mode

The main calculation parameters and options in the estimation mode operation are shown in the table below.

Table 9.1-4 Parameter selection of atmospheric estimation mode for this project

Station name	Parameters		Value
Receiving terminal	City/rural options	City/rural	Rural
		Population (city option)	10000
	Maximum ambient temperature (℃)		39.4
	Minimum ambient temperature (℃)		-15.2
	Land use type		Water surface and city
	Regional humidity condition		medium
	Consider terrain or not	Consider terrain	Consider
		Resolution of terrain data (m)	90
	Consider or not	Consider shoreline fume	Not consider
		Shoreline distance (m)	
		Shoreline direction (°)	

Table 9.1-5 The surface parameter value of atmospheric estimation mode of this project

Sector	Season	Albedo	BOWEN	Surface roughness
Receiving terminal sector 1 (0°-180°) (City)	Winter	0.35	1.5	0.35
	Spring	0.14	1	0.35
	Summer	0.16	2	0.35
	Autumn	0.18	2	0.35
Receiving terminal sector 2 (180°-0°) (Water surface)	Winter	0.2	1.5	0.0001
	Spring	0.12	0.1	0.0001
	Summer	0.1	0.1	0.0001
	Autumn	0.14	0.1	0.0001

9.1.5 Evaluation factor

Receiving terminal: SO2, NOx, PM2.5, Non-methane total hydrocarbon.

9.1.6 Evaluation content

Predicting the compliance of NOx, SO2, and PM2.5 of the combustion venting of the combustion gas in the submerged Combustion vaporizer and the combustion exhaust gas of the boiler under normal working conditions; the compliance of the distribution of the non-methane total hydrocarbon ground concentration at the Receiving terminal without any organization, and evaluating it and the characteristics of pollutants in the boundary of the factory.

9.1.7 Evaluation criteria

The atmospheric environmental quality evaluation standard for NOx is 0.25mg/m3 (hourly average), for SO2, it is 0.50mg/m3 (hourly average), and the PM2.5 hour concentration evaluation standard refers to 3 times of the daily average concentration standard, i.e. 0.225. Mg/m3. Evaluation standard for non-methane total hydrocarbons is 2.0 mg/m3.

9.1.8 Pollutant emissions accounting

According to the above calculations, the exhaust emissions of Tianjin receiving terminal are listed in the table below.

Table 9.1-6 The accounting table of air pollutants organized emissions in receiving station

NO.	Emission port number	Pollutants	Accounting emission concentration / (mg/m3)	Accounting emission rate of single outlet/ (kg/h)	Accounting annual emissions / (t/a)
Main emission port					
1	SCV	NOX	70	3.169	33.808
		Smoke	10	0.4527	4.830
		SO2	2.86	0.1295	1.3813
2	Boiler	NOX	70	0.2447	0.705
		Smoke	10	0.035	0.101
		SO2	2.86	0.0100	0.0287
3	Flare	NOX	167.62	0.0238	0.417
		Smoke	13.33	0.0019	0.033
		SO2	2.86	0.0005	0.0093
Sum of main emission port		NOX			34.930
		SO2			1.6547
		Smoke			4.258
Total organized emissions					
Total organized emissions		NOX			34.930
		SO2			1.6547
		Smoke			4.258

Table 9.1-7 The accounting table of air pollutants unorganized emissions in receiving station

NO.	Pollution production	Pollutants	Main pollution prevention measures	National or local pollutant discharge standards		Annual emissions / (t/a)
				Name of criteria	Concentration limit / (μg/m3)	
M1	Receiving	Volatile organic	Concealed loading	Tianjin Industrial Enterprise Volatile	2000	3.1536

	terminal unorganized exhaust	compounds	and unloading	Organic Compound Emission Control Standard		
Total unorganized emissions						
Total unorganized emissions			Volatile organic compounds		3.1536	

Table 9.1-8 Accounting table of annual emission of air pollutants in Receiving station

NO.	Pollutants	Annual emissions / (t/a)
1	Volatile organic compounds	3.1536
2	NOX	34.930
3	SO2	1.6547
4	Smoke	4.258

9.1.9 Results of prediction and analysis

The specific prediction results are shown in the following table (Table 8.1-11): During normal operation, the ratio of the downwind maximum concentration contribution of the NOx, SO2, PM2.5 and non-methane total hydrocarbons generated by the submerged Combustion vaporizer combustion, flare long-light burning, boiler combustion exhaust gas and unorganized emission to environmental standards is less than 9.08%, 0.10%, 0.81%, and 5.85% at the Receiving terminal, respectively. There is no atmospheric environmental sensitive target within 2.5km of the project boundary, and the Receiving terminal submerged Combustion vaporizer exhaust gas, flare exhaust gas, and boiler exhaust gas have less impact on the environment.

The downwind maximum concentration contribution of the non-methane total hydrocarbons at the Receiving terminal to the factory boundary standard is less than 5.85%. Non-methane emissions from unorganized emissions can achieve compliance at the factory boundary.

Table 9.1-9 Atmospheric prediction results under normal working conditions (1)

NO.	Distance (m)	Submerged Combustion vaporizer						Boiler combustion exhaust					
		SO2		PM2.5		NOx		SO2		PM2.5		NOx	
		Downwind concentration (μg/m3)	Ratio to standard (%)	Downwind concentration (μg/m3)	Ratio to standard (%)	Downwind concentration (μg/m3)	Ratio to standard (%)	Downwind concentration (μg/m3)	Ratio to standard (%)	Downwind concentration (μg/m3)	Ratio to standard (%)	Downwind concentration (μg/m3)	Ratio to standard (%)
1	10	0.087	0.02	0.1015	0.05	0.7088	0.28	0.1417	0.03	0.1653	0.07	1.1564	0.46
2	25	0.9923	0.2	1.1577	0.51	8.0855	3.23	0.8081	0.16	0.9429	0.42	6.5966	2.64
3	47/27	1.3913	0.28	1.6232	0.72	11.3365	4.53	0.814	0.16	0.9499	0.42	6.6451	2.66
4	50	1.3838	0.28	1.6144	0.72	11.2754	4.51	0.5684	0.11	0.6633	0.29	4.6402	1.86
5	75	1.1107	0.22	1.2958	0.58	9.0501	3.62	0.7224	0.14	0.8429	0.37	5.8969	2.36
6	100	1.054	0.21	1.2297	0.55	8.5881	3.44	0.6317	0.13	0.7371	0.33	5.1566	2.06
7	200	1.2507	0.25	1.4592	0.65	10.1909	4.08	0.58	0.12	0.6768	0.3	4.7349	1.89
8	300	1.1761	0.24	1.3721	0.61	9.583	3.83	0.5479	0.11	0.6393	0.28	4.4726	1.79
9	400	1.0011	0.2	1.168	0.52	8.1571	3.26	0.4737	0.09	0.5527	0.25	3.8668	1.55
10	500	0.8997	0.18	1.0496	0.47	7.3306	2.93	0.4432	0.09	0.5171	0.23	3.6178	1.45
11	600	1.0849	0.22	1.2657	0.56	8.8399	3.54	0.4279	0.09	0.4992	0.22	3.4927	1.4
12	700	1.2326	0.25	1.438	0.64	10.0434	4.02	0.3983	0.08	0.4647	0.21	3.2512	1.3
13	800	1.3177	0.26	1.5373	0.68	10.7368	4.29	0.3729	0.07	0.4351	0.19	3.0438	1.22
14	900	1.3566	0.27	1.5827	0.7	11.0538	4.42	0.3591	0.07	0.419	0.19	2.9315	1.17
15	1000	1.3655	0.27	1.5931	0.71	11.1263	4.45	0.3619	0.07	0.4223	0.19	2.9544	1.18
16	……												
17	2500	0.8856	0.18	1.0332	0.46	7.216	2.89	0.2173	0.04	0.2536	0.11	1.7741	0.71
Downwind maximum concentration		1.3913	0.28	1.6232	0.72	11.3365	4.53	0.814	0.16	0.9499	0.42	6.6451	2.66

Table 9.1-10 Atmospheric prediction results under normal working conditions (2)

NO.	Distance (m)	Flare stacks						Unorganized exhaust gas	
		SO2		PM2.5		NOx		Non-methane total hydrocarbon	
		Downwind concentration (μg/m3)	Ratio to standard (%)	Downwind concentration (μg/m3)	Ratio to standard (%)	Downwind concentration (μg/m3)	Ratio to standard (%)	Downwind concentration (μg/m3)	Ratio to standard (%)
1	10	0.3807	0.08	1.3402	0.6	16.7779	6.71	66.367	3.32
2	25	0.4587	0.09	1.6146	0.72	20.2129	8.09	68.036	3.40
3	37	0.5154	0.1	1.8141	0.81	22.7111	9.08	70.781	3.54
4	50	0.5	0.1	1.7601	0.78	22.0342	8.81	73.481	3.67
5	75	0.3948	0.08	1.3898	0.62	17.3984	6.96	76.138	3.81
6	100	0.3249	0.06	1.1436	0.51	14.3173	5.73	86.363	4.32
7	200	0.2033	0.04	0.7158	0.32	8.9605	3.58	96	4.80
8	300	0.1555	0.03	0.5473	0.24	6.851	2.74	105.12	5.26
9	400	0.1331	0.03	0.4684	0.21	5.864	2.35	114.15	5.71
10	500	0.119	0.02	0.4188	0.19	5.2426	2.1	116.98	5.85
11	600	0.1135	0.02	0.3995	0.18	5.0016	2	116.46	5.82
12	700	0.1056	0.02	0.3718	0.17	4.6543	1.86	113.2	5.66
13	800	0.0973	0.02	0.3425	0.15	4.2881	1.72	109.3	5.47
14	900	0.0894	0.02	0.3146	0.14	3.9381	1.58	105.01	5.25
15	1000	0.0824	0.02	0.2901	0.13	3.6312	1.45	70.781	3.54
16	……								
17	2500	0.0387	0.01	0.1364	0.06	1.7075	0.68	66.943	3.35
Downwind maximum concentration		0.5154	0.1	1.8141	0.81	22.7111	9.08	116.98	5.85

9.1.10 Compliance analysis

(1) Compliance analysis of organized exhaust gas

The organized exhaust gas under normal working conditions of this project are SCV and boiler, which can meet the Boiler Air Pollutant Emission Standard (DB12/151-2016). The organized exhaust gas of this project reaches the emission standards.

Table 9.1-11 Organized compliance demonstration

Source of pollution	Pollutant concentration of NOx (mg/m3)	Pollutant concentration of smoke (mg/m3)	Pollutant concentration of SO2 (mg/m3)	Emission concentration of NOx (mg/m3)	Emission concentration of smoke (mg/m3)	Emission concentration of SO2 (mg/m3)	Name of criteria	Compliance or not
SCV	70	10	2.86	80	10	20	Boiler Air Pollutant Emission Standard (DB12/151-2016)	Compliance
Boiler	70	10	2.86					Compliance

(2) Compliance analysis at the factory boundary

According to the calculation results, the maximum emission concentration of the project can meet the requirements of industrial enterprises for volatile organic matter emission control standards (DB12/524-2014) and comprehensive emission standards for air pollutants (GB16297-1996). The unorganized emission of this project meets the standards at the factory boundary.

Table 9.1-12 Unorganized compliance demonstration

Pollutant	Emission concentration (μg/m3)	Monitoring limit of unorganized concentration at factory boundary (mg/m3)	Source of criteria	Compliance or not
VOCS	116.98	2.0	Industrial enterprise volatile organic matter emission control standards (DB12/524-2014) Table 5	Compliance
SO2	0.5154	0.4	Integrated emission standards for atmospheric pollutants (GB16297-1996)	Compliance
NOx	22.7111	0.12		Compliance
Particulate matter	1.8141	1.0		Compliance

9.1.11 Atmospheric environmental protection distance

According to the "Technical Guidelines for Environmental Impact Assessment - Atmospheric Environment" (HJ2.2-2018) and the prediction results of the AERSCREEN model, among the emission pollutants of the project: the concentration of non-methane total hydrocarbons at the factory boundary is lower than the concentration limit, the average hourly concentration of SO2, NOx, PM2.5 and non-methane total hydrocarbons outside the factory boundary is lower than the environmental quality concentration limit. Therefore, the atmospheric environmental protection distance is not required for this project.

9.1.12 Summary

(1) During normal operation, the ratio of the downwind maximum concentration contribution of the NOx, SO2, PM2.5 and non-methane total hydrocarbons generated by the submerged Combustion vaporizer combustion, flare long-light burning, boiler combustion exhaust gas and unorganized emission to environmental standards is less than 9.08%, 0.10%, 0.81%, and 5.85% at the Receiving terminal, respectively. The pollutants emitted by this project have little impact on the regional atmospheric environmental quality.

(2) The organized and unorganized exhaust gases of this project can reach the emission standard.

(3) The atmospheric environmental protection distance is not required for this project.

9.2 Prediction and analysis of water environment impact during operation period

9.2.1 Prediction and analysis of environmental impacts of cold drainage during operation period

The content of this section is quoted from the “Hydraulic Dynamics Related Mathematical Model Test of Beijing Gas Nangang LNG Emergency Reserve Project Supporting Terminal Project” (Nanjing Hydraulic Research Institute, December 2018).

9.2.1.1 Mathematical model of temperature field

The basic equation of the mathematical model of the two-dimensional temperature field along the water depth is the following:

$$\frac{\partial H\Delta T}{\partial t}+\frac{\partial uH\Delta T}{\partial \xi}+\frac{\partial vH\Delta T}{\partial \eta}=\frac{\partial}{\partial \xi}\left(E_{\xi}H\frac{\partial \Delta T}{\partial \xi}\right)+\frac{\partial}{\partial \eta}\left(E_{\eta}H\frac{\partial \Delta T}{\partial \eta}\right)-\frac{K_s\Delta T}{\rho C_p}+q\Delta T^*$$

where: $H=d+\zeta$ is the water depth (m)

ΔT is temperature difference of water body (℃)

E_ξ and $E\eta$ are diffusion coefficients in the direction of ξ and η, respectively (m^2/s)

Ks is comprehensive heat dissipation coefficient of water surface (W/ (m^2 ℃))

Cp is constant pressure specific heat of water (W s/ (m^3℃))

q is unit area flow of source or sink (m/s)

ΔT^* is water temperature difference of source or sink (℃)

The initial condition of the above equation is $\Delta T(t,\xi,\eta)\big|_{t=t_0}=\Delta T_0(\xi,\eta)$. Inflow boundary conditions is $\Delta T|_{\Gamma_0}=\Delta T(t)$, outflow boundary conditions is $\partial\Delta T/\partial n=0$, n is normal unit vector of outflow boundary.

9.2.1.2 Parameter selection

According to the engineering design plan, the water intake is arranged at the LNG berth and the south side of the work boat dock, and a total of 6 seawater gasifiers are installed. The seawater consumption of a single seawater gasifier is 9800 m3/h, and the water intake is 58800 m3/h (16.33 m3/s).

The clearance size of the water intake is B×H=4.00m×2.50m, and the design flow of each pump is 2.86m3/s, that is, the water withdrawal flow rate is 0.286m/s.

The drainage outlet is located in the East basin, 665m south of the water intake, and adopts a 2-hole B×H=4×2m drainage tank culvert with a flow rate of V=1.07m/s.

The high tide is selected as the representative tide type.

In the temperature field model, the ambient temperature is 15 °C, and the diffusion coefficient is taken as: $E\xi=E\eta=10.0m^2/s$.

The water emitted by LNG is colder than the ambient temperature, which has a relatively large density and thus it sinks to the bottom. The heat exchange between the surface of the water and the air is relatively small. Therefore, the heat exchange of the water-air interface is not considered in the calculation, that is, the comprehensive heat dissipation coefficient of the water surface is zero.

Figure 9.2-1 shows the flow rate of the monitoring point at 70m outside the water intake and outlet. Figure 9.2-2 shows the change of the flow velocity component at 70m outside the outlet with the tidal level fluctuation.

The intake and outlet are located in the weak flow area of the East basin, and the rapid flow rate is less than 0.1m/s. When the water intake and outlet ports work, it will cause a certain degree of deflection in the direction of the nearby water flow. The water intake port will attract the nearby water flow to deflect eastward, and the vicinity of the water discharge port will deflect westward. The water flow rate is small and will not have a significant impact on the flow pattern in the East basin; the drainage flow rate is relatively large, and the drainage kinetic energy will dissipate quickly, and will also not have a significant impact on the flow pattern in the East basin.

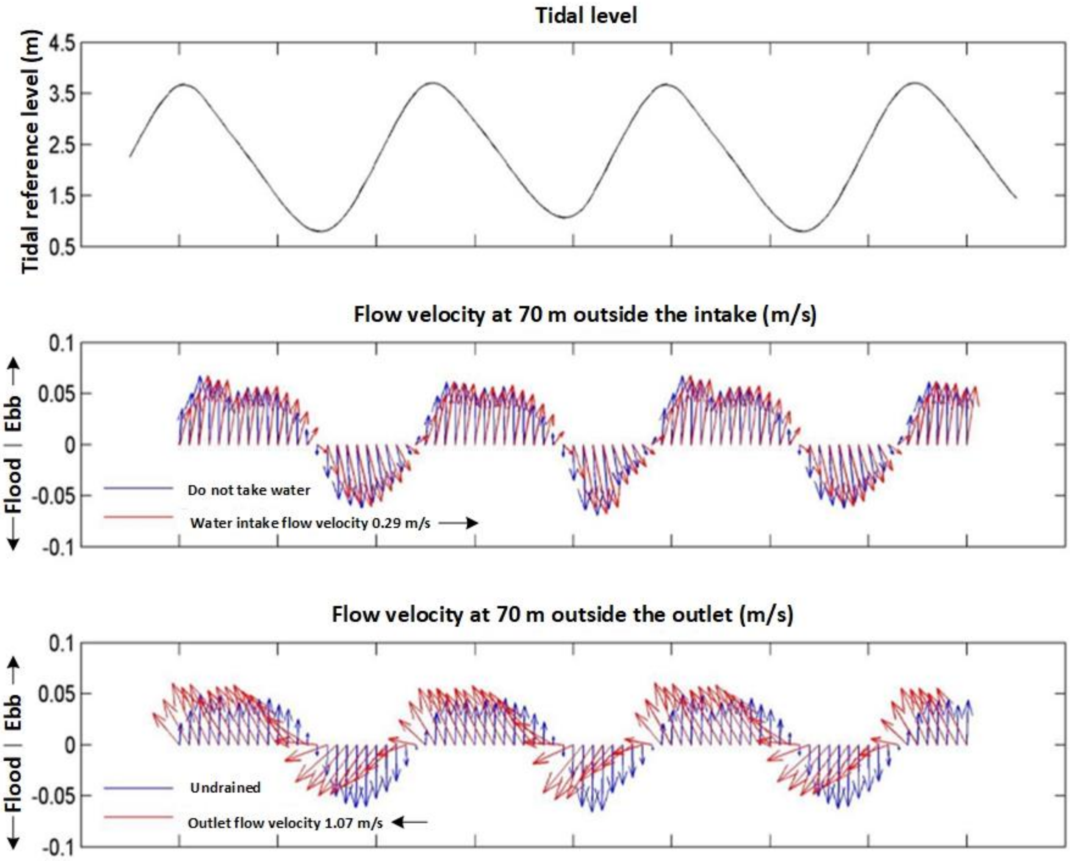


Figure 9.2-1 Influence of flow velocity near the intake and outlet in the East basin

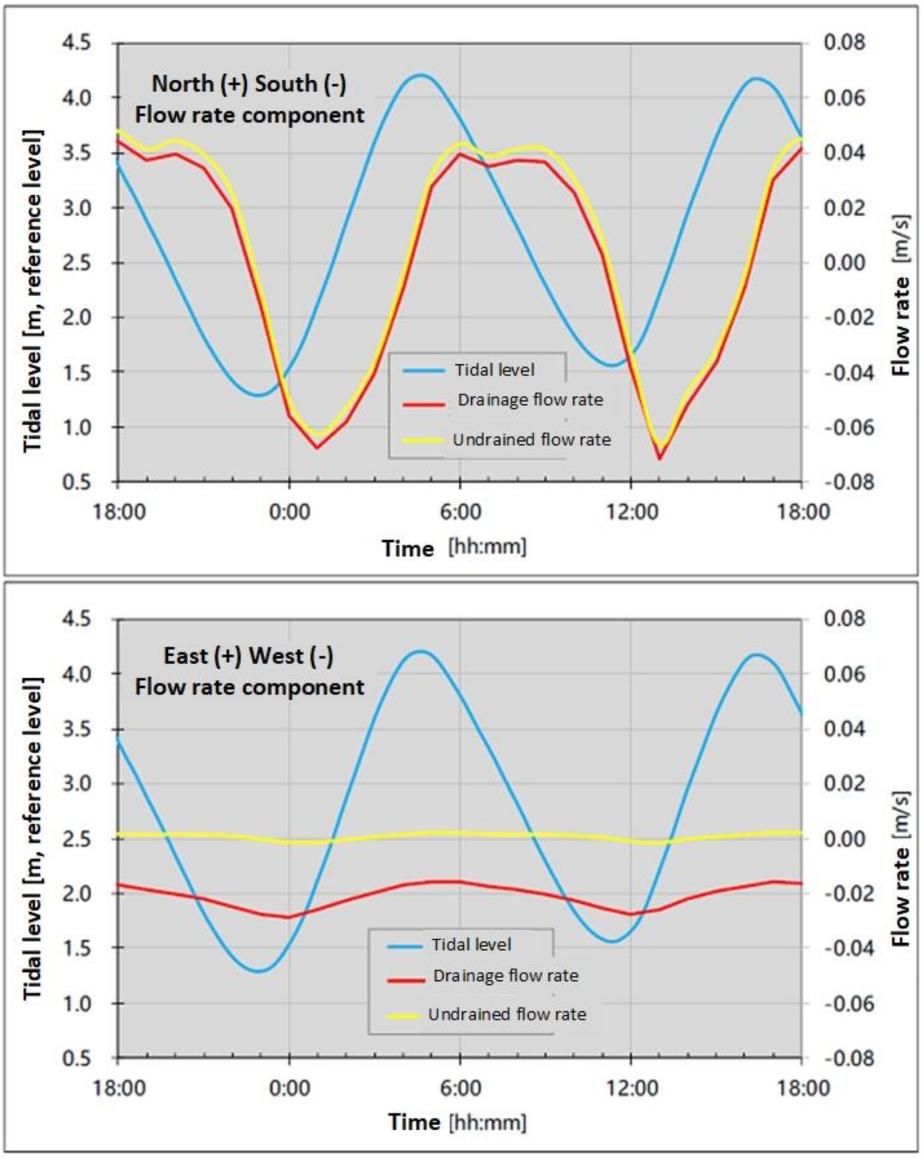


Figure 9.2-2 The flow velocity component at 70m outside the outlet.

9.2.1.3 Prediction results

According to the "Sea Water Quality Standards" (GB3097-1997), the seawater temperature rise caused by human activities does not exceed 1 °C for the second type of seawater in the summer, ≤2 °C in other seasons, and ≤4 °C in the fourth type of seawater. There is no standard for temperature drop caused by cold seawater discharge in seawater quality standards. Since the lower temperature limit of most marine organisms is larger than the upper limit, from a conservative perspective, the effect of cold drainage is considered according to the temperature rise standard in the report.

Figure 9.2-3 shows the envelope of the maximum influence range of the cold drainage temperature drop. Table 9.2-1 shows the farthest distance and area of the envelope of cold drainage temperature drop. It can be seen from the calculation results that the farthest diffusion distance with a temperature drop exceeding 0.5 °C is 731 m, the maximum diffusion area is 1.207 km2; the farthest diffusion distance with a temperature drop exceeding 0.4 °C is 1125 m, the maximum diffusion area is 2.381 km2; the temperature drop exceeds 0.3 °C. The farthest diffusion distance is 1845m, the maximum diffusion area is 7.779km2; the farthest diffusion distance with temperature drop over 0.2°C is 2276m, and the maximum diffusion area is 33.979km2.

The temperature drop caused by the cold water discharge of the project will not affect the South Port, so it will not affect the nearest environmentally sensitive protection target outside the Nangang Industrial Zone, the agricultural and fishery area in southeastern Tianjin.

Table 9.2-1 The maximum distance and area of cold drainage temperature drop envelope.

Temperature drop (°C)	>=0.5℃	>=0.4℃	>=0.3℃	>=0.2℃
Farthest diffusion distance (m)	731	1125	1845	2276
Maximum diffusion area (km^2)	1.207	2.381	7.379	33.979

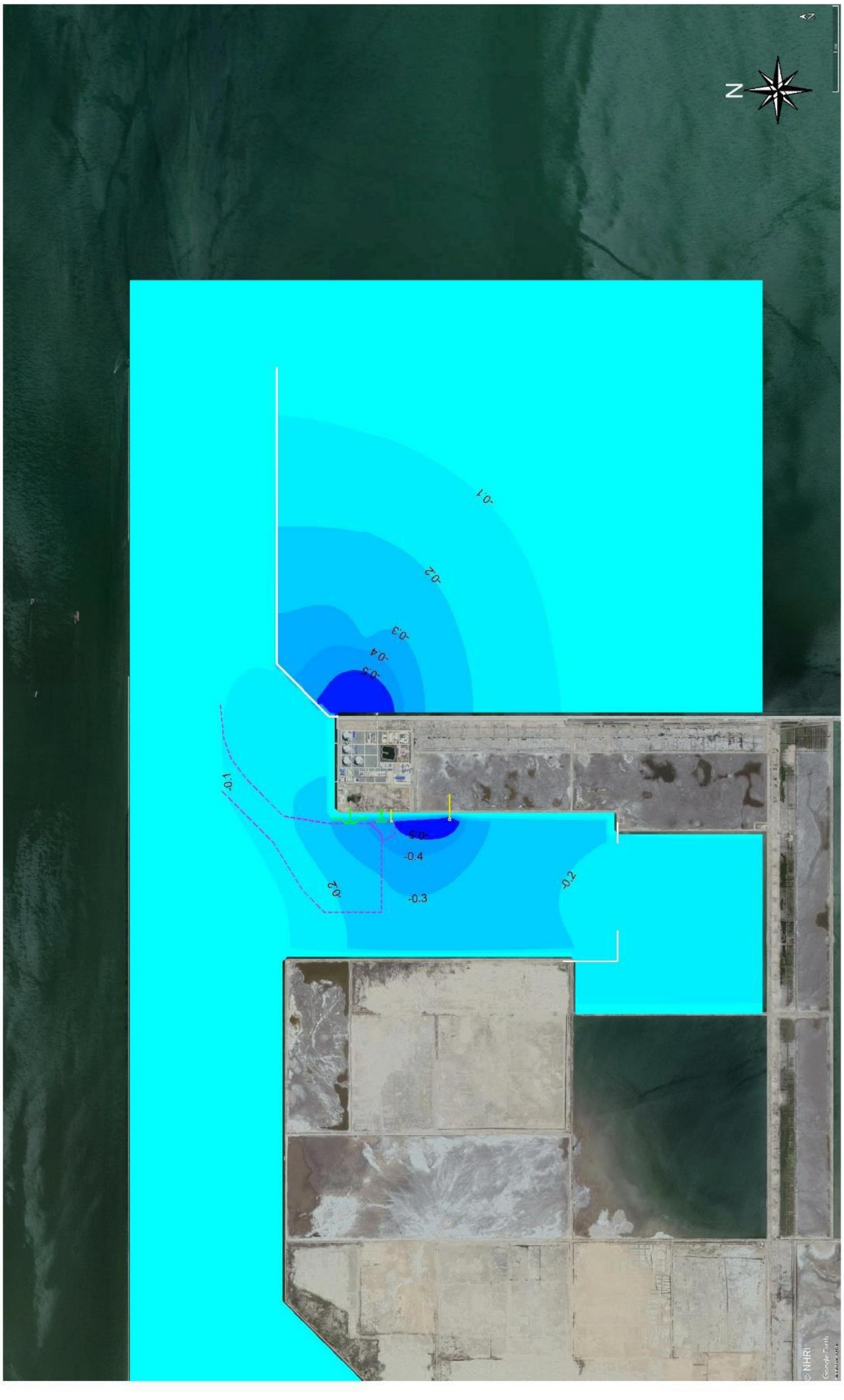


Figure 9.2-3 The envelope of maximum influence range of cold drainage temperature drop.

9.2.2 Prediction and analysis of environmental impacts of residual chlorine emissions during operation period

9.2.2.1 Two-dimensional convection-diffusion model of residual chlorine

For the problem of convective diffusion of residual chlorine in seawater, seawater is regarded as an incompressible fluid, so the basic equation of convective diffusion of residual chlorine in a two-dimensional non-uniform flow can be expressed as:

$$\frac{\partial C}{\partial t}+u\frac{\partial C}{\partial x}+v\frac{\partial C}{\partial y}=\frac{\partial}{\partial x}(E_x\frac{\partial C}{\partial x})+\frac{\partial}{\partial y}(E_x\frac{\partial C}{\partial y})-KC+S \qquad (1)$$

where: C is residual chlorine concentration, kg/m^3; t is time, s; *x* and *y* are longitudinal and lateral distance, respectively, m; *u* and *v* are longitudinal and lateral vertical mean flow rate, m/s; E_x is longitudinal diffusion coefficient, m^2/s; E_y is lateral diffusion coefficient, m^2/s; *K* is attenuation coefficient, s^{-1}; S is strength of pollutant source, kg/m^3.

9.2.2.2 Definite solution conditions

Boundary conditions

Land boundary: $D_n\frac{\partial \rho}{\partial t}=0$

Open boundary: $\rho=0$, inflow segment

$\frac{\partial \rho}{\partial t}+v_n\frac{\partial \rho}{\partial n}=0$, outflow segment

where: n is normal direction; D_n is diffusion coefficient in normal direction, m^2/s

Initial conditions

$t=0;\rho=0$

9.2.2.3 Determination of parameters and source strength

(1) Diffusion coefficient

The natural sea area generally has an uneven velocity field. The diffusion coefficient is an important parameter and difficult to determine. It often has a property of the empirical coefficient. The formula for calculating the diffusion coefficient used in this paper is:

$$E_x=\alpha_x h u_*;E_y=\alpha_y h u_x \qquad (2)$$

where: h is water depth, m; u_* is friction flow rate ($u_*=\sqrt{ghj}$, j is hydraulic gradient), m/s; α_x,α_y are empirical coefficient which is 4.0 and 0.5, respectively.

(2) Attenuation coefficient

Since the decay process of residual chlorine in the ocean is not yet clear, the attenuation coefficient is generally determined experimentally. Lanfen Liu et al. combined field and laboratory experiments to quantitatively study the decay time of residual chlorine. The results show that in the case of a sea area in Shanghai, a laboratory with sunlight, and no sunlight in the laboratory, the time is 0.5, 2.0, 18h for 50% attenuation of residual chlorine., and the time taken for 90% attenuation is 1.8, 22, 56h, respectively; Sui Zhang et al. investigated the attenuation curve of residual chlorine in seawater by investigating the adjacent waters of the cooling water outlet of Daya Bay Nuclear Power Station.

Generally, the residual chlorine decay is assumed to be a first-order reaction, and the model is as follows:

$$\frac{dC}{dt} = -KC \qquad (3)$$

where: C is residual chlorine concentration, kg /m^3; K is attenuation coefficient， s^{-1}.

Referring to the results of these experiments, the half-life of residual chlorine in this study was taken as 1 h, and the attenuation coefficient of residual chlorine was calculated to be 0.69 according to the first-order attenuation model of residual chlorine.

(3) Drainage

The drainage outlet is located in the East basin, 665m south of the water intake, and adopts a 2-hole B×H=4×2m drainage tank culvert with a flow velocity of V=1.07m/s.

The high tide is selected as the representative tide type.

9.2.2.4 Prediction results

Figure 9.2-4 shows the envelope of the maximum impact range of residual chlorine. Table 9.2-2 shows the maximum distance and area of the envelope affected by residual chlorine. It can be seen from the calculation results that the farthest diffusion distance of residual chlorine exceeding 0.01 mg/L is 3750 m, the maximum diffusion area is 2.475 km2; the farthest diffusion distance of residual chlorine exceeding 0.02 mg/L is 3150 m, and the maximum diffusion area is 1.135 km2; The farthest diffusion distance of chlorine exceeding 0.03mg/L is 2650m, the maximum diffusion area is 0.545km2; the farthest diffusion distance of residual chlorine exceeding 0.04mg/L is 2150m, the maximum diffusion area is 0.275km2; the residual chlorine is over 0.1mg/L. The farthest diffusion distance is 1300m and the maximum diffusion area is 0.088km2.

The maximum impact range of drainage residual chlorine will not reach the South Port, so it will not affect the nearest environmentally sensitive protection target outside the Nangang Industrial Zone, the agricultural and fishery area in southeastern Tianjin.

Table 9.2-2 The farthest distance and area of the drainage residual chlorine affects envelope.

Concentration (mg/L)	0.01	0.02	0.03	0.04	0.1	0.2
Farthest diffusion distance (m)	3750	3150	2650	2150	1300	0
Maximum diffusion area (km^2)	2.475	1.135	0.545	0.275	0.088	0.000

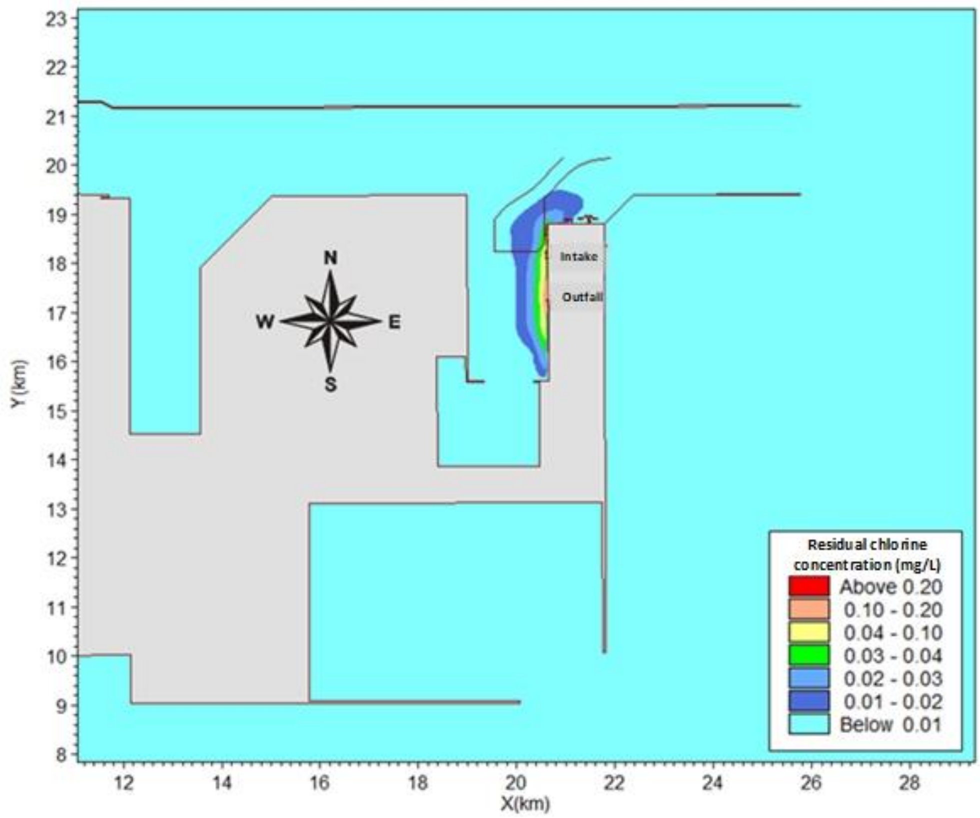


Figure 9.2-4 The maximum influence range of drain residual chlorine envelope.

9.2.3 Environmental Impact Analysis of Other Wastewater in Terminals and Receiving terminal during Operation Period

9.2.3.1 Domestic sewage, machine oil sewage, washing wastewater, initial rainwater

The land-based domestic sewage and ship domestic sewage of the proposed project shall be discharged into the self-built sewage treatment station for treatment after reaching the standard; the machine oil-sewage, washing wastewater and initial rainwater shall be collected and discharged into the self-built sewage treatment station for compliance treatment.

The self-built sewage treatment station has a treatment capacity of 10m3/h, and adopts the treatment process of “oil-water separation + air-floating deoiling” two-stage degreasing and “MBR biochemical reaction”. It can meet the treatment needs of domestic sewage, machine oil wastewater, washing wastewater and initial rainwater. These waters will be treated in the self-built sewage treatment station to reach the “Urban Wastewater Recycling City Miscellaneous Water Quality” (GB/T18920-2002) standard. The part of treated water will be used as the greening water in Receiving terminal, road spraying and ground washing water, and the rest will be discharged into domestic sewage collection pool and received and processed by the Nangang Wastewater Treatment factory during the non-heating season; during the heating season, it is treated by the self-built sewage treatment station and discharged into the Nangang Wastewater Treatment factory for treatment.

9.2.3.2 Ship oily sewage

The ship oily sewage is entrusted to a qualified unit for processing.

During the operation period, all kinds of wastewater are effectively collected, separated and treated. After treatment, they will be reused or disposed of by external authorities. They will not be directly discharged to the outside world and will not directly affect the surrounding seawater environment.

9.2.4 Summary

In summary, the scope of the temperature drop caused by the cold water discharge of the proposed project during the operation period and the maximum impact range of residual chlorine will not reach the South Port, and will not affect the environmentally sensitive protection targets of the open sea; the remaining wastewater will be separated and treated. Therefore, the operational period of the proposed project has little impact on the surrounding seawater environment and can be accepted by the environment.

9.3 Prediction and evaluation of acoustic environmental impact during operation period

9.3.1 Noise sources

During the normal working conditions of the proposed project, the noise sources mainly include loader pumps, compressors, gasifiers and other equipment, and the noise value is about 80～95dB (A).

Table 9.3-1 List of noise sources of proposed projects

Category	Name of noise source	Indoor/out door	Noise value after noise reduction (dB (A))	Number of operating equipment
Port engineering	Ship pump	Inboard	91	4
BOG recycling system	BOG compressor	Outdoor	90	2
	High pressure BOG compressor	Outdoor	93	1
Gasification system	Seawater gasifier	Indoor	85	1
	Immersion combustion gasifier	Indoor	85	1
	Sea water pump	Indoor	93	7
	External pump	Indoor	85	2
Air compression nitrogen system	Instrument air compressor	Indoor	90	1
	PSA Nitrogen system	Indoor	90	1
Water supply system	Water supply system pressure pump	Indoor	85	2
	Circulating pump	Indoor	85	1
Sewage treatment system	Various lifting pumps	Indoor	80	6
	Roots blower	Indoor	95	1

9.3.2 Prediction mode

This evaluation uses the recommended mode in the Environmental Impact Assessment Technical Guidelines - Acoustic Environment (HJ2.4-2009) for prediction. The A sound level is used to calculate, the calculation mode of sound pressure level of the outdoor sound source at the predicted point is as follows:

LP (r)=LP (ro) – (Adiv+Aatm+Abar+Agr+Amisc)

where: LP (r) is A sound level from the sound source r, dB (A);

Lp (ro) is A sound level at reference position ro, dB (A);

Adiv is A-level attenuation introduced by acoustic wave divergence, dB (A);

Aatm is sound level attenuation caused by atmospheric absorption, dB (A);

Agr is sound level attenuation caused by ground effect, dB (A);

Abar is sound level attenuation caused by barrier shielding, dB (A);

Amisc is sound level attenuation caused by other multifaceted effects, dB (A);

When only the geometric divergence attenuation is considered, the calculation mode is as follows:

LA (r)=LA (ro)–Adiv

9.3.3 Evaluation criteria

The proposed project boundary implements the third class standard in the "Environmental Noise Emission Standard for Industrial Enterprises Boundary" (GB12348-2008), namely 65dB (A) during daytime and 55dB (A) at night.

9.3.4 Results of prediction and its evaluation

Noise prediction results of the proposed project during operation period are shown in Table 9.3-2

Table 9.3-2 Noise prediction results during operational period Unit: dB (A)

Name of factory boundary	Daytime		Night time	
	Predictive value	Standard value	Predictive value	Standard value
East factory boundary	54	65	54	55
South factory boundary	53.4		53.4	

It can be seen from Table 8.3-2 that for both daytime and nighttime, the noise at the east side and the south side of the factory boundary of the Receiving terminal during the operation period can meet the requirements of the third-class standard in the Environmental Noise Emission Standard for Industrial Enterprises (GB12348-2008). The construction of the project has little impact on the external acoustic environment.

9.3.5 Summary

For both daytime and nighttime, the noise at the east side and the south side of the factory boundary of the Receiving terminal during the operation period can meet the requirements of the third-class standard in the Environmental Noise Emission Standard for Industrial Enterprises (GB12348-2008). The construction of the project has little impact on the external acoustic environment.

9.4 Analysis of marine ecological environment impact during operation period

9.4.1 Ecological impact of cold drainage during operation period

(1) Influence mechanism of cold drainage

After the cold seawater is discharged into the sea, under the action of hydrodynamic conditions, the temperature of the cold seawater water mass rises rapidly after the diffusion and dilution heat dissipation process. At the same time, the water temperature of the marine environment within a certain range near the discharge port will decrease. Studies have shown that seawater temperature changes affect the metabolism of marine organisms, affecting their respiratory, metabolic rate, growth, reproduction and other functions. Various marine organisms have a certain range of normal growth temperatures and optimal temperature ranges, and their ability to withstand sudden changes in temperature is limited, while marine organisms are much less tolerant of temperature than terrestrial or freshwater organisms. In addition, the optimal temperature for most marine life is close to the maximum temperature tolerance limit (the upper temperature limit); while the safety factor is more tolerant on the lower temperature side than on the upper limit side. In other words, the damage of low temperature to life is not as good as high temperature in some aspects.

When the water temperature of the environmental water falls below the appropriate temperature range for the growth of marine organisms, it may lead to the inhibition or death of marine organisms; if the water temperature of the environmental water falls but is still within the proper temperature range of marine organism growth, it will not affect the marine life. The growth and reproduction, under certain conditions, may also promote the growth and reproduction of marine life. The closer the ambient water temperature is to the optimal water temperature of the species, the smaller the population abundance change caused by the temperature drop, and the closer to the limit water temperature, the smaller the temperature drop may also have greater consequences. Therefore, the effects of winter cold effects on aquatic organisms will be more pronounced than in other seasons.

(2) The effect of temperature drop on plankton

Plankton is not only a bait organism for some fish, shrimp, and shellfish, but its quantity determines the size of the primary productivity of the sea, which can affect the potential of fishery resources. The effect of temperature drop can be referred to the foreign research on temperature rise. When the water temperature rises above 6-8 °C, the activity of photosynthesis of phytoplankton is only weakened in summer. This phenomenon does not destroy the cells of algae. The photosynthesis of phytoplankton can be restored in hours (no more than one night). For zooplankton, when the temperature rise of water is less than 3 °C, it will not adversely affect its population in most cases.

(3) The effect of temperature drop on fish

Fish at different stages of development often have different requirements for temperature conditions. The requirements for reproduction and development are particularly strict. Many marine animals do not spawn at a certain water temperature. Sometimes marine animals can live in a certain sea area, but because they cannot meet the conditions required for reproduction and development (including suitable temperature and duration), these animals cannot complete reproduction and development in this sea area. Therefore, there is a difference between the reproductive zone and the sterile zone.

On the one hand, if the water temperature is below the moderate temperature range, it will inhibit the metabolism and growth of the fish, and if it exceeds its tolerance, it will also lead to death. On the other hand, fish can feel the slight change of the ambient water temperature, and have an avoidance response to the low temperature water body below the moderate temperature range, which makes many fishes carry out long-distance temperature-friendly migration. This avoidance precludes the possibility of cold threats to juvenile and adult fish in winter. In addition, changes in water temperature will affect the spawning of fish, affecting the sooner or later of the fishing season, changes in the fishery, and affecting the catch.

In summer, proper temperature reduction is beneficial to fish organisms, while winter temperature decline is detrimental to fish growth. The area where the temperature drop is greater than the environment of 4-5 °C, the catch reduction is more obvious. In the region where the temperature drop is 4-5 °C, the catch in winter will be lower, while in summer it will recover; in the region where the temperature drop is 2-3 °C, low catch will occur in winter, but high catch occur in summer and spring. The effect of areas where the temperature drops below 2 °C will not be noticeable. For most warm-water fish, the temperature drop of 1 °C is basically within its temperature range and generally does not affect the growth of fish.

(4) Effect of temperature drop on shrimp

According to the relevant research results, the adaptation temperature of Chinese shrimp and shrimp is 20-32 °C. During the summer and autumn seasons, the temperature drop caused by the cold drainage of the Receiving terminal will not have obvious adverse effects on the shrimps in the sea area, and the shrimps can grow and reproduce normally; in the cold season of winter and spring, when the temperature drops exceed 3 °C The growth of shrimp larvae may be inhibited, and the survival rate may be reduced. Most of the adult individuals of shrimp will avoid the low temperature zone, thus affecting the shrimp intake in the temperature drop field.

（5）Effect of temperature drop on shellfish cultivation

According to the survey, the optimum temperature range for most shellfish is around 15-30 °C. Within the appropriate temperature range, temperature reduction may affect the growth and development of shellfish. In the temperature range, if the temperature suddenly changes suddenly, the shellfish cannot adapt to it, which will lead to diapause or death. Therefore, in the hot summer season, the impact of cold seawater discharge on shellfish is relatively small, and may even promote the growth and development of shellfish, but in the lower temperature season, cold seawater discharge will have a greater impact on shellfish, possibly lead to diapause or death of shellfish.

9.4.2 Ecological impact of residual chlorine during the operation period

Jiangning Zeng, Quanzhen Chen and others studied the effects of residual chlorine on aquatic organisms in 2005. This section mainly analyzes the impact of residual chlorine emissions on the ecological environment during the operation period based on their paper “Effects of residual chlorine on aquatic organisms” published in the journal of Ecology.

(1) Effect of residual chlorine on phytoplankton

The residual chlorine in the cold drainage of the LNG Receiving terminal is the main factor that damages phytoplankton. 0.2 mg/L of chlorine can directly kill 60% to 80% of algae in cooling water. But GLasstone et al. believe that even if 20% of the phytoplankton population is killed, the net effect of the waters can be ignored. Sarvanane et al. considered that when the effective chlorine concentration in the seawater outlet of the coastal industry was controlled between 0.2-0.5 mg/L, three water samples in the water intake, cooling pipe and drain were cultured indoors. The initial concentrations of diatom were 413, 352 and 381 ind/mL, reaching the same cell density (617×104~813×104 ind/mL) requires 3, 6, and 8d, respectively, indicating that phytoplankton has strong recovery potential, and the damage of residual chlorine to phytoplankton can be recovered quickly. In addition, the effects of chlorine on phytoplankton are different under different water quality conditions. When the proportion of total particulate matter and dissolved organic carbon in seawater is high, the same concentration of chlorine has less effect on phytoplankton because a large amount of chlorine is mainly consumed by the former.

(2) Effect of residual chlorine on zooplankton

Although zooplankton is an important part of the aquatic ecosystem, there are few reports on the effects of chloride on zooplankton. According to a small amount of research results, zooplankton is more sensitive to chlorine, and lower concentrations of chlorine can have a significant effect on zooplankton; the concentration of zooplankton affected by continuous chlorine exposure is lower than that of intermittent exposure.

(4) Effect of residual chlorine on shellfish

Residual chlorine can cause the reduction of sub-lethal parameters such as shellfish filter-feeding rate, activity frequency, shell opening and closing frequency, oxygen consumption, foot secretion, and fecal output, so that shellfish lose their adhesion ability. When the residual chlorine concentration is less than 1 mg/L, the shellfish can still open the outer casing for feeding, but the feeding rate is lowered. MasiLamoni et al believe that the mechanism of residual chlorine poisoning on shellfish may be: ① chlorine directly causes damage to shellfish epithelial cells; ② oxidation caused by chlorine destroys shellfish respiratory membrane, causing its body to lack oxygen and suffocation; ③Chlorine directly participates in the oxidation of the shellfish enzyme system.

(4) Effect of residual chlorine on fish

Residual chlorine has a damaging effect on the surimi, causing lesions in the surimi tissue, such as tissue hyperplasia, epithelial tissue detachment, accumulation of a large amount of mucus in the sputum, and formation of an aneurysm, thereby affecting and hindering the exchange of dissolved oxygen in the fish carp and water. Residual chlorine may also penetrate into the blood through the fish gill tissue, oxidize the oxygen-reducing reduced hemoglobin in the blood into orthohemoglobin that cannot carry oxygen, and may also inhibit the activity of the methemoglobin-reducing enzyme, thereby declining the ability of blood to carry oxygen.

Some fish can develop certain resistance to chlorine through their own regulation and improve their tolerance to chlorine. For example, Lotts et al. believe that residual chlorine of 0.04～0.08 mg/L can induce the adaptability of salmonids to chlorine, but the physiological and biochemical changes of fish in this adaptation process are not clear.

(5) Form and attenuation of residual chlorine in seawater

Residual chlorine has strong oxidizing properties. It not only kills bacteria, but also harms biological organisms. Therefore, it will have certain impact on the ecological environment of adjacent seas. According to the research of Guizhong Li, Jiangning Zeng, Lanfen Liu, Yucai Bai, etc., the residual chlorine in the water exists in the form of free residual chlorine (FRC) and combined residual chlorine (CRC), among which the free residual chlorine is more toxic to aquatic organisms, about 6 times stronger than the combined residual chlorine. The free residual chlorine in seawater is unstable, and the residual chlorine combines with ammonia or organic amines in seawater to form chloramine. Studies have shown that its half-life in seawater is about 1 hour.

(6) Analogy investigation of residual chlorine

According to Zhang Sui et al., the investigation of residual chlorine in the sea adjacent to the discharge of the Daya Bay nuclear power plant. The survey was sampled once a season in a year, and three monitoring points were set at intervals of 50 m in the drain. The monitored residual chlorine concentrations were 0.20, 0.17, and 0.13 kg/L, respectively. The residual chlorine concentration at the initial point of drainage was 0.2 mg/L, after a distance of 100m, the residual chlorine concentration is 0.13 mg/L, indicating that the decay rate of residual chlorine is very fast; the high residual chlorine area in the sea area appears near the drainage outlet, and the content is 0.03~0.04 mg/L; the concentration of residual chlorine in the area close to the drain is slightly higher, generally 0.02 ~ 0.03 mg/L; the content near offshore station is relatively low, usually ≤0.01 mg/L; The residual chlorine content in the waters adjacent to the Daya Bay Nuclear Power Station is relatively low. The average level in the four seasons is only 0.01-0.02 mg/L. The seasonal distribution is even, the winter is relatively high, and the summer is low, but there is no significant difference. Besides, the vertical distribution of residual chlorine in the water body is consistent, and there is no significant difference in the content of residual chlorine in the water in the surface and bottom layer. The form of residual chlorine in seawater is in a combined state.

(7) Analysis of the influence of residual chlorine in cold drainage

According to the above-mentioned extensive data, the residual chlorine has certain toxic effects on marine organisms, and the degree of its influence depends on various factors, among which the main content is the level of residual chlorine, the sensitivity of the biological species itself to residual chlorine or the ability to resist the toxic effects of residual chlorine, the length of contact time and the temperature of seawater, in addition to a variety of environmental factors, such as the supply of biological bait, pH, etc. also play an important role; in addition, fish have obvious avoiding-reaction.

The affected area of residual chlorine in this project is mainly concentrated in the sea area near the discharge port. For this sea area, some sensitive fish will have an avoidance reaction to avoid, but for other fish and marine organisms, the residual chlorine emission of this project may have certain adverse effects on its growth, development and reproduction. Some organisms sensitive to residual chlorine may die or stop growing, and the number of organisms will be reduced. The number of species will also decrease due to disappearance and reduction of sensitive species. However, for the whole sea area, the scope of its impact is limited. From the results of the analogy survey, it will not have a significant impact on the overall ecology of the sea area.

9.4.3 Ecological impact of the water intake process during the operation period

In order to remove the sand and large aquatic organisms in the seawater, the water intake system includes water pumps, water intake channels or water pipes, rotating filters, trash racks and other equipment. Under the action of the filter screen and the trash rack, large creatures collide with the mesh screen and are caught. Smaller plankton and floating fish eggs and larvae can enter the cooling system. Due to the rapid extraction of seawater from the pump, the aquatic organisms are subject to mechanical collision damage. In fact, the hazard of the roll-off effect during the water intake process is a combination of three factors, namely the impact collision of high-speed water flow, cold shock and the toxicity of residual chlorine.

(1) Analysis of the impact on plankton

The Institute of Environmental Science of Northeast Normal University studied the damage of phytoplankton in the cooling water system of Qingdao Power Plant from 1987 to

1990. The study found that the mechanical damage rate of planktonic algae and zooplankton in the cooling water caused by the roller load effect was 12-27% and 55%, respectively. After the cooling water is discharged into the sea, about 3 days, the floating algae can recover the original quantity, while the recovery period of the zooplankton is about l-6 days.

According to this analysis, the roll-load effect produced by the LNG water intake system will cause a certain degree of damage to plankton, which will reduce the plankton biomass in the water intake group and reduce the marine primary productivity. However, because plankton has a short reproductive cycle and rapid reproduction, its recovery after damage is also faster. Therefore, the damage caused by the roller-load effect has little effect on the total plankton biomass and population structure in the sea area.

(2) Analysis of the impact on fish eggs and larvae

According to the field test results of the Institute of Environmental Science of Northeast Normal University, the injury rate of the pike juveniles (body length 25.40 mm) entering the cooling water system was 31.6-46.3%, with an average of 43.88%. According to foreign reports, the fatal rate of juvenile fish is related to the body length of juvenile fish, and there is a negative correlation between the two. The length of the fish is in the range of 14-40 mm, and for every 1 mm increase in body length, the mortality rate of juvenile fish due to coiling is reduced by about 3%. According to relevant information, the disability rate of fish eggs entering the cooling water system is 40.7%, and the disability rate of larvae is 43.8%. Therefore, the impact of the water intake process on the fish eggs and larvae entering the gasification system is relatively large.

Because marine fish has the characteristics of strong reproductive ability and spawning, and is affected by many factors of the marine natural environment, the natural mortality rate of fish eggs and larvae is very high. In addition, the water intake of this project is 25500 m^3/h. Compared with the water body of the whole sea, the water intake is not large, the water intake process has certain influence on the fish eggs and larvae in the whole sea area, but the range is relatively small.

(3) Synergistic effects of sudden temperature drop, residual chlorine and mechanical entrainment on the entrapped organism

The organisms that suffer from synergy are mainly phytoplankton, zooplankton (including fish eggs, larvae and microbes, etc.). The Daya Bay Nuclear Power Plant Ecology Survey measures the rate of biological ATP and photosynthesis, as well as the combined effects of the reaction. The conclusion is that in the culvert environment and in the absence of chlorine, the mechanical and thermal effects have no significant effect on zooplankton, but the photosynthesis ability of phytoplankton is significantly reduced; Under the combined effect, the residual chlorine effect on phytoplankton or zooplankton is more significant than that of mechanical and thermal, especially for phytoplankton, and its damage degree is positively correlated with chlorine intensity.

The marine organisms will be harmed during the water intake process by the fact that some of the larger marine organisms (mainly young fish less than 12mm in length) after chemical damage caused by chlorination disinfection have been subjected to the impact effect through the rotary filter. The mortality rate of this part of the marine organism through the rotating filter is very high, reaching 92-99%; another part of the smaller individuals of marine life (such as fish eggs, larvae and plankton) through the filter and the circulation pump into the gasifier to withstand impact, entrainment, sudden pressure changes, sudden temperature drop 5 °C cold impact and other synergies and then discharged from the culvert into the sea. The mortality of this synergistic marine organism varies from species to species: phytoplankton deaths are relatively small; zooplankton deaths are relatively high; fish eggs and larvae almost no survive.

Therefore, the sudden temperature drop, chlorination and mechanical entrainment of the water intake process of this project have serious effects on plankton and fish eggs in the water intake system. However, compared with the whole sea water body, the water intake of the project is not large, the water intake process has certain influence on the fish eggs and larvae in the whole sea area, but the scope is relatively small, and there will be no obvious adverse consequences for the marine ecological balance of the entire sea area.

9.4.4 Impact of Project Construction on National Aquatic Germplasm Resources Conservation Area in Liaodong Bay, Bohai Bay, Laizhou Bay

According to the conclusions of "Special Demonstration Report of the impact of Beijing Gas Nangang LNG Emergency Reserve Project on National Aquatic Germplasm Resources Protection Area in Liaodong Bay, Bohai Bay, Laizhou Bay" (Chinese Academy of Fishery Sciences Yellow Sea Fisheries Research Institute, February 2019):

The proposed project is located in the core area of the Bohai Bay Reserve of the National Aquatic Germplasm Resources Conservation Area in the Liaodong Bay, Bohai Bay, Laizhou Bay. The construction of the project will result in the loss of spawning grounds and habitats of fishery resources in the region. Since the occupied sea areas are shallow coastal waters, there is a certain impact on the spawning migration of fishery organisms in the region.

(1) This project has little effect on the spawning grounds of the small protected yellow mullet and the three-spotted crab, which are the main protection objects in the protected area, and will have certain impact on the spawning ground of Chinese prawn; In particular, long-term discharge of cooling water containing residual chlorine will cause long-term damage to the shrimp spawning ground. Therefore, during the construction and operation of the project, measures such as proliferation and release should be adopted to repair and maintain the Chinese shrimp resources and make Chinese prawn resources be effectively restored. In addition, due to the wide distribution of Chinese prawn in the Bohai Sea, biological remediation measures such as proliferation and release can be used to supplement resources every year. Therefore, although the project has caused certain harm to the spawning ground of Chinese prawn, it will not cause huge damage to the main function of its spawning ground.

(2) During the construction period of the project, the surrounding sea area will be contaminated by suspended solids. However, after the completion of the construction, the water environment will return to the original level within a certain period of time. Therefore, the impact of the suspended solids generated by the construction on the fishery ecological environment is temporary.

(3) According to the “Technical Regulations for Impact Assessment of Construction Projects on Marine Biological Resources” (SC/T 9110-2007), the project occupies fishery waters, suspended sediment during construction, drainage and loading effects during operation, cold drainage and residual chlorine discharge, and maintenance dredging will result in losses of adult animals (including fish, crustaceans, cephalopods) and young fish, fish eggs, larvae and benthic organisms.

Therefore, effective measures such as proliferation and release, bioremediation, and fishery resource conservation should be taken during the implementation of the project construction and after the construction of the project to minimize the damage to the fishery ecological environment and fishery resources; it is recommended that the construction unit should sign a fishery resource compensation agreement with the management department of the protected area before construction. For the purpose of regional economic development, fishery ecological environment protection and sustainable development of fishery resources, the impact of this project on the fishery ecological environment and fishery resources is acceptable under the premise of implementing compensation for fishery resources.

9.4.5 Loss assessment of marine living resources

(1) Overview of biological resources in engineering sea areas

According to the survey data of biological resources and fishery resources in the project sea area, the number of biological resources in the survey site near the project is shown in the following table.

Table 9.4-1 Overview of biological resources in engineering sea areas

Biological species	Resource density		Average	Unit	Remark
	Spring	Autumn			
Swimming animal (adult)	97.8	242.8	170.30	kg/km^2	May and October in 2017
Baby fish	1498	8266	4882	$No./km^2$	
Fish eggs	0.31	0	0.155	$grain/m^3$	
Juvenile fish	0.50	0.019	0.260	$No./m^3$	
Benthic organism	24.87	25.73	25.30	g/m^2	Spring and Autumn in 2017

Note: Swimming animals include fish, cephalopods and crustaceans.

(2) Assessment content

According to the above analysis, the damage assessment of marine living resources in this project is mainly as follows:

①Loss of marine living resources caused by land reclamation, construction of hydraulic structures and waters occupied by harbor basins;

②Loss of marine living resources caused by suspended sediment generated during construction;

③Loss of marine living resources caused by drainage and loading effects during the operation period;

④Loss of marine living resources caused by cold drainage and residual chlorine emissions during the operation period;

(3) Assessment method

①Damage assessment of marine living resources in occupied sea areas

The method is applicable to the occupation of fishery waters due to the needs of engineering construction, so that the function of fishery waters is destroyed or the habitat of marine living resources is lost. The damage assessment of various biological resources is calculated according to the formula:

$$W_i = D_i \times S_i$$

where: Wi is the damage amount of i^{th} type biological resources, the unit can be number or kg;

Di is the resource density of i^{th} type species biological in the assessment area, the unit can be $no./km^2$ or kg/km^2;

Si is the area or volume of fishery water occupied by i^{th} type organisms, the unit is km^2 or km^3.

②Assessment of damage to marine living resources within the scope of pollutant dispersion

Assessment of damage to marine living resources within the scope of the spread of pollutants can be divided into one-time damage and persistent damage. The increase in suspended sediment concentration during the construction period of this project is less than 15 days in the area, so it is evaluated according to the one-time average damage.

The one-time average damage amount is calculated by the following formula:

$$W_i = \sum_{j=1}^{n} D_{ij} \times S_j \times K_{ij}$$

where: Wi is the one-time average loss of the i^{th} type biological resources;

Dij is the i^{th} type biological resource density in j^{th} type concentration increment zone of a pollutant;

Sj is the area of j^{th} concentration increment area of a certain pollutant;

Kij is the loss rate of the i^{th} species of biological resources in the j^{th} type concentration increment zone of a certain pollutant;

n is the total number of partitions of a certain pollutant concentration increment.

The cumulative damage amount is calculated as shown in the following formula:

$$M_i = W_i \times T$$

where: Mi is the cumulative damage of i^{th} type biological resources;

Wi is one-time average damage of i^{th} type biological resources;

T is the number of continuous cycles affected by the increase in pollutant concentration (Divide the number of days actually affected in a year by 15).

③Biological resource damage assessment of extraction and drainage effect

The damage assessment of fish eggs, larvae and juveniles by the extraction and drainage effect is calculated according to the following formula:

$$W_i = D_i \times Q \times P_i$$

where: Wi is annual loss of i^{th} type biological resources; Di is the average distribution density of i^{th} type biological resources in the assessment area, quantity/m^3; Q is annual total water intake, m^3; Pi is the proportion of days of year in which i^{th} type biological resources occur, %.

(4) Assessment results of biological resources loss

①Damage to marine living resources caused by occupation of sea areas

The actual permanent sea area occupied by the LNG Receiving terminal and the send-out pipelines, such as the filling area of the LNG terminal, the terminal and the water intake and drainage port, is 81.7854 hm^2. The actual sea area occupied by the basinis 47.9130 hm^2. The average water depth of the occupied sea area is 4.0 m. The loss rate of marine living resources in this area is 100%. The estimated loss of biological resources is shown in Table 9.4-2.

Table 9.4-2 Assessment of damage to biological resources caused by sea areas occupied by land reclamation, hydraulic structures and harbor basins

Biological species	Resource density	Type	Occupied area		Water depth	Loss amount		
Fish eggs	0.155 pellets/m^3	Permanent occupation	81.7854	hm^2	4m	50.72	$\times10^4$	pellets
		Harbor pool	47.9130	hm^2	4m	29.70	$\times10^4$	pellets
Juvenile fish	0.260 NO./m^3	Permanent occupation	81.7854	hm^2	4m	85.05	$\times10^4$	NO.
		Harbor pool	47.9130	hm^2	4m	49.83	$\times10^4$	NO.
Swimming animal (adult)	170.30 kg/km^2	Permanent occupation	81.7854	hm^2	--	139.28	kg	
		Harbor pool	47.9130	hm^2	--	81.60	kg	
Baby fish	4882 NO./km^2	Permanent occupation	81.7854	hm^2	--	3993	NO.	
		Harbor pool	47.9130	hm^2	--	2339	NO.	
Benthic organism	25.30g/m^2	Permanent occupation	81.7854	hm^2	--	20.69	t	
		Harbor pool	47.9130	hm^2	--	12.12	t	

②Damage to marine living resources caused by the spread of suspended sediment during construction period

According to the results of environmental impact analysis, the maximum envelope area of the suspended solids produced during the construction period of the project exceeds the standard value of Class I and II of the Seawater Quality Standards by 0 to 9 times (the increase is 10 to 100 mg/L) is 7.145×106 m^2. The adult body loss rate of swimming animals in this area is 10%, the larval loss rate is 20%, and the loss rate of fish eggs and larvae is 30%; the maximum envelope area exceeding 9 times (increase ≥100 mg/L) the standard value of the "sea water quality standard" is 2.328×106m^2. The adult body loss rate of swimming animals in this area is 30%, and the larval loss rate is 40%. The loss rate of eggs and larvae is 60%, and the estimated loss of biological resources is shown in Table 9.4-3.

Table 9.4-3 Assessment of damage to biological resources caused by suspended sediment during construction period

Biological species	Resource density	Times of exceed standard	Area of influence		Loss rate	Water depth	Loss amount		
Fish eggs	0.155 pellets /m^3	0~9	7.145	$\times10^6m^2$	30%	4m	1.33	$\times10^6$	pellets
		≥9	2.328	$\times10^6m^2$	60%	4m	0.86	$\times10^6$	pellets
Juvenile fish	0.260 NO./m^3	0~9	7.145	$\times10^6m^2$	30%	4m	2.23	$\times10^6$	NO.
		≥9	2.328	$\times10^6m^2$	60%	4m	1.46	$\times10^6$	NO.
Swimming animal (adult)	170.30 kg/km^2	0~9	7.145	$\times10^6m^2$	10%	--	121.68	kg	
		≥9	2.328	$\times10^6m^2$	30%	--	118.94	kg	
Baby fish	4882 NO./km^2	0~9	7.145	$\times10^6m^2$	20%	--	6976	NO.	
		≥9	2.328	$\times10^6m^2$	40%	--	4546	NO.	

③Damage to marine living resources caused by drainage and loading effects during the operation period

Most of the swimming animals with swimming ability during the water intake of this project can avoid the death caused by mechanical coiling, but the fish eggs, larvae and juveniles are difficult to avoid due to lack of swimming ability, so the evaluation of the drainage and loading effect on the losses of swimming animals, only the damage caused to fish eggs, larvae and juveniles is considered. According to the experimental results, the mortality rate of fish eggs and larvae in the drainage effect is 70-81% , but considering that the drainage effect caused by rapid extraction of seawater causes obvious damage to the fish eggs and larvae, even the very few surviving eggs and larvae cannot grow normally, so the mortality rate is 100% .The loss rate for young fish is 20%.

The main season of fish eggs and larvae in this sea area is spring and summer, so the loss of fish eggs and larvae caused by drainage effect is calculated by spring (May-June, 60 days) and summer (July-August, 60 days), for a total of 120 days. The operation time of the seawater gasifier of this project is from March to November, and the number of days of juvenile fish is 270 days. The normal water intake of this project is 29400 m^3/h, so the results of the loss of fish eggs, larvae and juveniles are shown in Table 9.4-4.

Table 9.4-4 Assessment of damage to biological resources caused by drainage and loading effects during operation period

Biological species	Resource density	Water intake		Loss rate	Number of days	Water depth	Loss amount		
Fish eggs	0.155 pellets /m^3	705600	m^3/day	1	120	--	13.12	$\times10^6$	pellets
Juvenile fish	0.260 NO./m^3	705600	m^3/day	1	120	--	20.01	$\times10^6$	NO.
Baby fish	4882 NO./km^2	705600	m^3/day	0.2	270	4m	74.41	$\times10^4$ NO.	

④Damage to marine living resources caused by cold drainage and residual chlorine emissions during operation period

Because the " seawater quality standard " does not regulate temperature drop and residual chlorine, according to the " surface water environmental quality standard " and relevant experimental results, the biological resource damage assessment is carried out according to the standard of temperature drop of 2.0 ℃ and the content of residual chlorine is greater than 0.02 mg/L. According to the environmental impact prediction results, the maximum diffusion area with a temperature drop of more than 0.5 °C is 1.207 km^2, and there is no area where the temperature drop exceeds 2.0 °C due to cold drainage; the area of residual chlorine exceeding 0.02 mg/L is 1.135 km^2. Since the cold drainage and residual chlorine are discharged from the same drainage port, the loss of biological resources is calculated according to the area affected by the residual chlorine which has a large diffusion range. Within the range of the residual chlorine of 0.02mg/L, the loss rate of fish eggs and larvae is 50%, the loss rate of swimming animals is 5%, for juvenile is 20%, and the loss rate of benthic organisms is 10 %. The calculation results are shown in Table 9.4-5.

Table 9.4-5 Assessment of damage to marine living resources caused by cold drainage and residual chlorine emissions during operation period

Biological species	Resource density	Area of influence		Loss rate	Water depth	Loss amount		
Fish eggs	0.155 pellets /m^3	113.5	hm^2	0.5	4m	35.18	$\times10^4$	pellets
Baby fish	0.260	113.5	hm^2	0.5	4m	59.02	$\times10^4$	NO.

	NO./m^3						
Swimming animal (adult)	170.30 kg/km^2	113.5	hm^2	0.05	--	9.66	kg
Juvenile fish	4882 NO./km^2	113.5	hm^2	0.2	--	1108	NO.
Benthic organism	25.30 g/m^2	113.5	hm^2	0.1	--	2.87	t

In summary, the direct loss of biological resources caused by the construction of this project is 471.15 kg for swimming animals (including fish, crustaceans, cephalopods), 76.31×104 for baby fish, and 16.46×106 for fish eggs, 25.64 × 106 for juvenile fish, and 35.68 t for benthic organism

9.5 Impact analysis of solid waste during operation period

Table 9.5-1 List of solid waste disposal methods in project terminal and receiving station during operation period

NO.	Solid waste	Classification of solid waste	Disposal method
1	Land domestic garbage	General solid waste	Disposed by the municipal sanitation department
2	Filter object of seawater pumping house		
3	Sewage treatment facility sludge		
4	Ship domestic garbage	Ship solid waste	The solid waste from the ship in the epidemic area shall be treated according to relevant regulations after it has been quarantined by the sanitation inspection and quarantine department with corresponding qualifications; Ship solid waste in non-epidemic areas will be disposed of by qualified units
5	Ship maintenance waste		
6	Machine oil cotton yarn	Hazardous Waste (HW49)	It is listed in the “Hazardous Waste Exemption Management List” and is mixed into domestic garbage according to the exemption conditions, and is uniformly disposed by the municipal sanitation department.
7	Waste oil sludge	Hazardous Waste (HW08)	Temporarily stored in the newly built hazardous waste storage room of the proposed project, and regularly disposed of by qualified units.
8	Waste motor oil		

9.5.1 Environmental impact analysis of general solid waste

The proposed solid wastes are generally collected and treated by the municipal sanitation department, and have little impact on the surrounding environment.

9.5.2 Environmental impact analysis of ship solid waste

Ships from the epidemic area shall be disposed of by the sanitation inspection and quarantine department with corresponding qualifications and quarantined according to relevant regulations; the solid wastes of non-epidemic areas shall be entrusted by qualified units to receive and handle, not to be discharged, and have less impact on the surrounding environment. .

9.5.3 Environmental impact analysis of hazardous waste

(1) Environmental impact analysis of hazardous waste storage sites (facilities)

(a) Feasibility analysis of site selection for hazardous waste storage sites

①The geological structure of location of the proposed new hazardous waste storage facility is stable and meets the site selection requirements.

②The location of the proposed new hazardous waste storage room is formed by reclamation and land formation, and the bottom is higher than the highest water level of the groundwater, which meets the site selection requirements.

③The location of the newly built hazardous waste storage room of the proposed project is more than 2.0km from the nearest residential area, which meets the site selection requirements.

④The proposed new hazardous waste storage room is not located in the cave area or vulnerable to natural disasters. The project is located within the existing breakwater cover of the port area, which mitigates the impact of tides and meets the site selection requirements.

⑤The location of the newly built hazardous waste storage room of the proposed project is far away from the LNG storage tank, and outside the dangerous goods protection area. It meets the site selection requirements.

⑥The base anti-seepage layer of the proposed new hazardous waste storage room is made of 2mm high-density polyethylene with a permeability coefficient of 10-10cm/s.

(b) Analysis of storage capacity of hazardous waste storage sites

The proposed new hazardous waste storage area is 50m2, the storage capacity of waste sludge is 1.5t, and the storage capacity of waste oil is 3.5t. The receiving unit collects and transports every three months. The production of waste sludge and waste oil of the proposed project are respectively It is 1 t/a and 1.5 t/a. Therefore, the storage capacity of the new hazardous waste storage room is fully satisfactory.

(c) Analysis of the impact on the surrounding environment and sensitive protection objectives

The proposed hazardous waste storage facility will store the hazardous wastes produced, and carry out anti-seepage treatment according to relevant requirements, with less impact on the surrounding environment and sensitive protection targets.

(2) Environmental impact analysis of transportation process

The hazardous waste transportation in the factory is mainly collected by employees and transported to the hazardous waste storage room, and is regularly transported by qualified units. The collection of hazardous wastes in the factory area shall be based on the discharge cycle and characteristics of the hazardous wastes, and the collection plan and operation procedures shall be formulated, and the collection personnel shall be trained, and necessary personal protective equipment and fire prevention, explosion-proof, anti-leakage and other pollution prevention measures shall be provided as needed. In the collection process of hazardous waste, it is necessary to set the boundary of the operation to mark the warning signs, and use special tools for collection and transportation to reduce the impact on the surrounding environment. Therefore, based on the implementation of relevant preventive measures, hazardous waste transportation has less impact on the surrounding environment.

(3) Environmental impact analysis of commissioned disposal

The proposed project hazardous wastes will be disposed of safely by qualified units. The receiving and handling unit shall have a hazardous waste business license, and the collected waste sludge and waste engine oil shall be incinerated and disposed of in landfill, in line with the relevant national hazardous waste disposal requirements.

Therefore, from the perspective of the setting, transportation process and commissioned disposal unit of the hazardous waste storage place (facilities), the hazardous waste generated during the operation of the proposed project has less impact on the surrounding environment.

10 Environmental risk assessment

10.1 Purpose of the evaluation

(1) Purpose of the evaluation

The purpose of the environmental risk assessment is to analyze and predict the potential risk and harmful factors of the construction project, the unexpected events or accidents that may occur during the construction and operation of the construction project (generally excluding man-made damage and natural disasters), the leakage of toxic, harmful and inflammable and explosive substances, which cause the personal safety and environmental impact and damage caused. Proposing reasonable and feasible preventive, emergency and mitigation measures is to make the level of the accident rate, loss and environmental impact of the construction project acceptable.

(2) Evaluation focus

The proposed project is a liquefied natural gas terminal and Receiving terminal, as well as pipeline and station works . The main transportation and storage of liquefied natural gas are flammable. Failure to take effective measures, in the event of an explosion or leakage, will inevitably endanger the safety of the surrounding population and the environment of the coastal waters. Therefore, the focus of this risk evaluation is as follows :

① Risk identification and source item analysis should be carried out according to the concrete situation of the proposed project.

② The proposed project includes a LNG Receiving terminal and a terminal . LNG is a flammable substance, and the risk of fire is high.

③ Quantitatively predicting the influence of marine oil spill accidents on marine environment in marine transportation engineering.

10.2 Rating and scope of evaluation

See section 2.3 Rating Scale and Scope.

10.3 Risk identification

10.3.1 Material risk identification involved in the proposed project

The construction scope of the proposed project is to construct a unloading berth for a 26.6 Million LNG Ship, a 5000000 Ton/Year LNG Receiving terminal and pipeline and station yard. The main substances at risk for the proposed project are stored liquefied natural gas and fuel oil used by LNG carriers.

10.3.2 Material risk identification

The main material involved in the proposed project is natural gas, which belongs to Class I-B fire hazard according to *the Standard of Oil and Gas Engineering Design Fire Protection Code* (GB 50183-2015).

The process of this project includes LNG marine transportation, unloading, storage, etc. The LNG storage and transportation process is different from the petrochemical plant production process under high temperature and high pressure. The operation conditions are mild, but there are still many potential risk factors for the project due to its large reserves and easy volatilization. According to the analogical investigation and statistics of the accident, combined with the analysis of the process of the project, the main risks are fire, explosion and fuel oil and natural gas leakage at the Receiving terminal and terminal of the project. The main components of natural gas contain more than 99. 8% methane (mol %), and the sulfur content is very low. When the natural gas leakage accident occurs, the fire and explosion will be accompanied by CO secondary pollutants, CO is a toxic and harmful substance.

This evaluation is aimed at the environmental risk of CO associated with incomplete combustion of methane and natural gas from marine fuel oil leakage and natural gas leakage.

10.3.2.1 Fuel oil hazard characteristic

Details of the fuel oil characteristics used by the LNG carrier for the proposed project are given in Table 10.3-1.

Table 10.3-1 Dangerous characteristics of fuel oil and emergency preventive measures

理化性质			
外观	黑色油状物		
闪点	120℃	引燃温度	520℃
健康危害			
侵入途径	吸入、食入		
健康危害	对皮肤有一定的损害，可致接触性皮炎、毛囊性损害等。接触后，尚可有咳嗽、胸闷、头痛、乏力、食欲不振等全身症状和眼、鼻、咽部的刺激症状。		
急救措施			
皮肤接触	脱去污染的衣着，用大量流动清水冲洗。		
眼睛接触	提起眼睑，用流动清水或生理盐水冲洗。就医。		
吸入	脱离现场至空气新鲜处。如呼吸困难，给输氧。就医。		
食入	饮足量温水，催吐。就医。		
燃爆特性和消防			
燃烧性：	本品可燃，具刺激性。	有害燃烧产物	一氧化碳、二氧化碳、成分未知的黑色烟雾。
危险特性：	受高热分解，放出腐蚀性、刺激性的烟雾。		
灭火方法：	消防人员须佩戴防毒面具、穿全身消防服，在上风向灭火。尽可能将容器从火场移至空旷处。喷水保持火场容器冷却，直至灭火结束。处在火场中的容器若已变色或从安全泄压装置中产生声音，必须马上撤离。		
灭火剂：	雾状水、泡沫、干粉、二氧化碳、砂土。		
其他			
泄漏应急处理	迅速撤离泄漏污染区人员至安全区，并进行隔离，严格限制出入。切断火源。建议应急处理人员戴自给正压式呼吸器，穿防毒服。尽可能切断泄漏源。防止流入下水道、排洪沟等限制性空间。小量泄漏：用砂土或其他不燃材料吸附或吸收。大量泄漏：构筑围堤或挖坑收容。用泵转移至槽车或专用收集器内，回收或运至废物处理场所处置。		
储存注意事项	储存于阴凉、通风的库房。远离火种、热源。应与氧化剂、酸类分开存放，切忌混储。配备相应品种和数量的消防器材。储区应备有泄漏应急处理设备和合适的收容材料。		
运输注意事项	运输前应先检查包装容器是否完整、密封，运输过程中要确保容器不泄漏、不倒塌、不坠落、不损坏。严禁与氧化剂、酸类、食用化学品等混装混运。运输车船必须彻底清洗、消毒，否则不得装运其他物品。船运时，配装位置应远离卧室、厨房，并与机舱、电源、火源等部位隔离。公路运输时要按规定路线行驶。		
操作处置注意事项	密闭操作，提供良好的自然通风条件。操作人员必须经过专门培训，严格遵守操作规程。建议操作人员佩戴自吸过滤式防毒面具(半面罩)，戴化学安全防护眼镜，穿防毒物渗透工作服，戴橡胶耐油手套。远离火种、热源，工作场所严禁吸烟。使用防爆型的通风系统和设备。防止蒸气泄漏到工作场所空气中。避免与氧化剂、酸类接触。搬运时要轻装轻卸，防止包装及容器损坏。配备相应品种和数量的消防器材及泄漏应急处理设备。倒空的容器可能残留		
	有害物。		
个体防护	工程控制：提供良好的自然通风条件。 呼吸系统防护：空气中浓度超标时，必须佩戴自吸过滤式防毒面具(半面罩)。紧急事态抢救或撤离时，应该佩戴空气呼吸器。 眼睛防护：戴化学安全防护眼镜。 身体防护：穿防毒物渗透工作服。 手防护：戴橡胶耐油手套。 其他：工作完毕，淋浴更衣。工作完毕，彻底清洗。		
稳定性和反应活性	稳定性：稳定　聚合危害：不聚合 禁忌物：强氧化剂、强酸。		

Table 10.3-1 shows the fuel oil properties as follows :

Chemical property: it is mainly hydrocarbon. Its composition structure is mainly composed of three series of alkane (group), naphthene (group) and aromatic (group).

Physical properties: the physical properties of fuel oil vary with its chemical composition, from dark brown to dark green to black; Fuel oil with high sulfur content gives off a strong, pungent odor; The density of fuel oil is smaller than that of water. Fuel oil is insoluble in water, but soluble in organic solvents, such as benzene, flavor, ether, trichloromethane, carbon sulfide, carbon tetrachloride, etc., can also be partially dissolved in alcohol.

10.3.2.2 Natural gas hazard characteristic

(1) Flammability

Natural gas belongs to category A B fire hazard. Only a small amount of ignition energy in the air will burn, so there is a greater risk of fire.

(2) Explosive

Natural gas and air constitute a mixture of gases, its concentration in a certain range, when fire occurs. The explosive limit range of natural gas (methane) is 5.3-15 (%V/V). The wider the limit range of natural gas explosion concentration, the lower the lower the lower the concentration, the greater the material explosion risk.

(3) Toxicity

Natural gas is a hydrocarbon mixture, a low toxic substances, but long-term exposure can lead to neurasthenia syndrome. Methane is a simple asphyxiation gas, high concentration of oxygen asphyxia caused by poisoning. Dizziness, respiratory acceleration and movement disorder occur when the concentration of methane in the air reaches 25% ~ 30%.

(4) Thermal expansion

The volume of natural gas expands with the increase of temperature. If the station container is exposed to the sun or near the high temperature heat source, the medium inside the container expands due to the increase of internal pressure due to thermal expansion. This thermal expansion and contraction often damage storage containers, resulting in media leakage. Natural gas storage containers can also cause external pressure instability at low temperatures.

(5) Electrostatic charge aggregation

Although the electrostatic charge mainly occurs in the transportation, flow, loading and unloading of natural gas, but compressed gas from the nozzle or breakage of the high-speed jet, due to strong friction, will also generate static electricity. The harm of electrostatic discharge is mainly electrostatic discharge. If the spark energy produced by electrostatic discharge reaches or exceeds the minimum ignition energy of combustible material, it will immediately cause combustion and explosion.

(6) Diffusibility

The leakage of natural gas not only affects the normal transmission of pipelines, but also pollutes the surrounding environment and even causes people to be poisoned, and more seriously increases the risk of fire and explosion. When the pipeline system is not sealed properly, natural gas can easily leak, and can spread around with the wind, meet open flame is very easy to cause fire or explosion.

The hazard characteristics of natural gas are shown in Table 10.3-2 and the nature of natural gas is shown in Table 10.3-3.

Table 10.3-2 Hazardous characteristics of natural gas

Critical temperature (℃)	-79.48	Combustion heat (kJ/kmol）	884768.6
Critical pressure (bar)	46.7	LFL (%V/V）	4.56
Standard boiling point (℃)	-161.5	UFL (%V/V）	19.13
Melting point (℃)	-182.5	Molecular weight (kg/kmol）	16.98
Maximum radiant energy kW/m^2	200.28	Maximum burning rate	0.13

			(kg/m^2.s）	
Explosion limit % (v）	Upper limit	5.0	Risk of combustion explosion	1.8
	Lower limit	14.0	Hazard class	Class 2.1 flammable gases
Density (kg/m^3）		0.7407 (In Standard State）		

Table 10.3-3 Nature of natural gas

中文名称	甲烷；沼气			英文名称	Methane；Marsh gas		
外观与气味	无色无臭气体						
熔点(℃)	-182.5	沸点(℃)	-161.5	闪点(℃)	<-50	自燃温度(℃)	537
相对密度	水＝1	0.42（-164℃）	毒性	级别			
	空气＝1	0.55		危害程度			
爆炸极限(V%)	5.3～15	灭火剂	雾状水、泡沫、二氧化碳、干粉				
工作场所空气中容许浓度（mg/m^3）	MAC		PC-TWA		PC-STEL		
毒物侵入途径	吸入、食入、经皮吸收						
物质危险性类别	第 2.1 类 易燃气体	火灾危险性分类	甲$_A$				
爆炸物质级别及组别	级别	I	组别	T_1			
危险货物编号	21007	UN 编号	1971	CAS No.	74-82-8		
包装类别	II类包装	包装标志	易燃气体				
危险特性	与空气混合能形成爆炸性混合物；遇明火、高热会引起燃烧爆炸。						
灭火方法	切断气源。若不能切断气源，则不允许熄灭泄漏处的火焰。喷水冷却容器，可能的话将容器从火场移至空旷处。						
健康危害	空气中甲烷浓度过高，能使人窒息。当空气中甲烷达 25～30%时，可引起头痛、头晕、乏力、注意力不集中、呼吸和心跳加速、精细动作障碍等，甚至因缺氧而窒息、昏迷。						
泄漏紧急处理	迅速撤离泄漏污染区人员至上风处，并进行隔离，严格限制出入。切断火源。建议应急处理人员戴自给正压式呼吸器，穿防静电工作服。尽可能切断泄漏源。合理通风，加速扩散。喷雾状水稀释、溶解。构筑围堤或挖坑收容产生的大量废水。如有可能，将漏出气用排风机送至空旷地方或装设适当喷头烧掉。也可以将漏气的容器移至空旷处，注意通风。漏气容器要妥善处理，修复、检验后再用。						
操作处置注意事项	密闭操作，全面通风。操作人员必须经过专门培训，严格遵守操作规程。远离火种、热源，工作场所严禁吸烟。使用防爆型的通风系统和设备。防止气体泄漏到工作场所空气中。避免与氧化剂接触。在传送过程中，钢瓶和容器必须接地和跨接，防止产生静电。搬运时轻装轻卸，防止钢瓶及附件破损。配备相应品种和数量的消防器材及泄漏应急处理设备。						
储存注意事项	储存于阴凉、通风的库房。远离火种、热源。库温不宜超过 30℃。应与氧化剂等分开存放，切忌混储。采用防爆型照明、通风设施。禁止使用易产生火花的机械设备和工具。储区应备有泄漏应急处理设备。						

10.3.2.3 CO hazard characteristic

In case of the leakage accident of the proposed project, the secondary pollutants associated with the fire or explosion at high temperature are mainly CO.

Table 10.3-4 Physical and chemical properties and hazard characteristics of CO

ID	Chinese name	CO	CAS	630-08-0	RTECS No.	FG3500000
	English name	Carbon monoxide	Molecular weight	28	UN No.	1016
	Molecular formula	CO			Dangerous goods number	21005
Physicochemical properties	Appearance and character	Colorless odorless odor				
	Solubility	Be slightly soluble in water, soluble in most organic solvents such as ethanol, benzene, chloroform, etc				
	Melting point (℃)	-205	Relative density (water = 1)	1.25 (0℃)	Combustion heat (kJ/mol)	285.624
	Boiling point (℃)	-191.5	Relative density (air = 1)	0.97	Saturated vapor pressure (kPa)	No data
	Combustibility	Flammable	Critical temperature (℃)	-140.2	Critical pressure (MPa)	3.50
Flash point (℃)		＜-50	Ignition temperatur (℃)	610	Combustion (decomposition) product	Carbon dioxide
Fire rating		Class A	Lower limit of explosion (V%)	12.5	Upper limit of explosion (V%)	74.2
Stability		Stable	Contraindication	Strong oxidant	Polymerization hazard	Unpolymerized
Hazard class		Class 2.1 flammable gases	Packing mark for dangerous goods	2	Packaging category	O52
Hazard characteristic	An inflammable and explosive gas can be mixed with air to form an explosive mixture, which can cause combustion explosion in the presence of open flame and high heat					
Fire extinguishing method	Cut off the gas. If the gas source cannot be cut off immediately, the burning gas shall not be extinguished. Cool the container with water spray and, if possible, move it from the fire to the open.					
Storage and transport considerations	Store in a cool, airy, flammable gas storage room. Stay away from the fire, and the heat. The temperature should not exceed 30℃. Should be stored separately with oxidant, alkali, edible chemicals, avoid mixing storage. Use explosion-proof lighting, ventilation facilities. Do not use mechanical equipment and tools that can spark easily. The storage area shall be equipped with emergency handling equipment for leakage.					
Health hazard	Carbon monoxide binds to hemoglobin in the blood and causes tissue hypoxia. Acute poisoning: mild poisoning, headache, tinnitus, palpitations, vomiting, weakness, blood carboxyhemoglobin concentration can be above 10%; In addition to the above symptoms, the skin mucous membrane showed fuchsia, rapid pulse, irritability, gait instability, shallow to moderate coma, blood carboxyhemoglobin concentration can be more than 30%; In severe patients with deep coma, miosis, myotonia, frequent convulsions, fecal incontinence, shock, and severe myocardial injury, blood carboxyhemoglobin can be more than 50%. Chronic effects: Whether chronic poisoning can be caused and cardiovascular effects are uncertain.					

First aid	Remove quickly from site to fresh air when inhaled.Keep your airway open.If breathing is difficult, give oxygen. When the breath is stopped, artificial respiration and chest compressions are performed immediately. See a doctor.	
Protective measures	Engineering protection	Closed production process, enhance ventilation; Safe shower and eye washing facilities available.
	Respiratory system protection	When the air concentration exceeds the standard, wear a self-suction filter gas mask (semi-mask). In case of emergency rescue or evacuation, it is recommended to wear air respirator, carbon monoxide filter self-rescuer.
	Eye protection	No special protection is required
	Protective clothing	Wear appropriate protective clothing.
	Other	Smoking is strictly prohibited at work. Pre-employment and regular medical examinations are carried out. Avoid high concentrations of inhalation. Access to restricted space or other high concentration areas shall be supervised.
Leakage disposal	Quickly evacuate the leaking contaminated area personnel to the upper wind and immediately isolate 150m, strictly restricting access. Cut off the fire. It is suggested that emergency personnel wear self-contained positive pressure respirator and anti-static work clothes. Cut off the source as much as possible. Reasonable ventilation, accelerated diffusion. Spray water is diluted and dissolved. A large amount of waste water produced by the construction of a dike or excavation. If possible, send the air leakage exhaust fan to the open area or install a suitable sprinkler to burn. The pipeline can also be used to guide the furnace, concave ground burning. The leaking container shall be handled properly, repaired and inspected before use.	

10.3.3 Production system risk identification

10.3.3.1 Identification of Risk Sources for Terminal Handling and Ship Transportation

(1) Causes of Marine Environmental Risk Accidents

The relevant data show that the environmental risk factors leading to the sudden leakage risk events of ships are :

① Operating system, auxiliary facilities and other reasons of their own, such as design errors, packaging damage ;

② The operation technology is not skilled, and the sense of responsibility is not strong ;

③ Natural disasters, such as earthquakes, typhoons, tsunamis, etc.

Major pollution accidents at sea are mainly caused by collision, stranding or damage to the ship's hull in the berth or channel of the terminal. Therefore, the transportation process of LNG ship in and out of waterway and the unloading process of terminal are identified as the environmental risk factors of this sea area. In the process of closing and leaving the terminal, due to improper operation, the ship's hull collided with the terminal, which resulted in the fuel oil leakage of the ship; The collision of the project ship with other vessels (such as working vessels, tugs or transport vessels of enterprises adjacent to the project, etc.) in the waters at the front of the terminal or during navigation on the waterway results in fuel oil leakage; Natural disasters, such as typhoons and earthquakes, cause the collision of ships on docks or ships and other ships.

(2) Marine Environmental Risk Accidents

① Environmental risk caused by leakage of fuel oil from ships into the sea.

② Environmental risk caused by LNG leakage from shipping.

10.3.3.2 Receiving terminal risk source identification

According to Table E.1 in HJ 169-2018, the production system hazards of the Receiving terminal are mainly handling process, pump and compressor risks, and gas tank risks.

10.3.4 Risk identification results

Leakage of fuel oil from ships entering and leaving the port of this project into the sea, resulting in pollution to the nearby marine environment.

This project is transporting purified natural gas, which belongs to Class A B fire hazard according to *the Standard of Oil and Gas Engineering Design Fire Protection Code (*GB 50183-2015). The main types of accidents are natural gas leakage, fire explosion.

The content of methane in the main component of natural gas is over 99. 8% (mol %). The total sulfur content in the gas source is very low, and the concentration of SO_2 pollutants produced by natural gas leakage combustion is limited (10 10 mg/m^3). In the event of leakage accident in the pipeline and station yard of this project, the fire and explosion of the leaking natural gas in the presence of open flames or high temperature heat energy will be accompanied by secondary CO pollutants, which are toxic and harmful substances.

This evaluation focuses on the environmental risk of CO associated with fuel oil leakage, natural gas leakage and incomplete combustion of natural gas.

10.4 Risk Accident scenario Analysis

10.4.1 Risk accident scenario setting

Through risk identification and case analysis of pollution accidents, the project has the possibility of oil spill into the sea due to improper operation or collision of navigation and so on. The biggest credible accident of environmental risk in the sea area of this project is the ship oil spill accident. The operation ship of this project is a LNG ship, so the marine environmental risk accidents mainly consider two aspects :

①A fuel oil leakage accident occurs when a LNG ship collides with another ship during navigation.

② LNG leakage occurs in the course of ship transportation and overflows the LNG to the sea surface.

(2) According to the characteristics of the project and the causes of release of toxic, harmful and inflammable and explosive substances, this evaluation analyzes the main dangerous pipe sections of the terminal and Receiving terminal, the fire explosion index analysis and the analogical investigation and analysis results.

10.4.2 Maximum credible accident and its source term analysis

10.4.2.1 Maximum credible accidents and source strength analysis of marine environmental risks

(1) Probability of maximum credible accident of marine environmental risk

①According to statistics from high seas ports in the United Kingdom, the frequency of accidents on LNG transport vessels is detailed in Table 10.4-1.

Table 10.4-1 Frequency of LNG Carrier Accidents

Accident cause	Accident frequency	Leakage probability of refrigerated ship
Collision	5.0 x 10-4	3.0 x 10-2
Hit the rocks	6.5 x 10-5	1.5 x 10-2
Hit	4.0 x 10-6	1.9 x 10-2
Impact	2.2 x 10-3	1.0 x 10-3
Explosions and fires	1.0 x 10-5	1.0 x 10-2

As can be seen from Table 9.5-1, the probability of fuel oil leakage caused by collision between LNG carrier and other vessels is about 5.0 × 10-4. The probability of collision of a LNG carrier resulting in a LNG spill is 5.0 × 10-4 × 3.0 × 10-2 = 1.5 × 10-5.

②Analysis of accident frequency according to domestic statistical data

Operational Accident Probability Analysis: Based on the historical statistics of domestic ship accidents, the possibility of oil spill accident in Tianjin Port is predicted by analogy method. The probability of occurrence of operational accidents is the largest . In the statistics of oil spill accidents in China from 2002 to 2008, operational oil spills account for more than 67% .

Compared with the frequency of coastal occurrence in China, the sea area of this project belongs to the four high risk sea areas in China at present, taking into account the increase of the number of ships entering and leaving the sea area of Tianjin Port, the probability of operational accidents occurring in 2015 and 2020 is calculated based on the present situation of accidents in the sea area of Tianjin Port. With the improvement of port ship safety and pollution prevention management, the crew quality will improve, the probability of operational accidents will be reduced, but the range of probability will still be in the scale of 0-0.7 .

Probability analysis of average accidents: marine average oil spill accidents are usually accompanied by ship traffic accidents. According to the number of vessels in the sea area of Tianjin Port, the accident probability of large non-oil vessels in the sea area of Tianjin Port is analyzed and predicted.

(2) Maximum trusted incident source strength

①Source strength of oil spill accident on ship

The maximum design type of the project is 266000 m3 LNG Ship with a maximum storage capacity of 400 t for a single fuel tank. According to the Technical Specification for Marine Pollution Marine Environment Risk Assessment (Trial Implementation), the source strength of a marine oil spill accident is determined by predicting the maximum oil spill of a marine pollution accident most likely to occur on the basis of the maximum oil carrying capacity of a maximum ship type and the oil leakage of a left or right oil tank or fuel tank. Therefore, this evaluation of the ship oil spill accident oil spill of 400 t.

②Source strength of LNG leakage accident in ship

Because of the particularity of LNG ship structure, there is no record of LNG ship leakage due to sea traffic or other accidents in the world.

10.4.2.2 Screening of the Most Trusted Accidents of Atmospheric Environmental Risk

According to the definition of the Technical Guidelines for Environmental Risk Assessment of Construction Projects (HJ 169-2018), the largest credible accidents are those that cause the most serious hazards among accidents occurring within a certain probability range, based on empirical statistical analysis.

Considering that the environmental risk impact of the project is mainly secondary to the environment after the explosion fire accident, the maximum credible accident selection mainly considers the distribution of population along the pipeline controlled node of the project, the online quantity of natural gas and the sensitivity of the periphery, and the maximum credible accident setting of the proposed pipeline is shown in the following table.

Table 10.4-2 Maximum trusted incident setting

Sequence number	Position	Accident site	Accident overview	Select Reason
1	Receiving terminal	Receiving terminal	Due to the third party reason, the pipeline is broken, the natural gas is leaking, and the mixture is easy to gas	The longest pipe section, the largest natural gas on-line quantity

10.4.2.3 Probability of the Most Trusted Accident of Atmospheric Environmental Risk

The maximum probability of a credible accident is referred to in Appendix E of the Environmental Risk Assessment Guidelines for Construction Projects (HJ 169-2018).

Table 10.4-3 Leak Probability Table for Quantitative Risk Assessment of Major Hazard Sources

Part type	Leakage mode	Leakage probability
Reactor/process tank/gas tank/tower	Leakage aperture is 10 mm	1.00 × 10-4/A
	Tank leakage within 10 min	5.00 × 10-6/A
	Tank full rupture	5.00 × 10-6/A
Pump body and compressor	Maximum connecting pipe leakage aperture of pump body and compressor is 10% (maximum 50 mm)	5.00 × 10-4A
	Maximum connecting pipe diameter leakage of pump body and compressor	1.00 × 10-4A
Handling arm	Handling arm connecting pipe leakage aperture is 10% (maximum 50 mm)	3.00 x 10-7h
	Handling arm full pipe diameter leakage	3.00 x 10-8 h
Handling hose	Handling hose connecting pipe leakage aperture is 10% (maximum 50 mm)	4.00 × 10-5 h
	Handling arm full pipe diameter leakage	4.00 x 10-6 h

The probability of total rupture of the LNG tank in the Receiving terminal is 5.00×10^{-6}/a.

10.4.2.4 Maximum trusted incident source entry

(1) Natural gas leakage

The liquefied natural gas is a cryogenic liquid . The leakage will form a liquid pool in the environment of no open flame . It can quickly absorb the heat evaporation around it. The speed and timing of the leak determine the severity of the consequences. According to HJ 169-2018, the direct evaporated liquid fraction (FV) is :

$$FV = CP\times (t-TC)/h$$

Formula: CP--specific heat of two-phase liquid at constant pressure, J/ (kg) • K) ;

T--liquid temperature before leakage, (k) ;

TC--boiling point of liquid at normal pressure ;

H--heat of vaporization (J/kg) ;

$$FV = 2070x\ (111.15-109.15)/\ 122000 = 0.03\ .$$

This evaluation takes the LNG tank leakage as the maximum credible accident, the leakage time is 10 min, the LNG tank LNG storage capacity of 200000 m3 is 75000 tons, the average leakage speed is 125000 kg/s, the evaporation liquid is calculated according to 0.03 , the evaporation speed of rigid natural gas is 3750 kg/s.

(2) Secondary pollutant carbon monoxide

Under normal operating conditions, the coefficient of CO production from natural gas combustion is 0.35 g/m3 according to the Beijing Environmental Master Plan Study (Volume II). In this evaluation, the total combustion of the whole tank of LNG was considered as the maximum credible accident . The fire duration was 30 minutes and the maximum CO production rate was 3.40 kg/s.

10.5 Risk prediction and evaluation

10.5.1 Risk prediction and assessment for oil spill from ships

10.5.1.1 Model for prediction of oil spill

（1）prediction of oil film trajectory

If the oil spill happens on the sea, the oil floats on the surface of the water. On one hand, the oil could be transported towards a certain direction with the effects of winds and currents, on the other hand, the oil film itself can be extended and its area will be increased. Besides, the different components in the oil film can be evaporated, emulsified, settled with adhesion to suspended substance, and biodegraded, etc., which are complex physical, chemical, and biological processes.

This model prediction only includes the physical processes like advection and diffusion of the oil on the sea, as well as the evaporation and emulsification, the other processes are not taken into account due to the difficulty in parameterization.

With hydrodynamic modelling results, the Eulerian-Lagrangian approach is used to predict the trajectory of the oil film center. The drift speed of the oil film center is determined by the wind speed above the sea surface and the surface flow, the function of space and time, and can be computed by interpolation from the velocities at the mesh nodes. In the space, for a certain moment the velocity at each mesh node is

$$\begin{cases} V_x = V_{rx} + \alpha V_{wind} \sin(180 + \theta_0 + \theta) \\ V_y = V_{ry} + \alpha V_{wind} \cos(180 + \theta_0 + \theta) \end{cases}$$

where V_{rx}, V_{ry} are surface flow in x and y directions respectively， which are calculated by the hydrodynamic model. V_{wind} is the wind speed at the mesh node, α is wind coefficient，and set equal to 0.03； θ_0 is wind direction, θ is drift angle of the oil particles due to wind effect. θ is correlated with the wind speed as below:

$$\theta = \begin{cases} 40 - 8\sqrt{V_{wind}} & 0 \le V_{wind} \le 25m/s \\ 0 & V_{wind} \ge 25m/s \end{cases}$$

The trajectory of the oil particles can be computed by the formula below:

$$\vec{S} = \vec{S}_0 + \int_t^{t+\Delta t} V_l(x(t), y(t), t)dt;$$

where S_0 is the initial position， S is the position of the oil slick center, V_l (x (t),y (t),t) is Lagrange tracking velocity, $V_l = \sqrt{V_x^2 + V_y^2}$.

If the oil spill happens at a different location or different time, the trajectory of the oil film center can be also different due to the non-uniform distribution of flow and wind in space and time.

(2）Prediction for extension and transportation of the oil slick

The diffusion caused by shear flow and turbulence is a kind of random motion, which can be simulated by the random walk method. The diffusion of an entire cloud in the water results from the random motion of each particle. The random diffusion of the oil slick on the surface of the water can be described by the formula below:

$r_a' = R\,(6k_\alpha \Delta t)^{1/2}$

where r_a' is the diffusion distance along α= (x,y,z) direction due to turbulence; R is uniform random number between -1 and 1. k_α is the coefficient of eddy diffusion in α direction, Δt is the time step.

The drift of oil spill is a result of interaction among advection, diffusion and wind. The displacement of the i-th particle during the time step Δt can be expressed as below:

$x_i = u_i \Delta t + r_x'$

$y_i = v_i\Delta t + r_y'$

where $u_i = u_{current}+u_{wind}+u_{Env.}$； $v_i = v_{current}+v_{wind}+v_{Env.}$； r_x', r_y' is the random moving distance in x and y direction; $u_{current}$、 u_{wind}、 $u_{Env.}$、 $v_{current}$， v_{wind}、 $v_{Env.}$ are computed by dynamic model of environment.

Since each particle represents a certain amount of oil, the expanded area of the oil spill and the thickness of the oil slick can be calculated according to the location of the particle and the amount of oil.

（3）Volatilization and emulsification of oil

The diffusion and transportation of the oil spill accompany with various chemical and biological processes, which are directly responsible for changes in the physical and chemical properties of the oil slick. The amount of oil slick is constantly reduced.

① volatilization of the oil spill

The evaporation is governed by the property, thickness and composition of the oil, as well as the wind. A exposure model proposed by Stiver and Mackay is used to calculate the volatilization of the oil:

$$F_V = \ln(1+\theta\cdot\frac{VP_a}{RT^2}\cdot BT_G\cdot\exp(B(1-T_0/T)))T/BT_G$$

in which, B is a coefficient, normally equal to 10.3; T_G is the gradient of volatilization curve; T is surface temperature of the oil, normally close to the atmospheric temperature; T_0 is the initial volatilization temperature of the oil; P_a is atmospheric pressure; V is volume of the oil molecule; R is the atmospheric constant; θ is the volatilization coefficient, normally equal to $2.5\times10^{-3}U_w^{0.78}$, U_w is the wind speed; the value of T_0、 T_G is given as below:

T_0=532.98-3.1295*API

T_G=985.62-13.597*API

② emulsification of the oil spill

The emulsification is affected by multiple factors such as wind speed, wave, oil thickness, ambient temperature, and weathering degree of the oil. The degree of emulsification is normally indicated by the water content (Mackay, 1990).

$$\frac{dYW_i}{dt} = R_1 - R_2$$

in which：

$$R_1 = \frac{K_1}{\eta_0}(1+U_W)^2(YW_{\text{sat}} - YW_i)$$

$$R_2 = \frac{K_2}{A_{\text{sph}}\cdot W_{\text{Ax}}\cdot\eta_i}\cdot YW_i$$

YW_i is the water content of the i-th oil particle, U_W is the wind speed, W_{Ax} is wax content (%) of the oil, A_{sph} is the mass content (%) of asphaltin the oil, η_0 is the anhydrous dynamic viscosity of the oil, YW_{sat} is the stable water content, K_1 and K_2 are constants, equal to 5.0×10^{-7} and 1.2×10^{-5} respectively. η_i is the dynamic viscosity of the oil which has been emulsified.

$$\eta_i = \eta^{oil} \exp \frac{2.5yw_i}{1-0.654\,yw_i}$$

in which， η_i is the dynamic viscosity of the oil which has been emulsified, η^{oil} is the dynamic viscosity of the oil which has not been emulsified.

10.5.1.2 Calculation conditions of the oil spill

According to wind conditions in the project area and the geographical location of the project, the conditions listed in the table below should be considered as inputs to the scenarios used for risk prediction of the oil spill.

Table 10.5-1 summary of scenarios

Leakage location and amount	Wind direction	Tidal hour	Wind speed
In front of the terminal (30 t)	dominant wind in winter: NNW	ebb slack, flood slack	3.7m/s
	dominant wind in summer: S	ebb slack, flood slack	4.1m/s
At entrance of the Nangang harbor (400 t)	dominant wind in winter: NNW	ebb slack, flood slack	3.7m/s
	dominant wind in summer: S	ebb slack, flood slack	4.1m/s
	adverse wind direction: NNW	ebb slack, flood slack	10.8m/s

10.5.1.3 Calculation result of oil spill accident

According to the analysis of source items, the leakage quantity is 30 tons and 400 tons respectively . The forecast scenario is selected in Table 10.5-1. The calculation results are shown in Figure 10.5-1~10, Figure 4.8-14 and Table 10.5-2.

(1) Operational leakage accident at the front edge of terminal

As can be seen from the chart, under the action of NNW wind direction in winter, the oil film gathers in the Donggang pool area of Nangang District, and will not spread outside the mouth to affect the environment sensitive target ;

Under the action of the normal wind direction in summer, the oil film can reach the coastal wetland and the tourist recreation area of Gaoxaling in east coast and Gaoxaling in summer . The oil spill accident occurred at low tide for 72 hours swept the sea area for 26.16 km^2 . The oil spill occurred at high tide for 72 hours swept the sea area for 102.68 km^2.

(2) Collision Accident on Channel at Entrance

It can be seen from the chart that under the action of wind direction NNW in winter, the oil film diffusion can reach the agricultural fishery area in southeast Tianjin and the coastal wetland in Dagang Harbor . The oil spill occurred at low tide for 72 hours and the oil spill occurred at high tide for 72 hours.

Under the action of the normal wind direction in summer, the oil film can reach the coastal wetland and the tourist recreation area of Gaoxaling in east coast and Gaoxaling in summer . The oil spill accident occurred at low tide for 72 hours and the oil spill occurred at high tide for 72 hours.

Under the action of adverse wind direction NNW (10.8 m/s), the oil film 72 hour sea sweeping range increases obviously, 72 hour oil spill accident 72 hour sea sweeping area is 120.32 km 2 at low tide, 72 hour oil spill accident at high tide 161.32 km 2, oil spill accident at high tide not only sweeps the sea area large, but also reaches the environment sensitive sea area short time.

It can be seen that, under the same wind direction and wind speed, the oil spill occurred at high tide time and the sea sweeping range increased obviously, and the time to sensitive sea area was shortened obviously. Under the action of S-wind in summer, it mainly affects the east coast wetland of Gaoxaling and the tourist recreation area of Gaoxaling. Under the action of NNW wind direction in winter, it mainly affects the farming and fishing area in southeast Tianjin and the coastal wetland in Dagang.

The marine environment of the project is sensitive, and there are sensitive environmental targets such as agro-fishery zones and marine special protection zones around it . If oil spill happens, it will have serious influence on the sensitive targets around it, and the occurrence of such accidents should be strictly prevented.

Table 10.5-2 Analysis of Oil Spill Accident

Leak point	Tidal time	Wind direction	Time H	Sea sweeping area KM 2	Impact on environmentally sensitive objectives
Code Head Before Along	Low Flat Tide	NNW 3.7 M/S	72	3.24	No effect
Code Head Before Along	Low Flat Tide	S 4.1 M/S	72	26.16	Arrived at the east coast wetland of Gaoxaling 24 hours ; Arrive at the leisure and tourism area of Gaoxaling at 29H ;
Code Head Before Along	High Flat Tide	NNW 3.7 M/S	72	2.72	No effect
Code Head Before Along	High Flat Tide	S 4.1 M/S	72	102.68	Reach the east coast wetland of Gaoxaling at 5.5 hours ; Arrive at Gaoxaling Tourism and Recreation Area at 9.5 hours ;
Mouth door	Low Flat Tide	NNW 3.7 M/S	72	80.08	Arrive at the farming and fishing area of southeast Tianjin at 17.5 hours ; Arrived at the coastal wetland of Dagang at 58h ;
Mouth door	Low Flat Tide	S 4.1 M/S	72	71.96	Reach the east coast wetland of Gaoxaling at 19h ; Arrive at the leisure and tourism area of Gaoxaling at 53h ;
Mouth door	Low Flat Tide	NNW 10.8 M/S	72	120.32	Arrive at the farming and fishing area of southeast Tianjin at 14.5 hours ; The 37H reached the coastal wetland of Dagang ;
Mouth door	High Flat Tide	NNW 3.7 M/S	72	105.52	Arrived at the southeastern Tianjin agricultural and fishing area ; Reach Dagang Binhai Wetland at 48.5 hours ;
Mouth door	High Flat Tide	S 4.1 M/S	72	96.48	Reach the east coast wetland of Gaoxaling at 1h ; Arrive at Gaoxaling Tourism Recreation Area at 16h ;
Mouth door	High Flat Tide	NNW 10.8 M/S	24	161.32	Arrive at the farming and fishing area in southeastern Tianjin for 1h ; Reach Dagang Binhai Wetland at 15.5 hours ;

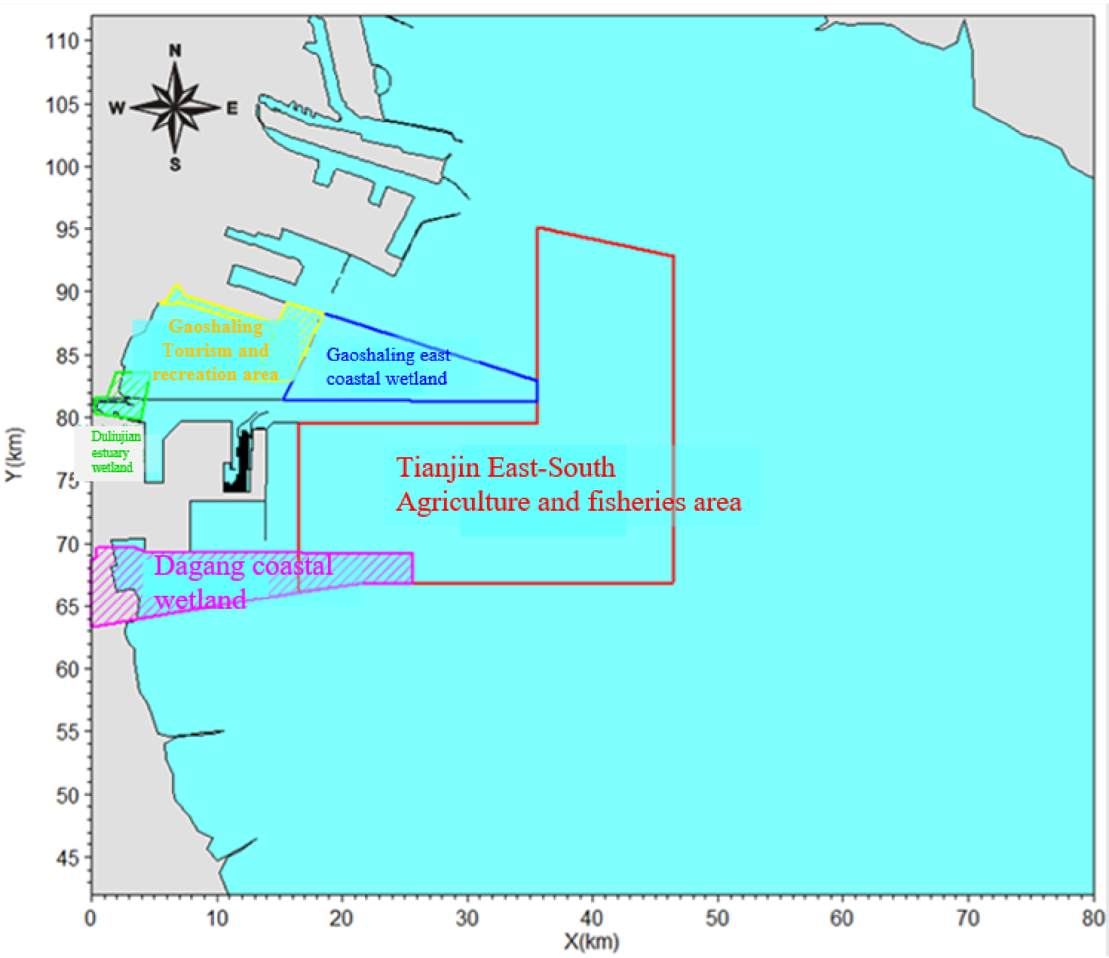


Figure 10.5-1 The 72 hour sweep of the front edge of the terminal (low tide, winter prevailing wind NNW to 3.7 m/s)

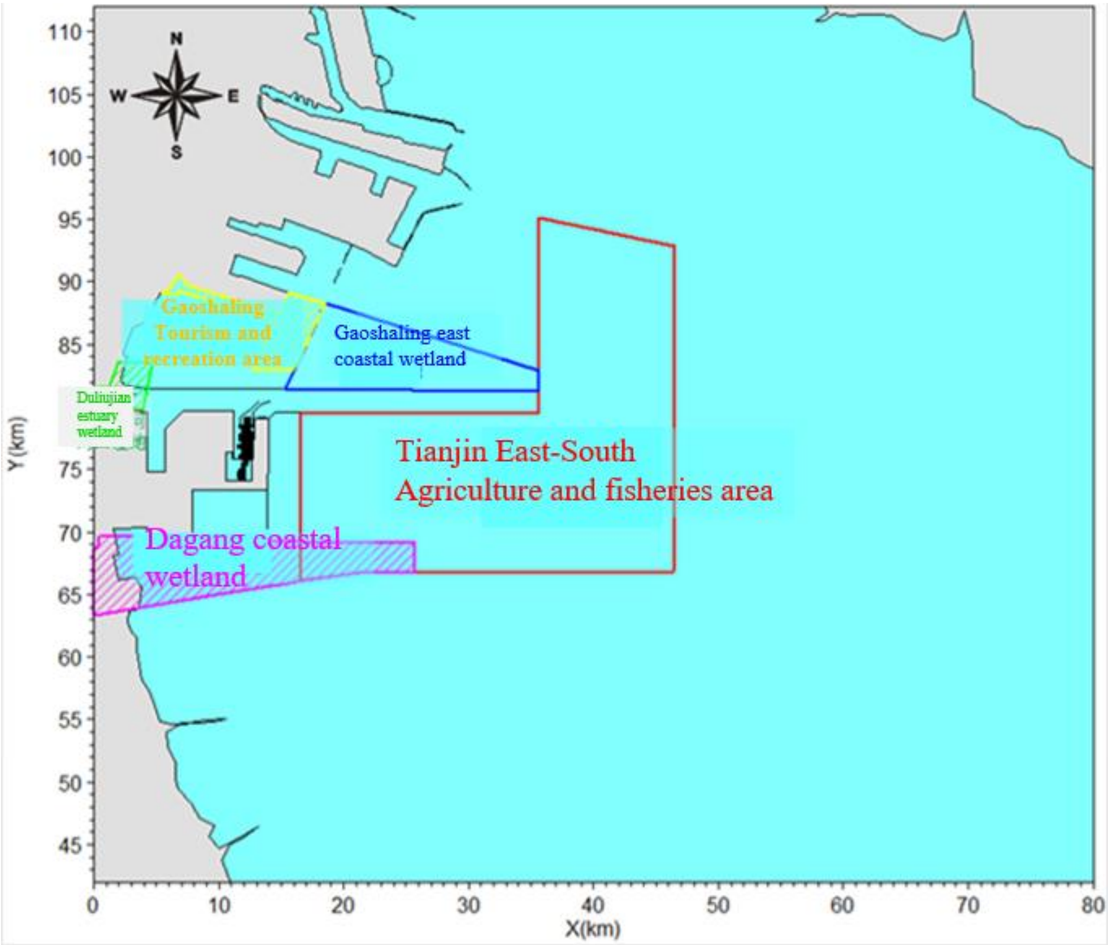


Figure 10.5-2 The 72 hour sweep of the front edge of the terminal (high tide, winter prevailing wind NNW to 3.7 m/s)

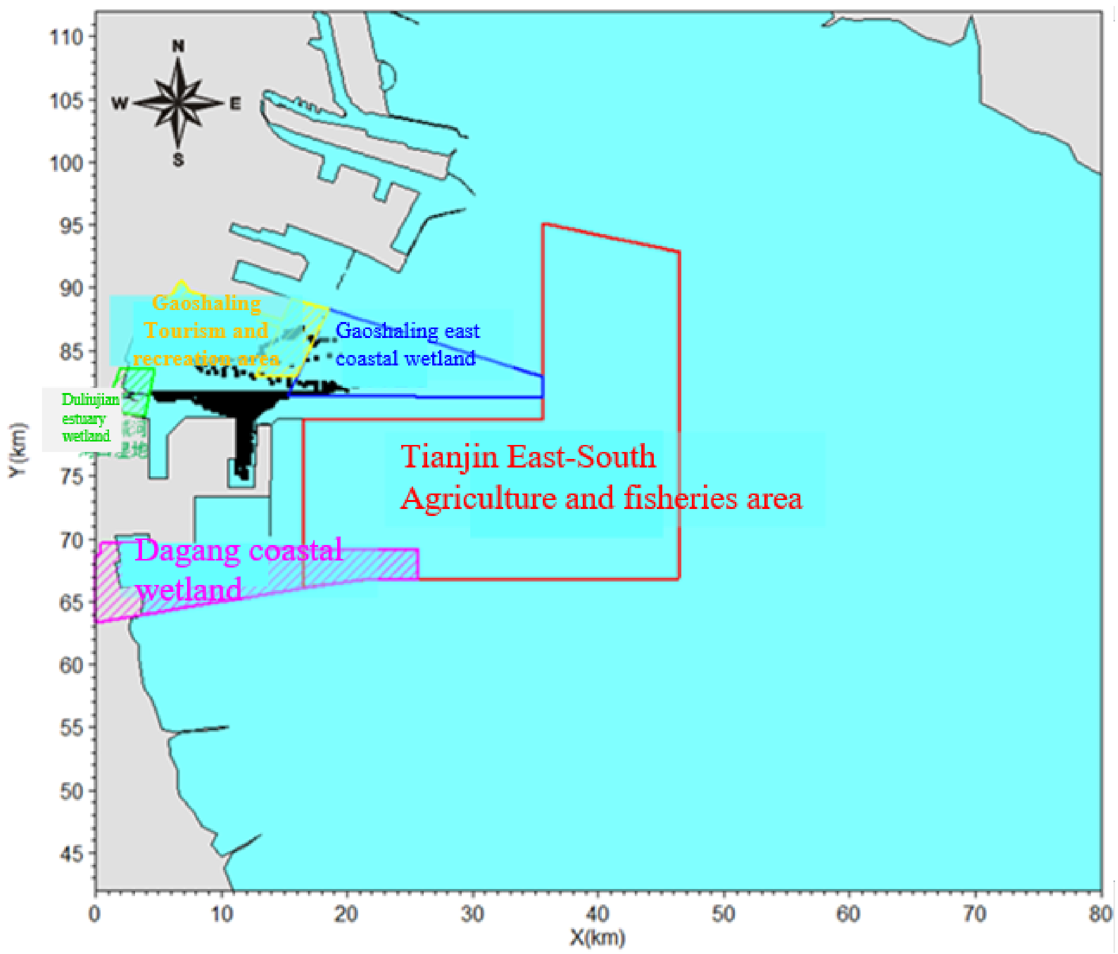


Figure 10.5-3 The 72 hour sweep range at the front of the terminal (low tide, summer prevailing wind S to 4.1 m/s)

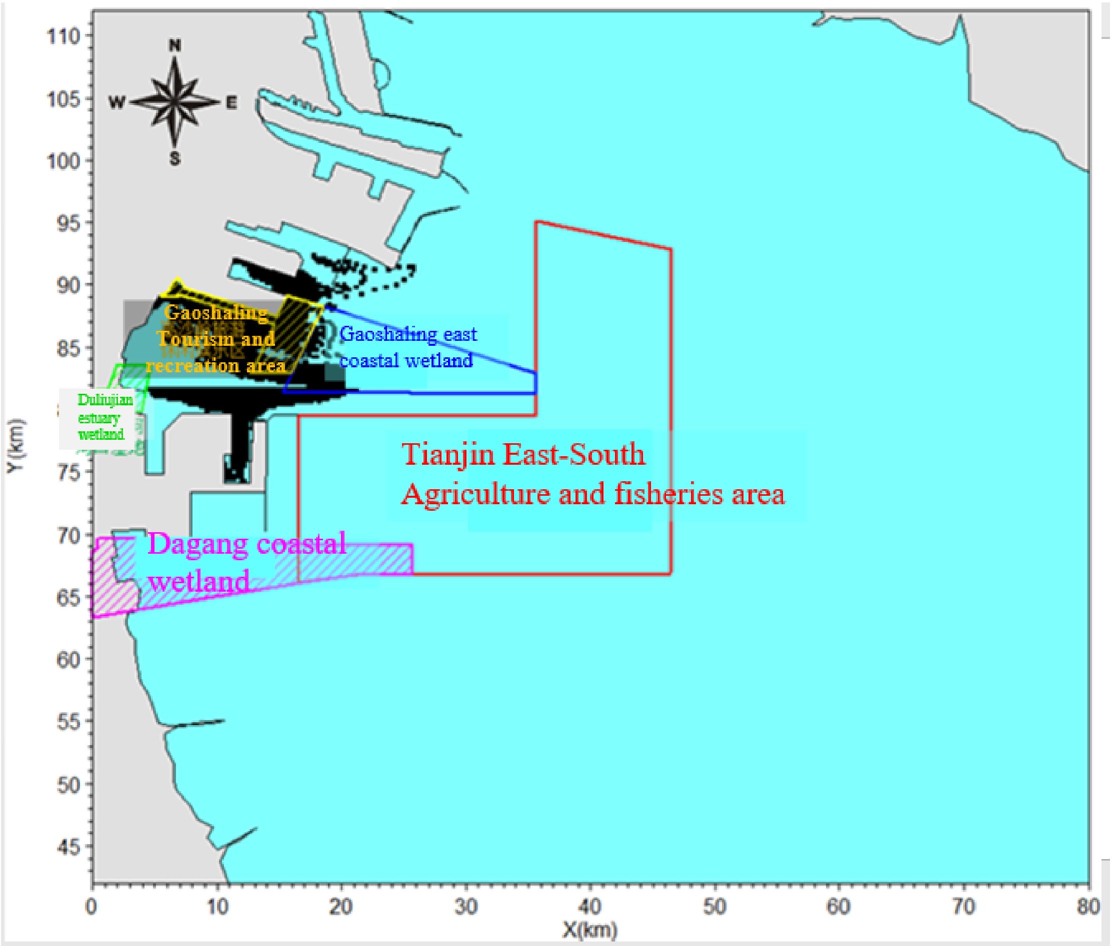


Figure 10.5-4 The 72 hour sweep range at the front of the terminal (high tide, summer prevailing wind S to 4.1 m/s)

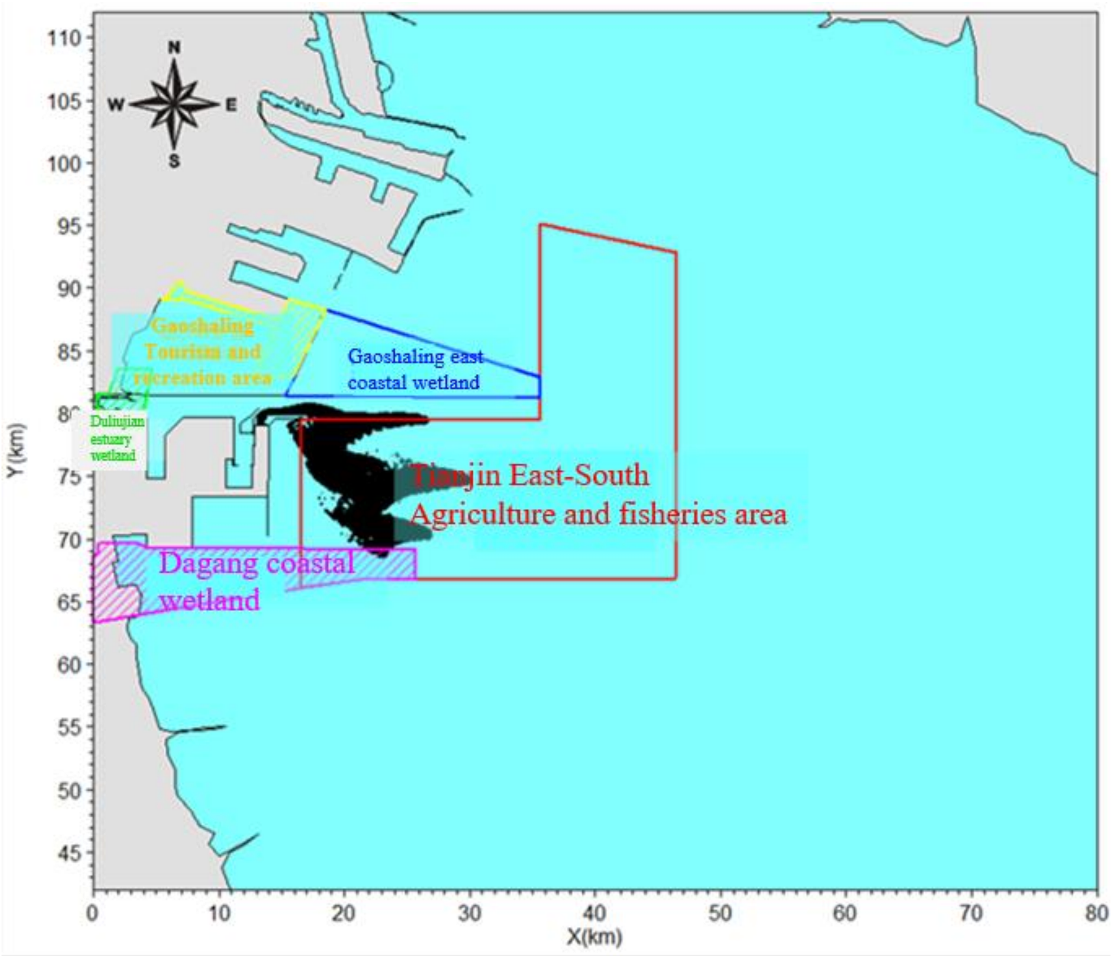


Figure 10.5-5 The 72 hour sea sweeping range at the entrance (low tide, winter prevailing wind NNW to 3.7 m/s)

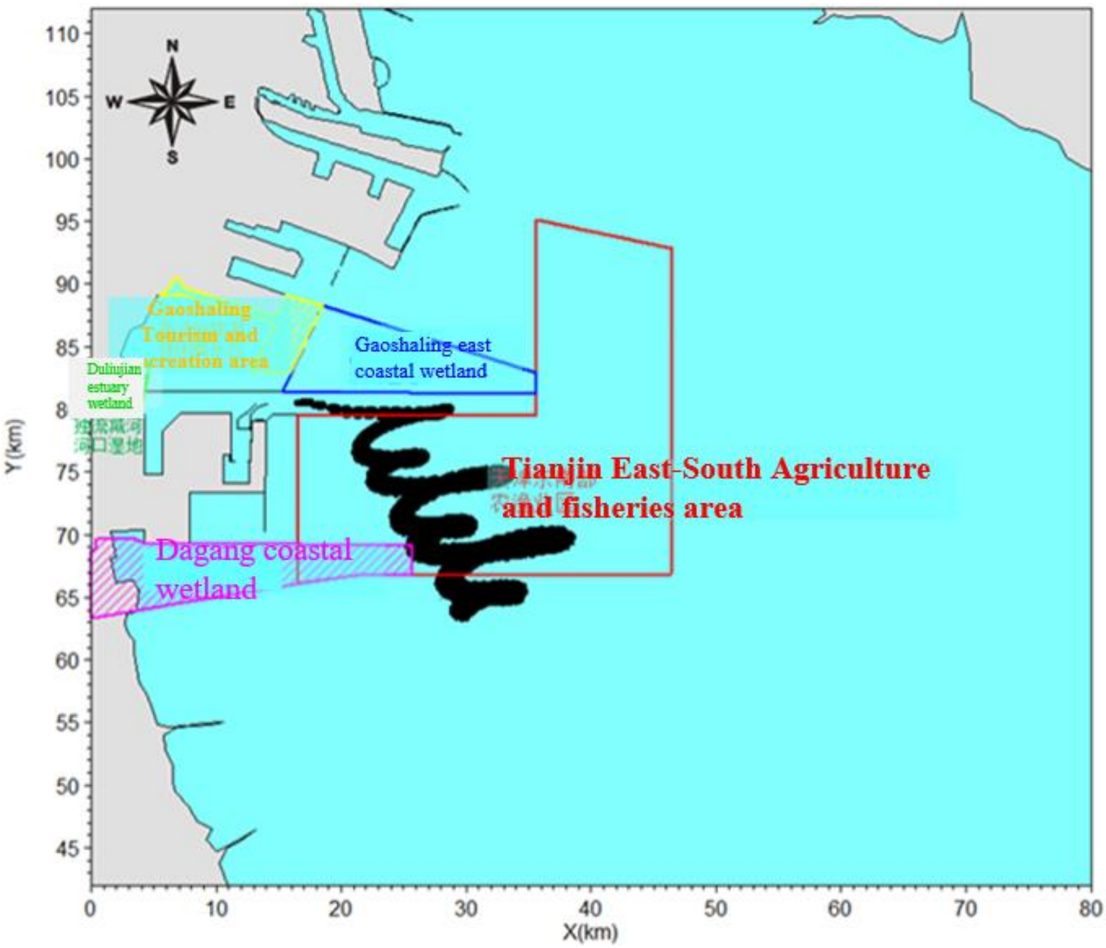


Figure 10.5-6 Area of 72 hour sea sweeping at door (high tide, winter prevailing wind NNW to 3.7 m/s)

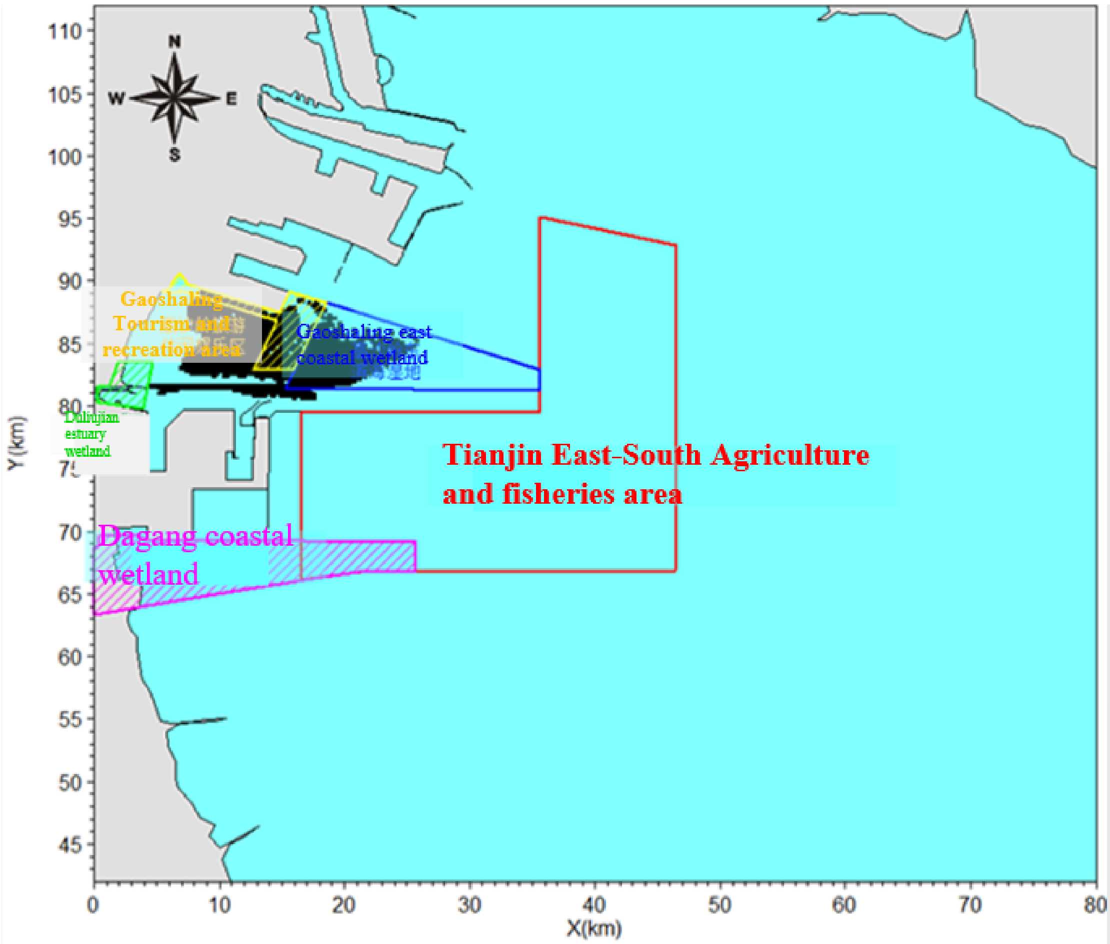


Figure 10.5-7 Area of 72 hour sea sweeping at door (high tide, winter prevailing wind NNW to 3.7 m/s)

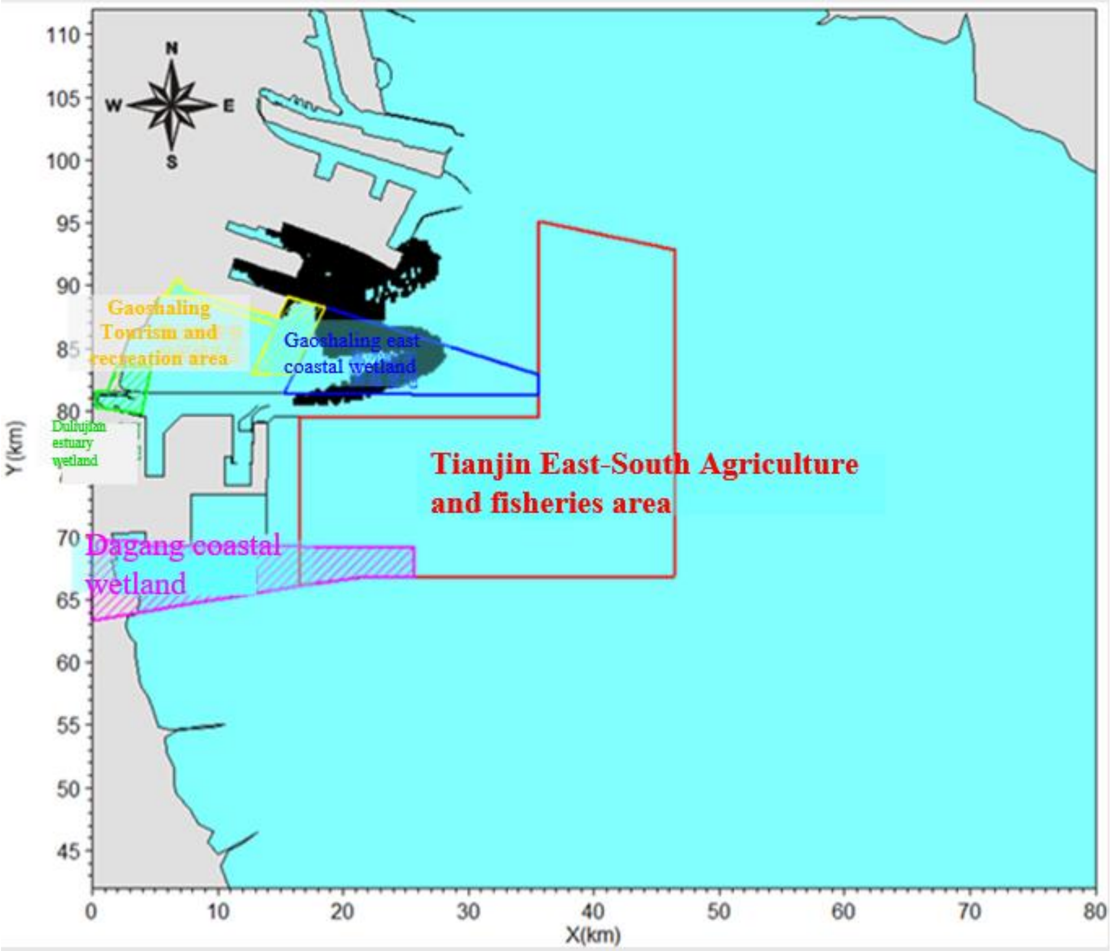


Figure 10.5-8 Area of 72 hour sea sweeping at door (high tide, winter prevailing wind NNW to 3.7 m/s)

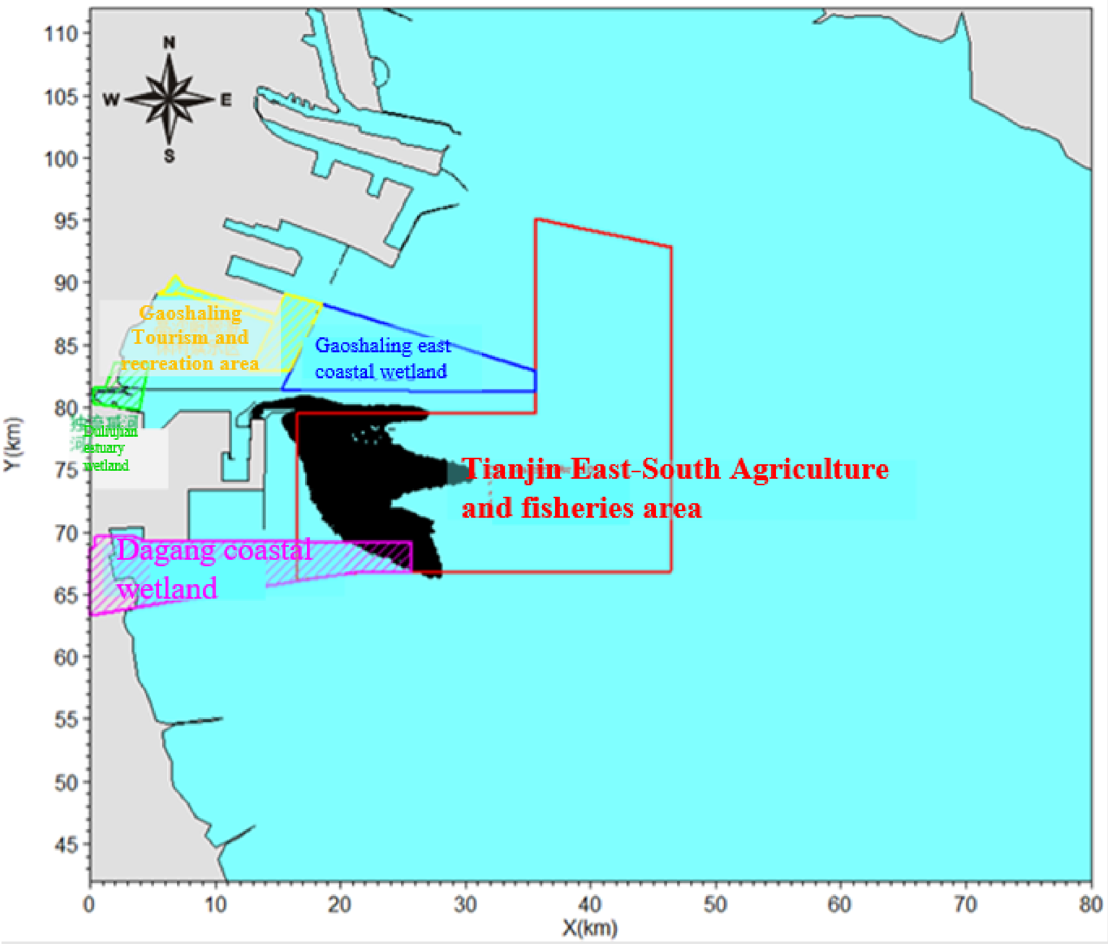


Figure 10.5-9 Area of 72 hour sea sweeping at door (high tide, winter prevailing wind NNW to 3.7 m/s)

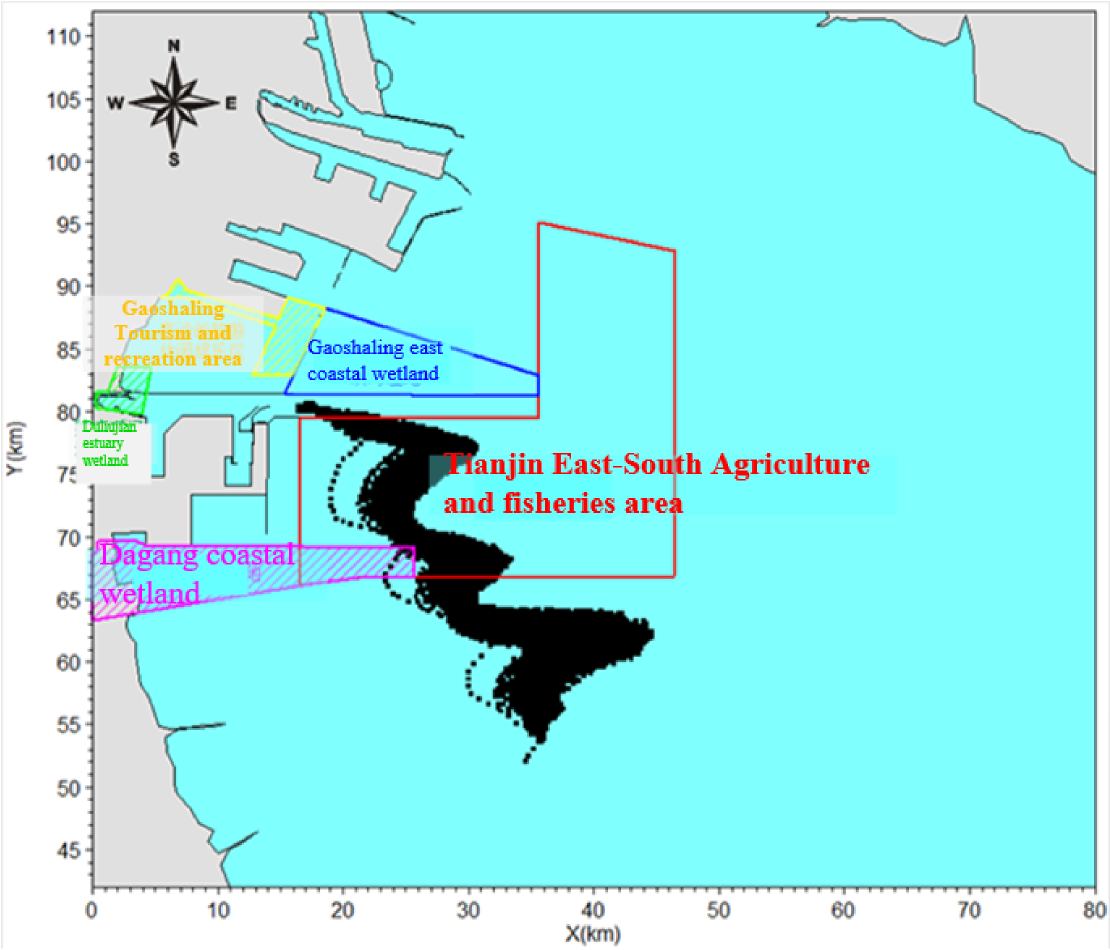


Figure 10.5-10 The 72 hour sea sweeping range at the gate (high tide, adverse wind direction NNW to 10.8 m/s)

10.5.1.4 Analysis on the consequence of oil spill accident

Although the probability of oil spill accident is very low, it will cause serious damage to the proliferating area and other water environment. After the oil spill enters the sea, it usually exists in three forms in the marine environment. One is floating on the surface of sea water, forming oil film ; Second, dissolved or dispersed in seawater, forming a dissolved and emulsified state ; The third is the formation of condensed residues, floating on the sea or deposited on the seabed. The spill will also cause serious damage to the marine ecological environment in the affected areas, as follows :

(1) Effects of oil spills on phytoplankton

Phytoplankton is the main producer of marine organic matter, it is the basic feed of zooplankton and the basic link of the structure of marine food webs. When oil spills occur, most of the oil spills float on the water surface and spread into oil film . The oil film's stay on the sea surface will affect the material exchange and heat exchange between seawater and atmosphere, make the oxygen content and temperature in the sea water change greatly, promote the death of zooplankton, and reduce the transmittance, and affect the photosynthesis of phytoplankton. Experiments have shown that oil can destroy phytoplankton cells, damage chlorophyll and interfere with gas exchange, thus hampering their photosynthesis. The extent of this damage depends on the type of oil, concentration and type of phytoplankton. The results of many toxicity experiments at home and abroad show that phytoplankton, as the basis of fish and shrimp bait, have low tolerance to various oils, and the lethal concentration of phytoplankton oil acute poisoning is 0.1-10 mg/L, usually 1 mg/L. For more sensitive species, even oil concentrations below 0.1 mg/L can interfere with the rate at which their cells divide and grow.

(2) Effects of oil spills on zooplankton

Marine zooplankton is the main link in the marine food chain . In marine ecosystem, it plays an important role in material circulation and energy flow, marine biological productivity and its regulation mechanism. The sensitivity of zooplankton to petroleum is high, and the occurrence of oil spill will have a great toxic effect on zooplankton. Many of the test results show that when the oil concentration exceeds 50 mg/L, harmful effects will occur in copepods within 24 hours, and the sensitivity of larvae is higher than that of adults, such as cyclops, which are cultured in 500 mg/L of petroleum hydrocarbons, the number of deaths of individuals without arthropods has reached half for 82 hours, but half of adult deaths take one time. In addition, if oil spills occur, most of the oil spills float on the water surface and spread into oil film, the oil film's stay in the sea will affect the exchange and exchange of substances between the sea and the atmosphere, so that the oxygen content, temperature and other factors in the sea water will change greatly, so that if oil spills occur, the sea surface through the oil film will have a greater impact on zooplankton in the water.

(3) Effects of oil spills on benthos

Benthos are not only affected by oil in seawater, but also by oil deposited to the seabed. Benthic animals inhabit the sea floor, and when a large amount of oil sinks from the sea, molluscs can suffocate because oil clogs the water pipes of the mollusks or consumes oxygen from the underlying water when it is oxidized by oil. On the other hand, almost all bivalve animals are filterable, and when there are large drops of oil in the sea water, they are sucked into the water pipes of mollusks, gathered in the tunica cavity, if the oil is emulsified or adsorbed on the mud particles, or may stick to the gills or enter the intestines and stomach, damaging their physiological functions to the point of death.

On the other hand, the oil entering the sea can lead to the increase of carbon dioxide and organic matter in the sea water, dissolved oxygen is sharply reduced, in addition, in the process of decomposition of oil by bacteria, a large amount of oxygen needs to be consumed, usually, a liter of oil completely oxidized, 400000 litres of dissolved oxygen needs to be consumed in the sea water, so a large-scale oil spill can cause serious hypoxia in the sea area, causing serious harm to marine life, the damage of oil spills to benthos is different in different seasons, and the impacts of oil spills on benthos will be greater in autumn due to the larger biomass. The effects of oil spills on benthos are mainly due to the toxic effects of oil recombined subduction to the seabed, which are much smaller than those on other marine species living in water.

In conclusion, the effect of petroleum hydrocarbon on benthos mainly affects the stage of larvae and larvae, and the effect on the adult is relatively small. Crustaceans are most sensitive to petroleum hydrocarbon pollution in benthic communities. Mollusks have strong bioresistance to petroleum hydrocarbons, but because they have a strong concentration factor on petroleum hydrocarbons, it is easy to enrich petroleum hydrocarbons in oil pollution environment and cause " oil odor " in their bodies, which affects the economic quality of their products.

(4) Impact of oil spills on fishery resources

The effect of oil spill on the accumulation of fishery resources in the medium and long term is mainly caused by the change of fishery resources type, quantity and composition, thus making the fishery gradually reduce production in the long term. The impacts are sustainable in aquatic environments for years to decades, depending on the size of the spill and the location of the spill. The recovery time of oil spills in coastal, estuarine or salt marshes is usually relatively longer. Studies on the effects of the Amoco Cadiz oil spill in Brittany, France, have shown that the larvae of several species of fish disappear completely in two bays and their adult growth is reduced, and pathologies and distortions occur . It is estimated that it will take at least a few years for their resources to recover to equilibrium. According to a study of the Florida oil spill in Buzzards Bay, Massachusetts, the macrobenthos did not recover significantly 3-4 years after the spill, while some crabs in the intertidal zone of salt marshes did not recover completely after 7 years of oil spill, with an estimated oil spill lasting at least 10 years. According to an oil spill observation near California, most species did not recover until a few years after the spill, but aquatic abalone did not recover 16 years later, and many species did not reach pre-spill abundance. The species diversity of benthos was still significantly lower than that of control points 6 years after the oil spill, and the growth rate of soft-shell clams was lower than that of control points 9 years after the oil spill, according to a study of the oil spill of the Arrow tanker CHEDABUCTO. Barry et al. (1975) reported the results of an oil spill in which a large number of intertidal clam species died at the beginning of the spill and their resources were estimated to recover significantly at least five to six years later. Hiyama (1979) reported an oil spill observation by Japan's Seto Inland Sea, indicating that coastal fisheries resources had been severely damaged in the early stages of the spill, but were largely restored to normal a year later, mainly due to rapid and vigorous recovery efforts.

Marine oil pollution is harmful to fish eggs and larvae. The floating eggs, larvae and zooplankton of economic fish are very vulnerable to the harm of floating oil film on the sea surface, and the oil film's adhesion to eggs and permeability directly affect the hatching rate and quality of fish eggs. Low oil concentration can cause death and distortion of larvae and juveniles, inhibit eggs hatching, slow development, physiological function, and lead to deformity and death. The deposited oil blocks in the oil spill can also affect some of the sinking eggs. According to the relevant data, when the oil concentration in the sea water is more than 0.01 mg/L, fish living in the polluted sea area for more than 24 hours will be contaminated with oil, so the value is considered as the " critical concentration " of fish body odor. At a concentration of 0.1 mg/L, all hatchlings were defective and could only live for 1-2 days. For the larvae of sea shrimp, the " semi-lethal concentration " (i.e., the limit concentration to kill half within 24 hours) is 1 mg/L, which varies according to the species. In addition, because eggs are generally attached eggs, drift with the flow, and young fish swimming ability is poor, so if oil spills, eggs and young fish will be devastating damage.

(5) Damage of oil spills to birds

Oil spills on the sea are most harmful to birds, especially those that dive for food. These birds feed on marine plankton and fish, and when exposed to oil membranes, their feathers can soak up oil and lose their ability to water and heat. They, on the other hand, pack their feathers with their mouths because they can not feed, ingest oil spills, causing damage to their internal organs and eventually die from hunger, cold and poison. In the event of oil spill, it is very important to rescue birds from the angle of protecting natural ecology.

(6) Effect of Oil Spill on Coastal Environment

Once the oil slick on the sea reaches the shore or beach, it is deposited near the high tide line, in a rock pit or in a depression, coated on the surface of the shore's reef, and glued to pebbles, debris, and sand. If the oil is less viscous, it can also penetrate the sand on the beach, forming a thick oil-sand mixing layer, worsening the natural environment of the coast.

Based on the above analysis, if the oil spill occurs in the engineering area, it will cause great pollution damage to the local marine ecology and fishery resources. The pollution caused by the oil spill to the sea is serious and lasting, so we should pay more attention to it, strengthen management, prevent accidents from happening on ships, make necessary emergency plans, take timely measures to eliminate the oil spill in large areas.

After the occurrence of oil spill, the units shall make emergency response after being notified, and shall take emergency measures such as diversion of offshore oil barrier and interception of offshore oil spill in the direction of sensitive area in a timely manner.

10.5.2 Environmental Impact Analysis of LNG Leak Accident on Ships

10.5.2.1 Overview of LNG Leak into the Sea

In the event of an accident on a LNG ship, a small portion of the liquefied natural gas will be rapidly vaporized into steam as soon as it is released, and the remaining part will leak onto the ground, surface and surface of the ship. An explosive mixture formed may cause fire and explosion if it encounters a ignition source. The cold gas formed after the liquefied natural gas leakage is more concentrated than the surrounding air at the initial stage, and it is easy to form clouds or laminar flow. The amount of liquefied natural gas (LNG) released depends on the heat supply of soil, atmosphere and sea water. The gasification rate is very high at the moment of leakage. After a period of time, it approaches a constant. If there are no containment facilities, the liquefied natural gas will spread along the surface of the ground, ship surface, fire can be caused by fire. In the case of an accident, the liquefied natural gas discharged by the equipment's safe release facility may also cause fire. High concentrations of natural gas can cause asphyxiation due to hypoxia, cold frostbite caused by exposure to liquefied natural gas, and damage to equipment or building materials can result in secondary disasters. When the LNG is suddenly heated in contact with warm liquids such as sea water and water, an explosion of boiling occurs in the LNG, resulting in partial pressure release. When LNG is released into the marine environment, a small fraction of it is rapidly vaporized into steam, forming a cold gas with a higher initial concentration than the surrounding air, which is easy to form clouds or laminar flow. When LNG is released into the sea and vaporized in the sea water, the local water temperature of the sea water will drop rapidly, forming a low temperature area, leading to a certain range of biological death or frostbite, which will have a temporary adverse effect on marine life. Therefore, it is necessary to strengthen management to prevent ship accidents.

10.5.2.2 Characteristics of LNG Ship

The characteristics of ship structure and ship management depend mainly on the characteristics of the goods carried. The cargo carried by the LNG ship is characterized by low temperature, small specific gravity, easy combustion of the mixture of vapour and air. LNG ships are different from other conventional ships in design, construction, operation and equipment management to suit the characteristics of the cargo.

(1) Adopting low-temperature resistant material

In accordance with the provisions of the IGC (International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk), materials used for the construction of LNG holds are capable of withstanding at least -165 degrees Celsius.

(2) Use secondary shielding of cargo hold

MOSS-LNG holds are partially shielded according to IGC rules; The Membrane LNG Cargo Bay shall be fully shielded and shall be capable of accommodating leakage from the Main Shielding for more than 15 days (the 15-day period shall be determined because the LNG Ship's maximum sailing time from the LNG Loading Port to the Discharge Port shall not exceed 15 days).

(3) Installation of double hull

All LNG Ship bilayer hulls are designed to prevent and reduce damage to the LNG Ship's hold in the event of collision and grounding.

10.5.2.3 Effect of LNG Leak on Marine Environment

Due to the rapid gasification of LNG liquid after leakage, the range of condensed mixed gases is generally within 200-300m, which has a small influence on the marine environment, and the LNG will volatilize and disappear rapidly with the gasification, and has a small influence on the surrounding marine environment.

10.5.3 Atmospheric Environmental Risk Prediction and Assessment

10.5.3.1 Terrestrial atmospheric pollutant diffusion prediction method

(1) Prediction factor

According to the preceding section, the predictors of terrestrial leakage were methane and carbon monoxide with a predicted grid spacing of 100 meters.

(2) Forecast meteorological conditions

According to HJ 169-2018, the most adverse weather conditions for the secondary evaluation were class F stability, 1.5 m/s wind speed, temperature 25°C, relative humidity 50% .

(3) Predictive model

Calculations are based on the formula in appendix G to the Technical Guidelines for Environmental Risk Assessment of Construction Projects (HJ 169-2018), calculated using the AFTOX model.

10.5.3.2 Analysis of atmospheric environmental impact of natural gas leakage in Receiving terminal

According to the aforementioned accident situation, prediction model and calculation parameters, the pollution scope and harm degree of leakage natural gas are simulated and calculated.

Table 10.5-3 Prediction of maximum concentration of gas (methane) leakage axis

No.	Distance (m）	Concentration occurrence time (min)	Peak concentration (mg/m3)
1	60	0.67	1.42E+02
2	110	1.22	2.17E+04
3	160	1.78	7.24E+04
4	210	2.33	1.11E+05
5	260	2.89	1.31E+05
6	310	3.44	1.35E+05
7	360	4.00	1.31E+05
8	410	4.56	1.22E+05
9	460	5.11	1.12E+05
10	510	5.67	1.02E+05
11	560	6.22	9.15E+04
12	610	6.78	8.21E+04
13	660	7.33	7.37E+04
14	710	7.89	6.62E+04
15	760	8.44	5.95E+04
16	810	9.00	5.37E+04
17	860	9.56	4.85E+04
18	910	10.11	4.39E+04
19	960	10.67	3.99E+04
20	1010	11.22	3.63E+04
21	1060	11.78	3.31E+04
22	1110	12.33	3.03E+04
23	1160	12.89	2.78E+04
24	1210	13.44	2.55E+04
25	1260	14.00	2.35E+04
26	1310	14.56	2.17E+04
27	1360	15.11	2.01E+04
28	1410	15.67	1.85E+04
29	1460	16.22	1.74E+04
30	1510	16.78	1.63E+04
31	1560	17.33	1.54E+04
32	1610	17.89	1.45E+04
33	1660	18.44	1.37E+04
34	1710	19.00	1.29E+04
35	1760	19.56	1.22E+04
36	1810	20.11	1.16E+04
37	1860	20.67	1.10E+04
38	1910	21.22	1.04E+04
39	1960	21.78	9.93E+03

No.	Distance (m）	Concentration occurrence time (min)	Peak concentration (mg/m3)
40	2010	22.33	9.46E+03
41	2060	22.89	9.01E+03
42	2110	23.44	8.60E+03
43	2160	24.00	8.21E+03
44	2210	24.56	7.84E+03
45	2260	25.11	7.50E+03
46	2310	25.67	7.18E+03
47	2360	26.22	6.88E+03
48	2410	26.78	6.60E+03
49	2460	27.33	6.33E+03
50	2510	27.89	6.08E+03
51	2560	28.44	5.84E+03
52	2610	29.00	5.62E+03
53	2660	29.56	5.41E+03
54	2710	30.11	5.21E+03
55	2760	30.67	5.02E+03
56	2810	31.22	4.84E+03
57	2860	31.78	4.67E+03
58	2910	32.33	4.50E+03
59	2960	32.89	4.35E+03
60	3010	33.44	4.20E+03
61	3060	34.00	4.06E+03
62	3110	34.56	3.93E+03
63	3160	35.11	3.80E+03
64	3210	35.67	3.68E+03
65	3260	36.22	3.57E+03
66	3310	36.78	3.46E+03
67	3360	37.33	3.35E+03
68	3410	37.89	3.25E+03
69	3460	38.44	3.15E+03
70	3510	39.00	3.06E+03
71	3560	39.56	2.97E+03
72	3610	40.11	2.89E+03
73	3660	40.67	2.80E+03
74	3710	41.22	2.73E+03
75	3760	41.78	2.65E+03
76	3810	42.33	2.58E+03
77	3860	42.89	2.51E+03
78	3910	43.44	2.44E+03
79	3960	44.00	2.38E+03
80	4010	44.56	2.32E+03
81	4060	45.11	2.26E+03
82	4110	45.67	2.20E+03
83	4160	46.22	2.14E+03
84	4210	46.78	2.09E+03
85	4260	47.33	2.04E+03
86	4310	47.89	1.99E+03
87	4360	48.44	1.94E+03
88	4410	49.00	1.90E+03
89	4460	49.56	1.85E+03
90	4510	50.11	1.81E+03
91	4560	50.67	1.77E+03
92	4610	51.22	1.73E+03

No.	Distance (m)	Concentration occurrence time (min)	Peak concentration (mg/m3)
93	4660	51.78	1.69E+03
94	4710	52.33	1.65E+03
95	4760	52.89	1.61E+03
96	4810	53.45	1.58E+03
97	4860	54.00	1.54E+03
98	4910	54.56	1.51E+03
99	4960	55.11	1.48E+03

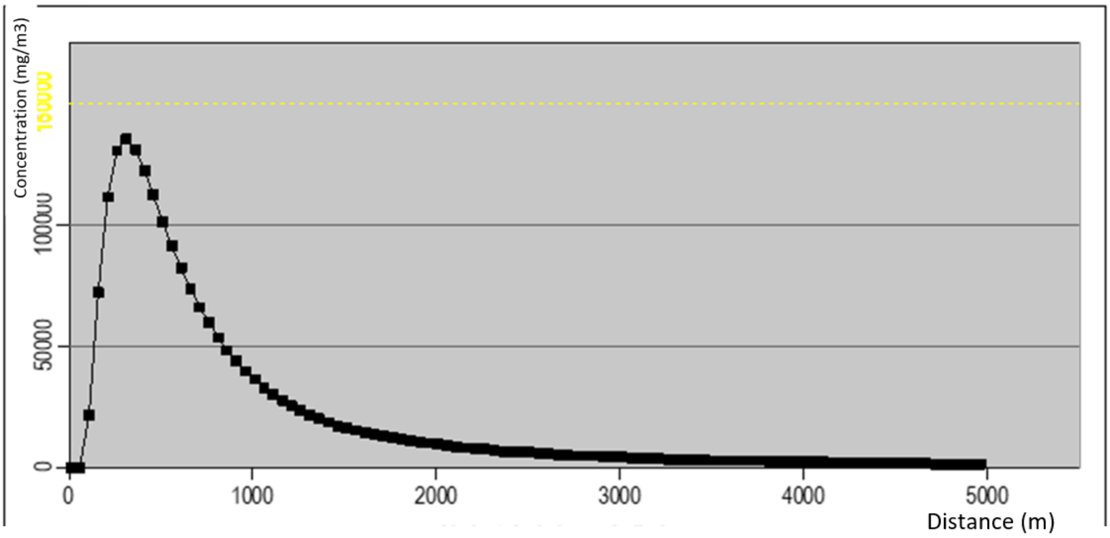


Figure 10.5-11 Axial concentration-distance plot of methane leakage in this project

From the analysis of the predicted results, it can be seen that the maximum concentration of axis line is 135000 mg/m3 under the most adverse weather conditions, which can meet the requirements of CH-1 (260000 mg/m3) and CH-2 (150000 mg/m3).

10.5.3.3 Analysis of atmospheric environment effect of secondary pollutant carbon monoxide in Receiving terminal

According to the accident situation, prediction model and calculation parameters, the pollution range and harm degree of carbon monoxide in secondary pollutants are simulated and calculated.

Table 10.5-4 Prediction of CO Pollution Associated with Fire

No.	Distance (m)	Concentration occurrence time (min)	Peak concentration (mg/m3)
1	60	0.67	5.76E-01
2	110	1.22	5.46E+01
3	160	1.78	1.44E+02
4	210	2.33	1.93E+02
5	260	2.89	2.08E+02
6	310	3.44	2.04E+02
7	360	4.00	1.90E+02
8	410	4.56	1.72E+02
9	460	5.11	1.54E+02
10	510	5.67	1.36E+02
11	560	6.22	1.20E+02
12	610	6.78	1.06E+02

No.	Distance (m）	Concentration occurrence time (min)	Peak concentration (mg/m3)
13	660	7.33	9.39E+01
14	710	7.89	8.31E+01
15	760	8.44	7.37E+01
16	810	9.00	6.56E+01
17	860	9.56	5.85E+01
18	910	10.11	5.24E+01
19	960	10.67	4.71E+01
20	1010	11.22	4.25E+01
21	1060	11.78	3.84E+01
22	1110	12.33	3.48E+01
23	1160	12.89	3.17E+01
24	1210	13.44	2.89E+01
25	1260	14.00	2.65E+01
26	1310	14.56	2.43E+01
27	1360	15.11	2.23E+01
28	1410	15.67	2.05E+01
29	1460	16.22	1.91E+01
30	1510	16.78	1.78E+01
31	1560	17.33	1.67E+01
32	1610	17.89	1.57E+01
33	1660	18.44	1.47E+01
34	1710	19.00	1.38E+01
35	1760	19.56	1.31E+01
36	1810	20.11	1.23E+01
37	1860	20.67	1.16E+01
38	1910	21.22	1.10E+01
39	1960	21.78	1.04E+01
40	2010	22.33	9.91E+00
41	2060	22.89	9.41E+00
42	2110	23.44	8.95E+00
43	2160	24.00	8.52E+00
44	2210	24.56	8.12E+00
45	2260	25.11	7.75E+00
46	2310	25.67	7.40E+00
47	2360	26.22	7.07E+00
48	2410	26.78	6.77E+00
49	2460	27.33	6.48E+00
50	2510	27.89	6.21E+00
51	2560	28.44	5.95E+00
52	2610	29.00	5.71E+00
53	2660	29.56	5.49E+00
54	2710	30.11	5.27E+00
55	2760	30.67	5.07E+00
56	2810	31.22	4.88E+00
57	2860	31.78	4.70E+00
58	2910	32.33	4.53E+00
59	2960	32.89	4.37E+00
60	3010	33.44	4.21E+00
61	3060	34.00	4.07E+00
62	3110	34.56	3.93E+00
63	3160	35.11	3.79E+00
64	3210	35.67	3.67E+00
65	3260	36.22	3.55E+00

No.	Distance (m）	Concentration occurrence time (min)	Peak concentration (mg/m3)
66	3310	36.78	3.43E+00
67	3360	37.33	3.32E+00
68	3410	37.89	3.22E+00
69	3460	38.44	3.12E+00
70	3510	39.00	3.03E+00
71	3560	39.56	2.93E+00
72	3610	40.11	2.85E+00
73	3660	40.67	2.76E+00
74	3710	41.22	2.68E+00
75	3760	41.78	2.61E+00
76	3810	42.33	2.53E+00
77	3860	42.89	2.46E+00
78	3910	43.44	2.39E+00
79	3960	44.00	2.33E+00
80	4010	44.56	2.27E+00
81	4060	45.11	2.21E+00
82	4110	45.67	2.15E+00
83	4160	46.22	2.09E+00
84	4210	46.78	2.04E+00
85	4260	47.33	1.99E+00
86	4310	47.89	1.94E+00
87	4360	48.44	1.89E+00
88	4410	49.00	1.84E+00
89	4460	49.56	1.80E+00
90	4510	50.11	1.76E+00
91	4560	50.67	1.71E+00
92	4610	51.22	1.67E+00
93	4660	51.78	1.63E+00
94	4710	52.33	1.60E+00
95	4760	52.89	1.56E+00
96	4810	53.45	1.53E+00
97	4860	54.00	1.49E+00
98	4910	54.56	1.46E+00
99	4960	55.11	1.43E+00

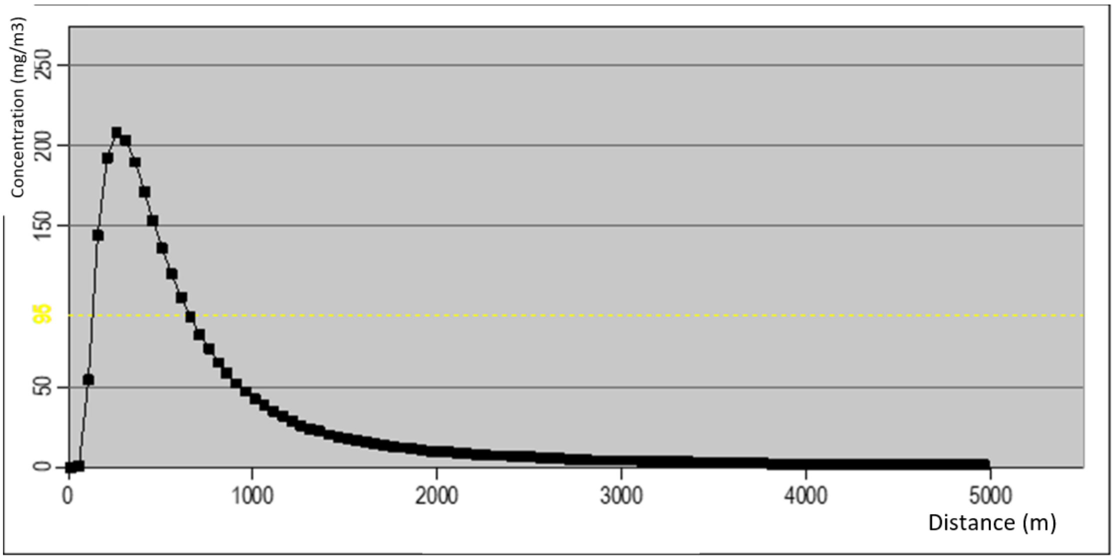


Figure 10.5-12 maximum concentration of axes

The predicted results show that the maximum concentration of carbon monoxide in the axis of secondary pollutant is 208 mg/m3 under the most adverse weather conditions, which can meet the requirement of carbon monoxide toxic end concentration-1 (380 mg/m3), and carbon monoxide can meet the requirement of toxic end concentration-2 (95 mg/m3) at 660 meters in the lower wind direction.

In case of fire, the secondary pollutant carbon monoxide has a large impact on the atmospheric environment. This evaluation requires the use of prior equipment. When leakage occurs, the response can occur in the shortest time, cut off the pipeline, stop the leakage, in order to reduce the impact of the accident.

10.5.3.4 Atmospheric Environmental Risk Prediction Conclusions

According to the predicted results, the maximum axial concentration of methane can meet the requirements of toxic end-concentration-1 and toxic end-concentration-2. The maximum axial concentration of secondary pollutant carbon monoxide can meet the requirements of the corresponding toxic end point concentration-1, and the requirement of toxic end point concentration-2 can be met at 660 meters in the lower wind direction. There is no residential area in this area.

10.6 Environmental risk management

10.6.1 Environmental Risk Management for Terminals and Receiving terminal

10.6.1.1 Prevention Measures of Oil Spill Risk in Construction Operation

(1) The construction unit and the construction ship shall, in accordance with the dynamics of the ship in the port area, arrange the construction working surface reasonably and take measures to avoid the construction in advance when the ship passes.

(2) All construction vessels shall display signals based on the provisions of traffic signal management during construction operations.

(3) The construction operation ship shall be on duty during the construction, and the construction operation personnel shall strictly follow the operation rules.

(4) In the event of an emergency, the construction vessel shall immediately take the necessary measures and report to the maritime traffic control center.

(5) During the construction, a special person shall be responsible for the supervision, so as to avoid the influence of the pipeline of the construction vessel on the normal navigation of the passing ship.

(6) It is strictly prohibited for construction operation units to expand the safety zone of construction operation without authorization, and for vessels not involved to enter the water area of construction operation, and to issue navigation notices in advance and on time.

(7) The construction unit shall submit a construction plan to the Dagang Maritime Bureau to the commencement of the project in advance. The Tianjin Port Traffic Control Center

and the port supervision department shall reasonably arrange for vessels to stay on, leave and sail in the waterway during the operation period to avoid collision accidents.

10.6.1.2 Prevention Countermeasures of Marine Traffic Accidents

(1) Provision of necessary safety and security facilities such as navigation aids

In order to ensure the navigation safety of ships in the sea area near the terminal and waterway, construction vessels and terminal operators shall accept the coordination, supervision and management of ship traffic and ship reports by the maritime administrative departments within their respective jurisdictions setting up necessary safety support facilities such as navigation aids. In the process of planning the project of waterway engineering construction, necessary safety support facilities such as navigation aids have been provided according to the regional engineering characteristics and regional environmental characteristics.

(2) Strengthening training and education for seafarers, improving operational skills and safety awareness

The causes of maritime accidents are closely related to the management of operators except that the bad weather is uncontrollable. To reduce the occurrence of accidents is to enhance the safety awareness and operation skills of operators. The shipping company shall organize regular marine safety awareness education and training of marine safety skills, do the regular inspection and maintenance of ships, and ensure the safety, efficiency and performance of all kinds of equipment. Popularize safety knowledge to improve crew quality, enhance crew members's knowledge of safety production and proficiency in safety technology. Scientific and reasonable schedule to avoid crew fatigue caused by slow response, attention, and other phenomena, reduce the human shipwreck factors.

(3）To urge construction vessels to strengthen risk control of navigation and berthing in and out of port

① To strengthen the preparation of navigation organizations and the waters of the entry and exit areas. Before entering or leaving the port of the construction ship, the master shall urge the relevant personnel to inspect, check, test and implement the inspection items in the inspection list item by item carefully, make relevant records and sign and confirm, so as to ensure that each inspection, check or test is conscientiously carried out.

② Supervise and urge the construction ship to make detailed navigation and operation plan and procedure before entering and leaving port and berthing.

③ Construction vessels shall keep abreast of the latest navigable data such as nautical charts, port navigation channels, tidal currents, hydrometeorology, navigational aids, bathymetric bases, vessel density, etc., understand and strictly observe the relevant regulations, navigation regulations and communication and reporting systems in the sea area of Tianjin Port, taking fully into account the influence of environmental and natural factors on ship manoeuvring.

④ The construction ship should fully analyze and evaluate the working condition of the power equipment, make emergency preparation measures according to the emergency preplan, make early inspection, early discovery and early solution, and prevent the construction ship from causing urgent situation due to the equipment problem. Request assistance from the shore-based if necessary.

⑤ Make full use of and manage the resources of the bridge, organize the crew on duty reasonably, clarify the respective positions, angles, routine duties, emergency duties, information communication and communication methods, records, emergency handling, working rules of the bridge, and so on.

⑥ Do a good job of communication and communication.The VHF shall listen to and keep in touch with, and be guided by, the port area console, the navigation radar station, the maritime traffic command centre, etc.

⑦ The ship is prohibited from entering and leaving the port area under the condition of hidden danger of key power and navigation aids, and from fatigue driving.

10.6.1.3 Emergency Measures and Countermeasures of Marine Pollution

(1) The basis of emergency capability for ship leakage in this sea area

As a kind of public emergency at sea, the marine leakage accident can easily lead to the environmental safety problem. The Tianjin Municipal Government and relevant departments have made active efforts in the prevention and control of accidents. According to the laws and regulations of the People's Republic of China on marine environment protection law and the relevant requirements of the international conventions to which China is a member, the emergency preparedness and response of the accidents must be done by the units and ships which may have major oil spills and chemical pollution accidents along the ports, terminals and coasts. At present, the Tianjin Maritime Bureau is actively promoting the implementation of the Special Plan for the Construction of Emergency Capacities for Preventing and Curing Pollution of the Marine Environment from Ships and Related Activities in Tianjin.

Considering the special navigation requirements of LNG ships, the occurrence of the operation of the anchorage of the ship is the main cause of the planned oil spill. Therefore, emergency prevention measures should be formulated and implemented from the following aspects.

① When refuelling, the ship shall operate strictly in accordance with the relevant regulations to prevent the occurrence of oil spills due to the careless effect of flax, and pay attention to the local hydrological and meteorological conditions at the time when refuelling, so as to avoid refuelling during windy and rainy days.

② In the event of oil spill, the primary objective is to protect the important area and limit the spread of oil pollution. If equipment, materials and manpower are insufficient to provide strong protection for sensitive areas, priority must be given to protecting critical areas.

③ At present, there are 1#-8# anchorage, 8 anchorage and no special emergency anchorage for LNG in General Plan of Tianjin Port (2011-2030). With the implementation of this plan, the throughput of LNG will increase significantly and the number of LNG ships entering and leaving port will increase.

According to the regulations, the water depth of anchorage shall not be less than 1.2 times of the full load water of the designed ship type. Under severe weather conditions, when the wave height (H 4%) exceeds 2m, the wave should be increased, taking into account 2/3 times the wave height.

Table 10.6-1 Calculation of Water Depth for LNG Anchorage

Design type (Ten thousand m3）	Full draft (m）	Minimum required anchorage depth (m）
1	5.8	9.3
3	7.5	11.3
8.43~14.0	11.7	16.4
14.0~15.5	12.3	17.1
21.7	12.3	17.1
26.6	12.2	17.0

According to the calculation, the required anchorage water depth for the LNG design representative ship type shall not be less than-17.1 m. The bottom elevation of the selected area shall not be less than-16.6 m~-17.4 m, which can meet the anchor requirements of the LNG representative ship with full load. Considering that this planning adjustment area is located in Dagang Port, it is suggested that the northeast water area of No. 8 Anchorage in General Plan of Tianjin Port (2011-2030) be provided with LNG emergency anchorage.

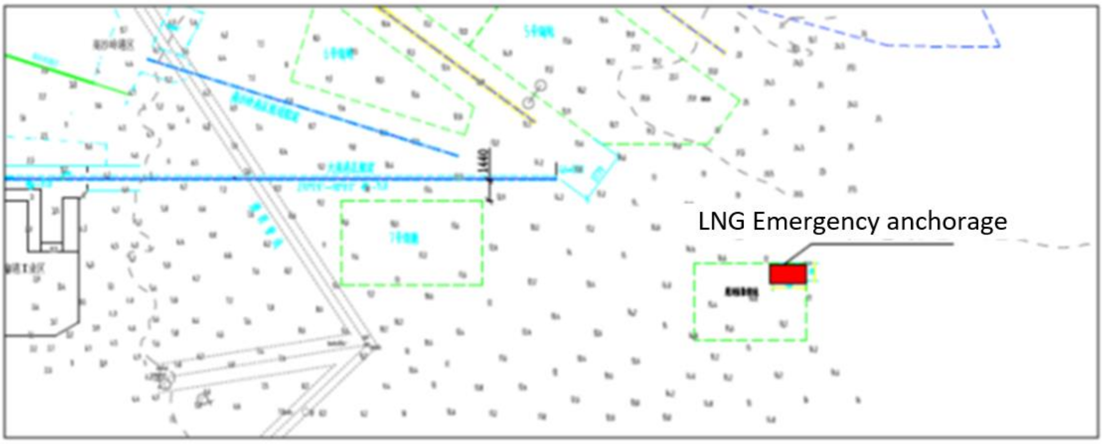


Figure 10.6-1 Location of LNG Emergency Anchorage

In addition, as required by the LNG Terminal Design Code (TJS 165-5-2009) and the Harbour Master Design Code (JTS 165-2013), “the safe net distance between the anchor position of the LNG ships and other anchorage shall not be less than 1000 m”. It is suggested that the selection and demonstration of LNG emergency anchorage should be carried out as soon as possible to ensure the safe operation of LNG ship.

(2）Prevention of Leakage Risk Accidents

① The design of the terminal shall be carried out in accordance with the relevant standards such as transportation, storage, loading and unloading of the terminal. The layout shall be reasonably arranged according to the prevailing wind direction, fire control safety and transportation spacing.

② No plants are allowed in the quay tank area, the pipeline area and the relevant reservoir area.

③ Strict operation rules and make reliable maintenance rules; We will strengthen post training and vocational quality education for operators, raise safety awareness and prevent accidents caused by improper operation and maintenance of equipment.

④ Set up the system standard management system of evaluation, examination and approval, operation, monitoring, rescue, emergency procedures, accident report, etc.

⑤ Strict management measures shall be taken to control open flames, prevent friction and impact, avoid electrical and static electric spark, lightning protection, heat source protection and solar radiation protection shall be considered in the design, and the storage of dangerous goods shall be minimized to prevent fire.

10.6.1.4 Emergency Measures for Oil Spill Risk Accidents

(1) Existing Emergency Resources in Dagang Port Area

At present, there are 1-8 # general terminals in Nangang Industrial Zone, TaiAo Petrochemical Terminal and Chemical Terminal in Nangang, NanAo Chemical Terminal and Tianjin LNG Terminal in Sinopec. According to the Special Plan of Tianjin for the Prevention and Control of Marine Environment Pollution Caused by Oil Spill, the oil spill emergency equipment warehouse in Dagang Port Area shall be built as a large equipment warehouse with the function of oil spill emergency, the warehouse area shall not be less than 3000 m2, and the emergency scope shall be the need of oil spill emergency in the waters of Nangang Industrial Zone and other waters of Tianjin Port.

Taking into account the present development of the port area, the temporary marine oil spill emergency equipment depot in Dagang Port Area is located at Gate 8 of South Harbour Port Company Warehouse 2, about 100 meters from the general terminal and the working vessel terminal. There are four shutter doors with dimensions of 4.5m wide and 6m high. The storeroom floor is 8m high, 48m long and 22.5m wide with an area of 1080 m2.

The proposed marine oil spill emergency equipment warehouse in Dagang Port Area is located in the land area behind the terminal of the South Port Working Vessel. The port building and the east side of the proposed marine management office of Dagang Port have been built. The building area is 3845.0 m2 and the building dimension is 97 x 38.5 m. It is a light steel structure of portal frame, single span 36 m, column spacing 6.0 m. The foundation is to adopt pile foundation scheme. There are emergency exits on the east side and north side of the overflow oil depot.

According to the conclusions of the Report on Risk Assessment of Marine Pollution and Marine Environment in Dagang Port Area (Draft for Record), taking into account the channel factors, the number of existing terminals and the risk of marine pollution and marine environment in the south port, the allocation target of emergency materials in Dagang Port Area is 600 tons.

Table 10.6-2 Emergency Equipment Allocation Programme

Equipment		Total equipment allocation Technical specifications	Specification model	Remark
Oil fence	Quick distribution type oil fence	3240m	KW1000	Each standard section is 200 meters long
	Fire-proof oil fence		HJ900H	Each Twenty meters
	Rubber inflatable oil fence		HRA1500	Each 100 meters
Oil fence auxiliary equipment	Cleaning device	4		
	Oil column inflator	8	HIS300 Inflator	
	Column rolling machine	4		
Oil receiver	Rope type oil collector	375 m3/h	--	Capability (m3/h)/Quantity (units)
	Turntable type oil receiver		--	Capability (m3/h)/Quantity (units)
Oil-absorbing material	Absorbent felt PP-1/ Quantity (t)	28.2t	PP-1	
	Absorbent felt PP-2/ Quantity (t)		PP-2	
Oil spill dispersant	Quantity (t)	12t		Micro Pu (Biodegradable)
Oil spill dispersant spraying device	Portable hand-held type / Quantity (set)	9 sets		Spray rate (t/h)≥ 0.25
	Marine spray type / Quantity (set)			
Storage device	Storage device	≥375 m3		Effective volume (m3)
Unloading pump	Quantity (set)	87m3/h		The unloading capacity of each pump shall not be less than 87m3/h
Oil spill recovery vessel	Recovery capacity (m3)	1		Oil collection capacity (100m3/h)
Fence boat	Quantity	1		
Auxiliary ship	Quantity	-		

(2) Emergency resource allocation and emergency response

With the implementation of this project, the number of LNG ships will increase obviously, and the risk level and risk type in Dagang Port will increase further. According to the requirements of the Risk Assessment Report of Marine Pollution Marine Environment in

Dagang Port Area (Draft for Record), " If the terminal is enlarged, universal berths are added, or functional positioning is changed, the emergency equipment allocation scheme shall be reworked according to the size of the terminal, the ship type and cargo type ". in order to ensure the ship anti-pollution risk emergency capacity and pollution risk level.

The International Convention for the Safety of Life at Sea (SOLAS), the International Code for the Transport of Dangerous Goods (IMDG Code) and China's Regulations for the Safe Management of Hazardous Chemicals all provide for emergency response to hazardous chemicals. Therefore, it is suggested that a corresponding emergency response plan be drawn up for the specific situation of this project, and corresponding command and coordination agencies be set up.

10.6.1.5 Oil spill emergency equipment

The oil spill emergency equipment shall be equipped with reference to the Chinese People's and China's transport industry standard - Port Oil Spill Emergency Facility Equipment Requirements (JT/T 451-2009). The emergency equipment of the project shall be stored in the front working area of the terminal.

Table 10.6-3 Requirements for oil spill emergency equipment

Device name		Equipped quantity
Oil fence	Permanent layout type (m）	Single berth of trestle pier: (length 345 m + width 53.8 m + 100 m) × 2 = 997.6
Oil receiver	Total capacity (m3/h）	125
Drag net	Quantity (set）	1
Oil-absorbing material	Quantity (t）	2
Oil spill dispersant	Concentrated type，Quantity (t）	1.5
Oil spill dispersant spraying device	Quantity (set）	1
Storage device	Effective volume (m3）	12
Monitoring alarm device	Quantity (set）	1
Oil fence laying boat	Quantity (the number)	1

See Table 10.6-4 for details of the oil spill emergency equipment.

Table 10.6-4 Emergency equipment allocation scheme for oil spill accident in this project

No.	Device name	Standard	Quantity	Units	Unit Price (ten thousand)	Total Price (ten thousand)
1	Oil spill monitoring equipment	1	1	set	40	40
1.1	Terminal oil spill monitoring and alarming device	1	1	set	30	30
1.2	Core service software system	1	1	set	5	5
1.3	Communication receiving device	1	1	set	5	5
2	Oil spill containment equipment					250
2.1	Permanent distribution type	997.6	1000	m	0.25	250

	oil fence					
3	Oil spill recovery equipment	3	—	m3/h	—	—
	Using existing pumping units in the port area					
4	Oil spill removal equipment and materials					3.8
4.1	Common dispersant	1.5	1.5	t	1.2	1.8
4.2	Hand-held oil-eliminating agent spraying device	1	1	set	2	2
5	Oil spill adsorption material					2.5
5.1	Absorbent felt	2	2	t	1	2
5.2	Oil trawl	1	1	set	0.5	0.5
6	Oil spill storage and transport equipment	12	12	m3	—	4
6.1	Oil storage bag	12	12	m3	—	4
7	Ship	1	—	the number	—	—
7.1	Oil fence laying boat	1	—	the number	—	—
	Using existing laying boats					
Total						300.3

10.6.1.6 Risk Prevention Measures for LNG Ship at Sea

Since LNG is a kind of extremely flammable and explosive dangerous goods, if there is a risk accident, there may be liquefied gas leakage, which will have a great impact on the marine environment and human life and property. Therefore, the whole process of transporting and loading LNG (including ship management) is a very demanding and strict work. The relevant departments shall be highly aware of and alert to the risk of LNG ship accidents, and incorporate it into the key risk prevention objectives of the port area.

In view of the fact that the LNG carrier is a large special dangerous goods ship, in order to ensure the safety of navigation and berthing from the terminal, the LNG carrier shall be equipped with a warning ship for inbound and outbound navigation, and shall carry out water traffic control (VTS).The LNG carrier will be assisted by 3-4 tugboats when turning and berthing, and will rest on the terminal at a steady speed not greater than the prescribed normal speed.In order to ensure the safety of ships and piers, the following main matters should be noted :

(1) In order to improve the safety of LNG ship's entry and exit navigation, real-time monitoring of LNG ship's position shall be carried out, electronic chart and DGPS positioning system shall be used to transmit the ship's position to the terminal control room and maritime safety department by radio, the ship's entry and departure conditions shall be dynamically understood, and pilotage shall be assisted by electronic chart and DGPS positioning system.

(2) No ship shall approach the LNG carrier within the prescribed driving safety zone when the LNG carrier is driving on the inbound and outbound lanes or turning around; When the LNG ship is sailing in and out of the waterway, it shall be escorted by a maritime patrol boat in front of it and a tow eliminating vessel in the rear. The liquefied natural gas (LNG) vessel shall be supervised by a tow and elimination wheel from the dock until the unloading is completed.

When the LNG carrier is moored, other ships shall maintain the necessary safe distance :

① The entry, departure and departure of LNG ships and the entry and exit anchorage shall be pilotage by senior pilotage, and the training and examination system for pilotage personnel shall be prescribed, the duties of the pilotage personnel shall be clarified, and the pilotage personnel shall be trained in the hydrographic conditions of the waterway, shoals, reefs and ports.

② Ships in the harbour should implement a duty and lookout system. Although the causes and uncertainties of ship accidents are complex, human factors, especially lack of vigilance, are the main causes of ship accidents. Therefore, it is an important measure to reduce the possibility of ship accidents to strengthen ship's duty and lookout.

③ The normal speed VN of the LNG carrier shall be less than 0.15 m/s when the LNG carrier is docked.

④ The rubber fender of piers should be inspected frequently, and no access shall be allowed when damaged, so as not to cause damage or spark.

⑤ All electrical zero-connection and anti-explosion, lightning grounding and pipeline anti-static devices shall be constantly checked and maintained in good condition . The LNG ship must be grounded on the terminal before unloading.

⑥ Alarm devices, fire control systems on land and water should be checked periodically to keep them in good condition.

⑦ The liquefied natural gas terminal is a flammable and explosive dangerous place, and the management and monitoring of fire prevention and explosion prevention shall be strictly strengthened. The liquefied natural gas storage tank shall be filled with inert gas in order to facilitate the safety of liquefied gas.

⑧ When the wind speed, wave height, velocity and visibility exceed the operation limit, the LNG carrier shall not engage in berthing operation.Under normal circumstances, liquefied natural gas vessels are not suitable for night navigation and night berthing.

10.6.1.7 Safety Measures for Transportation and Transportation of Hazardous Chemicals

(1) The LNG tank shall be a full containment tank and a liquid collecting tank shall be arranged around the tank.

(2) The LNG storage tank adopts adiabatic cooling design, and the LNG in the storage tank is at boiling point .Due to the introduction of external heat (or other energy), a small amount of LNG will be vaporized and gasified. The storage tank is equipped with safety and alarm facilities to ensure safe operation and prevent accidents such as overflow, rolling, delamination, overpressure and underpressure.

(3) To prevent the overpressure of the LNG tank, a BOG compressor is provided to continuously extract the evaporative gas (BOG) from the LNG tank.

(4) If the pressure in the gas phase space of the LNG tank is too high, the BOG compressor cannot be controlled and the pressure exceeds the setting value of the pressure regulating

valve, the pressure regulating valve shall be discharged to the flare system to reduce air pollution. If the pressure is still too high, excess vapour in the tank will be released through the safety valve.

(5) The design and manufacture of pressure vessels shall comply with the provisions of the Technical Supervision Rules for the Safety of Fixed Pressure Vessels and ensure the safe operation of pressure vessels in essence.

(6) The pressure vessel shall be equipped with various detection and alarm facilities, such as temperature, pressure and liquid level detection facilities, as well as safety pressure relief facilities, such as safety valve blasting film, etc.

(7) In order to prevent the under-pressure (vacuum) accident of LNG storage tank in operation, a vacuum compensation system is provided in the process system. When the LNG tank is below the normal operating pressure range, a high pressure natural gas from the main outlet pipe of the gasifier is replaced by a pressure control valve at the top of the tank to return to the tank.

(8) The LNG Receiving terminal shall be provided with a flare, and the emergency gas emitted in the event of an accident shall be discharged by burning the flare.

(9) The LNG transportation terminal and the gasification unit area of the loading area are respectively provided with a liquid collecting tank to prevent the risk of leakage from the LNG loading and unloading operation.

(10) Automatic monitoring, alarm and emergency shut-off parking system

The process control system of this project takes DCS as the core to realize the centralized monitoring and control of the whole device.Safety protection system (SIS) is composed of triple ESD accident protection system and FGS safety detection system to ensure the reliability of process control system.

(11) Fire prevention, explosion prevention and poisoning prevention alarm system

Flammable gas alarm, low temperature detector and flame detector are installed in terminal area, LNG tank area and tank truck loading area. Once a LNG and natural gas leak or fire has been detected, appropriate protective facilities may be activated through the control system or relevant pipelines and equipment may be cut off.

(12) Safety technical measures for building structures

According to the fire and explosion risk of production and storage, the structure form, fire resistance grade, fire spacing and building materials of each building are determined. The location of the buildings and structures and the requirements of seismic fortification shall be in accordance with the conclusions of the seismic safety assessment report and geological survey report of the site and the requirements of the specifications.

(13) Emergency and evacuation routes

All buildings are equipped with complete safety evacuation facilities and channels, evacuation stairs, walkways and doors width and quantity meet the requirements of the code;

Emergency lighting shall be provided in important operation positions, such as control room, power distribution room, evacuation stairs and passageway to facilitate emergency handling and safe evacuation.

10.6.1.8 Precautions against LNG Leakage in Handling Process

To prevent accidental leakage, the licensed personnel must carry out the operation in accordance with the normal procedure. In order to ensure the transportation and handling of LNG, it is necessary to have predictive devices, prepare emergency equipment, strictly implement the norms and standards of LNG operation, strengthen the training of crew members and the emergency response drill and take precautions as follows :

(1) Installation monitoring device

Monitor and alarm devices are installed in areas where natural gas is prone to leakage in order to take early action. The LNG terminal shall be provided with a fixed flammable gas detection and alarm device and a portable flammable gas detection and alarm device. Gas monitoring, flame monitoring and low temperature monitoring equipment shall be installed on the ship.

(2) Equipped with fire suppression system

In the event of a LNG fire, all handling equipment and associated openings shall be immediately closed in order to start the fire extinguishing operation. Generally, BC type dry powder fire extinguisher is used to extinguish LNG fire. Water can cause phase change and explosion of LNG, but it is used for cooling equipment. Valves and fire control can be used to control the spread of spray water. High multiple foam fire extinguishing system is generally used to control the flow fire of LNG and to control the volatilization of LNG. A large number of foam can effectively reduce the rate of steam generation and the range of combustible gas coverage.

(3) Daily inspection and examination

The inherent danger of LNG requires us not only to have reasonable design process and process, but also to strengthen the daily safety inspection and examination in order to deal with the accident in the germination state.

(4) Training of Professional Talents

The operation accident mainly refers to the man-made accident and the equipment fault, at present the operation accident is the main cause of the LNG fire, according to the experience of training and evaluation of the LNG ship crew abroad, the training plan and evaluation procedure suitable for our country shall be worked out, and the Special Training, Examination, Certification Scheme for LNG Ship shall be formulated.

(5) LNG Terminal Requirements

LNG Terminals shall be far from densely populated areas, and the depth of water shall meet the navigation requirements of LNG ships.

(6) Receiving terminal equipment requirements

① Selection of high quality equipment, fittings, valves, etc. to avoid corrosion and leakage due to improper design.

② Each reaction device is provided with a interlock system to detect and solve the reaction fault in time.

③ The natural gas pipeline entering and leaving the factory area shall be provided with a cut-off valve, which shall be easily accessible and easy to operate in the event of an accident. The shutoff valve shall have an automatic shutoff function. The pressure relief vent valve shall be provided before the cut-off valve on the natural gas pipeline of the plant.

④ The device area, the tank area and other places where potential hazards require constant observation shall be provided with a flame detection alarm device and a continuous detection alarm device for the concentration of flammable gases. Appropriate amount of the field manual alarm button is configured accordingly.

⑤ A liquid collecting tank shall be set up in the gasifier area, loading station area and tank area. After the leaking LNG is discharged into the liquid collection tank, the fire protection foam system is started by the signal chain, and the LNG is covered with the foam in the liquid collection tank to prevent the LNG from being vaporized in large quantities at once.

10.6.1.9 Automatic control design safety precautions

(1) This project adopts advanced distributed process control system (DCS), which forms the core of monitoring and control, and communicates with all other systems. Operators can monitor and control the operation of the LNG Receiving terminal through the DCS operation station in the central control room. Therefore, the reliability of the control system is guaranteed.

(2) This project sets up a set of station yard flammable gas leakage detection and alarm fire and gas monitoring system (FGS), which has communication interface with DCS. The system can detect LNG and natural gas leakage and take appropriate measures such as starting fire pump valve, opening foam or fire sprinkler. FGS system is equipped with field detection and alarm equipment: combustible gas detector, flame detector, smoke detector, low temperature leak detector, heat detector, fire alarm button and acousto-optic alarm device. The alarm signal enters the ESD system to ensure the safety and reliability of the equipment, person and production process.

(3) Fire detection and alarm system: Fire detection and alarm system is set up at each gas transmission station yard to monitor and alarm the fire situation in the control room, distribution room and conference room.

(4) The terminal area, the LNG tank area and the process equipment area are equipped with alarm facilities such as flammable gas detection alarm, low temperature detector and flame detector. Once a LNG and natural gas leak or fire has been detected, appropriate protective facilities may be activated through the control system or relevant pipelines and equipment may be cut off.

10.6.1.10 Prevention Measures of Vehicle Transportation Risk

(1) The tanker used to transport LNG shall comply with the safety management requirements of the Pressure Vessel Safety Technical Monitoring Procedure.

(2) The vehicle transporting LNG shall be a dedicated vehicle or a vehicle approved by the relevant authority to use a vehicle conforming to the safety requirements and shall comply with the relevant requirements; Carry out regular maintenance and inspection of the transport vehicle to prevent problems before they occur, keep the tank car in good working condition and ensure normal grounding.

(3) Rational planning of LNG transport routes and routes, as far as possible avoid transport vehicles passing through residential areas, water conservation areas and other environmentally sensitive areas, avoid peak traffic hours and high-risk areas.

(4) Personnel carrying LNG shall undergo induction training and periodic examination and approval before they can be licensed to work. Staff should be familiar with the use and maintenance of emergency equipment, understand the process of emergency treatment, in the event of an accident, while taking emergency treatment, promptly report the relevant departments such as public security, traffic and environmental protection, evacuate the masses when necessary to prevent further expansion and deterioration of the situation.

10.6.1.11 Prevention Measures of Environmental " Secondary Pollution "

The proposed project aims to prevent "secondary pollution" by setting up a collection tank, an accident tank and a cofferdam to collect potentially leaking LNG, fire-fighting waste water and initial rain sewage.

(I) The setting of the liquid collecting pool

(1) Setting of liquid collecting pool in terminal operation area

The terminal operating area shall be provided with a liquid collecting tank of 5m×5m×3m in size, which shall be provided nearby to accommodate possible LNG leakage during the loading and unloading of the ship. The operation area shall be provided with a diversion channel to the liquid collection tank with a size of 300mm × 300mm × 300mm. The liquid collecting pool is equipped with low temperature alarm system and high multiple foam fire control system.

(2) Setting of collecting tank in storage tank area

Each of the two LNG storage tanks in the storage tank area shall be provided with one liquid collecting tank, for a total of 6 liquid collecting pools of 5m×5m×3m in size .The guide channel shall be arranged from the operating platform of the full tank to the liquid collection tank, and the dimensions shall be 300mm × 300mm × 300mm. The liquid collecting pool is equipped with low temperature alarm system and high multiple foam fire control system.

(3) Setting of liquid collecting tank in gasification device area

The gasifier area is provided with a liquid collecting tank of 5m×5m×3m in size to accommodate possible LNG leaks. The LNG gasification equipment shall have a diversion channel to the liquid collection tank with a size of 300mm × 300mm × 300mm. The surface design of the gasification area is lower than that of the surrounding slope guide channel, and the low temperature alarm system is set up in the collecting tank, which is equipped with the high multiple foam fire control system.

(4) Setting of liquid collection tank in LNG loading area

The LNG loading area shall be provided with a liquid collecting tank with a size of 5m×5m×3m, which can meet the requirements of the maximum tank car after all LNG leakage. The LNG loading area shall be provided with a diversion ditch to the liquid collection tank with a size of 300mm × 300mm × 300mm. The liquid collecting pool is equipped with low temperature alarm system and high multiple foam fire control system.

(II) The setting of the accident pool

(1) Fire water quantity in BOG recovery unit area

According to the Code of Fire Protection for Oil and Gas Engineering Design (GB 50183-2004) and Code of Fire Protection for Architectural Design (GB 50016-2014), the amount of fire water in the compressor room of BOG recovery unit is Q=40L/s. The duration of fire is 3 hours, and the amount of water used for one fire is V= 432 m3.

(2) Fire water quantity in LNG loading area

According to Section 8.6.1 of the Code for Fire Protection Design of Petroleum and Natural Gas Engineering (GB 50183-2004), the amount of fire water in the LNG loading area is Q = 60 L/S. The duration of fire is 3 hours, and the amount of water used for one fire is V = 648 m3.

In sum, the amount of fire waste water required for the proposed land Receiving terminal to enter the accident pool V = 432 m3 + 648 m3 = 1080 m3.

(3) Initial rainfall amount

According to the actual situation of the proposed project, the initial rainwater in the loading area may be polluted and need to be collected and treated. It is calculated that the initial rainfall amount of the proposed project is 564.531 m3/time.

(4) Setting of Accident Pool

As the proposed project has a collection tank, the LNG that may leak during operation will be collected and accommodated by the collection tank and will not enter the accident tank. Because there is a cofferdam in the gasification plant area of the proposed project, the fire water from the gasification plant area will not enter the accident pool. The fire control wastewater which can enter into the accident pool is fire control wastewater in BOG recovery unit area and fire control wastewater in LNG loading area.

Therefore, the project is to build a 2500 m3 accident pool to meet the needs of the accident wastewater and initial rainwater collection.

(III) Installation of cofferdam

According to Section 8.6.1 of the Code for Fire Protection Design of Petroleum and Natural Gas Engineering (GB 50183-2004), Q=45L/s is used for fire control in the gasifier area, with a duration of 3 hours and a water consumption of V= 486 m3 for fire control. A cofferdam is arranged in the gasifier area, and the height of the cofferdam is 0.25 m.

(IV) Disposal of LNG Leakage, Accident Wastewater and Initial Rainwater

(1) Disposal of Leaked LNG

There are 1, 6, 1 and 1 collection tanks in terminal operation area, storage tank area, gasifier area and LNG loading area respectively, and 9 collection tanks in total. In case of leakage accident, the leakage LNG will be collected into the collection tank through the set diversion ditch to prevent the leakage of LNG from overflowing everywhere. At the same time, each liquid collecting pool is provided with a high multiple foam system. When the low temperature detector detects the leaking LNG in the liquid collecting pool, the self-moving liquid collecting pool is sprayed with a high multiple foam mixture to reduce the LNG gasification.

(2) Disposal of Fire Fighting Wastewater

After collecting, the fire control wastewater is temporarily stored in the accident pool of the proposed project (2500 m3), and then discharged into the new comprehensive sewage treatment station of the proposed project in batches. After the treatment is up to standard, the fire control wastewater is pumped back to the sprinkler truck for use on the road of the land Receiving terminal project and the reserved site for dust suppression without discharge.

(3) Disposal of initial rainwater

The initial rainwater is collected and temporarily stored in the newly-built accident pool (2500 m3) of the proposed project, and then discharged into the newly-built comprehensive sewage treatment station in batches. After the treatment is up to the standard, the sprinkler shall be pumped to the land Receiving terminal project road and the reserved site shall be used for dust suppression and shall not be discharged.

10.6.1.12 Three-stage emergency prevention and control measures

(I) Overview

The "three-level prevention and control" mainly refers to the "source, process, end" three links of environmental risk control measures system, adhering to the prevention, prevention and control combination. The project mainly transports and stores liquefied natural gas, which has a large potential risk, in order to prevent the risk accidents in this link from affecting the surrounding environment, the environmental risk should be set up a three-level emergency control system: first-level prevention and control measures: pollution control in the operating area; The secondary prevention and control will control the pollutant in the drainage system accident pool; The three-stage prevention and control will control the pollutant in the terminal sewage treatment station to ensure that no pollution event occurs under abnormal production conditions.

(II) The third level prevention and control measures of the proposed project

(1) Primary prevention and control measures

There are 1, 6, 1 and 1 collection tanks in the terminal operation area, storage tank area, gasifier area and LNG loading area respectively, and 9 collection tanks in total. In case of leakage accident, the leakage LNG will be collected into the collection tank through the set diversion ditch to prevent the leakage of LNG from overflowing everywhere.

(2) Secondary prevention and control measures

When fire occurs in the operation area of the terminal, the storage tank area, the gasifier area and the LNG loading area, the fire control wastewater of the starting accident tank is collected through the water collection ditch into the 2500 m3 accident tank set up by the project, and the pollutant and the external passage are cut off.

(3) Third level prevention and control measures

The third line of defense is to design the plant sewage and rainwater discharge system to set cut-off measures to prevent the materials into the sea in case of accidents. The accident waste water shall be disposed of by the pump in batches in the newly constructed comprehensive sewage treatment station to prevent material leakage from polluting the surrounding environment.

10.6.2 Natural disaster prevention measures

(1) Early warning and early prevention of possible adverse weather conditions through information networking with local meteorological departments. In severe weather conditions, in case of typhoon or thunderstorm, the operation of the LNG Ship shall be prohibited.

(2) The design of elevated facilities, such as steel structure working platform of terminal, flare and LNG storage tank, takes into account the influence of local typhoon on the stability of the equipment.

(3) The geological conditions of the site shall be explored in detail and the foundation shall be treated according to the detailed conditions to prevent accidents caused by the settlement of the foundation. The structure and foundation of this project are fortified according to the seismic intensity of 7 degrees.

10.6.3 Emergency plan for sudden accidents

According to the requirements of the National Environmental Protection Agency (90) document No. 057 and the Ministry of Environmental Protection [2012] document No. 77 ‘Notice on Further Strengthening Environmental Impact Assessment Management to Prevent Environmental Risks’, through the risk assessment of pollution accidents, all relevant enterprises should formulate work plans to prevent major environmental pollution accidents, eliminate the implementation of hidden dangers and emergency response measures. According to Article 31 of the Environmental Protection Law of the People's Republic of China, companies that cause or may cause pollution accidents due to accidents or other sudden incidents must take actions immediately. Inform the nearby companies and residents who may be affected by the pollution immediately. And report to the local administrative department of environmental protection. Enterprises and institutions that may have major pollution accidents shall take measures to lift or mitigate the hazards.

Emergency plan for marine environmental accidents

As a whole, Sea Area of Tianjin has established a three-level emergency oil spill emergency response agency, including the government, Tianjin Port and enterprises. It formulated the first, second and third level emergency plans correspondingly.

The first-level emergency organization is led by the Tianjin Municipal Government and is composed of relevant departments of the Tianjin Municipal Government;

The second-level emergency organization is led by Tianjin Port and is composed of relevant departments of Tianjin Port;

The third-level emergency organization is led by Beijing gas Refco Group Ltd and is composed of relevant internal departments of the company.

Small-scale sudden leakage accidents shall be handled by a three-level emergency organization to initiate a three-level emergency plan; if the leakage accident occurs is larger, and the third-level emergency organization has no ability to control, the secondary emergency organization shall intervene to initiate the secondary emergency plan to co-process. If the leakage accident occurs seriously and the secondary emergency organization has no ability to control, the first-level emergency organization will intervene to start the first-level emergency plan.

10.6.3.1 Emergency Accident Plan of the Receiving terminal

I. Emergency planning area

Main dangerous targets: equipment area, storage area, and environmental protection targets. Combined with the characteristics of the project, the source and location of the accident, such as the terminal, LNG ship, and storage tank area. The purpose of controlling the regional installation area and the storage tank area where the accident occurred is to control the accident not to spread in time, limit the accident to the factory as much as possible, and eliminate it as soon as possible. The target area for environmental protection is the person who has been or may be affected by the adverse environment after the incident, and the environmentally sensitive target of the land area.

II. Emergency organization, personnel

The emergency organization, personnel and response conditions at all levels are as follows:

(1）In-plant emergency organization and personnel

Set up an emergency group based on the company's department of safety and environmental protection. The general manager served as the team leader, responsible for directing the emergency rescue team and the emergency rescue team, reporting to the superiors and briefing the neighboring companies. The deputy general manager and QSHE head of the production department are the deputy heads, responsible for the command of accident alarm, report and accident handling, organizing the implementation of accident emergency rescue training and exercises, and supervising and inspecting the rescue preparation work. The emergency organization in the factory shall set up emergency leadership group, emergency office, material supply group, administrative comprehensive group, emergency rescue team, etc. According to the “Regulations on Emergency Measures for Acute Poisoning of Chemical Enterprises”, the project has 150 employees and enterprises under 1000 persons, therefore, an ambulance team should be set up.

(2）

When the accident hazard is limited to the factory (field), the regional emergency organization may rely on the emergency force of the company. However, when the degree of harm is larger or the scope of the hazard has affected the surrounding areas, the company cannot control the accident or cannot eliminate it in time, the regional emergency organization should be requested to assist the project company. The project is located in the Dagang Port of Tianjin. The project involves two parts, land and sea. Therefore, it should establish a cooperative relationship with the emergency organization of Tianjin Port and Tianjin Maritime Safety Administration.

(3）Personnel

Formulate the list of internal emergency response personnel and contact information, and investigate the contact information of the key person who are in charge in the regional emergency organization, so as to promptly request the assistance of the regional emergency force.

III. Hierarchical response

The hierarchical response procedure of the plan is shown in Figure 10.6-2

IV. Emergency rescue support

Equipped with the necessary emergency equipment, the emergency equipment should be kept, repaired and debugged to ensure that the equipment is in good condition and can be put into use as soon as an accident occurs.

Communication equipment: telephone, mobile phone, walkie-talkie, etc.;

Transportation: mainly cars;

Protective devices: Rescuers should be equipped with personal protective equipment, anti-virus masks and protective clothing.

The protective equipment of this project should be equipped with the low temperature characteristics of liquefied natural gas in the leakage accident and the suffocation of natural gas volatilization, and consider the protective equipment for emergency personnel handling fire and explosion accidents. Medical First Aid: Sign an agreement with the relevant hospital or emergency center, set up a professional rescue team, develop a treatment plan, and equip with emergency equipment and emergency medicine. Fire-fighting equipment: fire-fighting vehicles, special facilities for engineering rescue teams, etc.

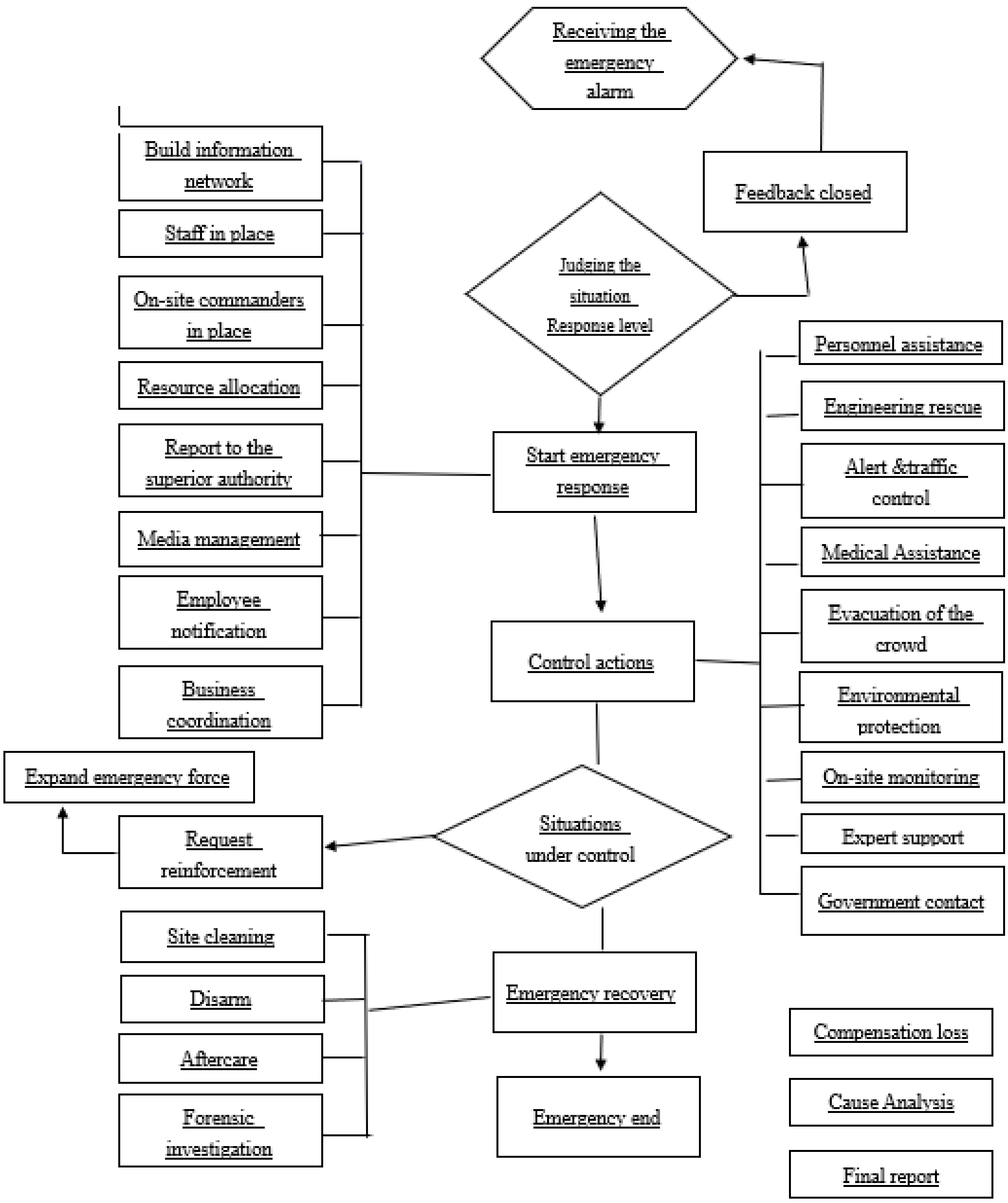


Figure 10.6-2 The hierarchical response procedure of the plan

V. Alarm and communication

After the completion of the project, according to the actual communication mode, the personnel in the field and the areas that may be involved in the project impact, such as the area where the pipeline passes, the competent authority for marine protection objectives, and the relevant government management department, shall notify the emergency contact number and the alarm number.

VI. Rescue and control measures

When an accident occurs, according to the enterprise reporting procedure, the discoverer should report to the enterprise emergency command department in time, and organize the rescue team to enter the site for self-rescue. It is treated according to the natural gas leakage treatment method, and the leakage is blocked to control the spread of the accident. At the same time, the emergency monitoring team monitors the key hazardous positions in the plant, and informs the emergency monitoring team of the environmental protection department to rush to the site to track and monitor the environmentally sensitive targets around the plant. When there is a person injured, the professional rescue team of the hospital emergency should be organized to arrive at the scene in time to treat the personnel and send them to the hospital in time to minimize the casualties.

VII. Protective measures and equipment for removing leakage

（1）Protective measures

Accidents that may occur in this project are fires or explosions caused by natural gas or liquefied natural gas leakage. Firefighters must wear gas masks and fire in the upper direction outside the safe distance. Responsible personnel on site must be equipped with appropriate personal protective equipment. At the same time, due to the number of leaks, fires, explosions and equipment in the plant area, it is necessary to pay close attention to other important fire and leakage prevention posts, and control the adjacent areas and fire prevention areas where accidents occur.

（2）When removing leakage measures and leakage of LNG in equipment tank area, dock area and loading area, the leakage should be introduced into the accident pool in time to prevent large-scale impacts and safety hazards caused by leakage liquid gasification, and measures for leakage removal should be formulated.

VIII. Emergency evacuation plan

When the dangerous substance leaks and loses control, and accompanied by major fires, explosions and other accidents that endanger the life safety of all personnel of the proposed dock project, on the one hand, the rescue should be actively organized, on the other hand, the emergency personnel evacuation plan should be quickly started to ensure the safety of the personnel. Personnel evacuation and protection actions shall be counted by the departments. Count the number of people in the designated area according to the evacuation route and the number of the enumerators shall be reported to the command department. Whether to search and rescue those who do not arrive in the designated area shall be determined by the emergency chief commander.

（1）The release of the emergency personnel plan is decided by the overall emergency commander.

①Contact with local governments, public security firefighting, armed police border defense, company headquarters and other institutions timey to get assistance.

②The personnel emergency evacuation signal uses a continuous and short alarm sound: “Di, di, di...” The signal is distributed to all the staff at the top of the dock office building, and is operated by the staff in the control room.

（2）After receiving the evacuation alarms, all employees of the project:

①Under the squad leader and dispatch organization, the production staff quickly turned off all equipment power, stopped equipment operation and media delivery, shut off the gas and liquid phase valves, and stopped the docking personnel to stop the loading and unloading operations, and notified the ship to leave the port and run to the designated place.

②The logistician stopped working, extinguished the open flame and quickly reached the designated location.

③Off-working personnel should quickly run along the fire exit of the dormitory to the designated location.

④All departments and team organizations will name the personnel who arrive at the meeting place one by one. If the name list is not complete, the teams will quickly find out the reasons, return to the post (dormitory) to find, and at the same time, organize the boarding in an orderly manner at the meeting place. Boarding the ship to evacuate.

(3) After receiving warnings for evacuation, other company personnel and nearby villagers should:

①Other personnel stopped all open flame operations quickly, shut down all powers, and ran along the fire exit to the meeting place.

②The nearby villagers extinguished the open flame, shut down all powers, and ran along the road to reach the assembly site to evacuate.

IX. Emergency termination

(1) Emergency termination conditions

①The scene of the incident is controlled and the event conditions have been eliminated;

②The leakage or release of the source of pollution has fallen below the specified limits;

③The harm caused by the incident has been completely eliminated, without the possibility to occur again;

④Various professional emergency response actions at the scene of the incident are no longer necessary;

⑤The necessary protective measures have been taken to protect the public from re-hazards and to make the medium and long-term effects that the incident may cause to be reasonable and as low as possible.

(2) Emergency termination procedure

①The on-site rescue headquarters confirmed the timing of termination and was approved by the emergency command leading group;

②The on-site rescue command issued an emergency termination order to all professional emergency rescue teams.

(3) Action after emergency termination

①Relevant departments and the company causing the emergency environmental event find out the cause of the incident and prevent repeated occurrence of similar incident.

②Record and establish files for emergency incidents. Based on practical experience, the professional departments will be organized to evaluate the emergency plan and timely revise the environmental emergency plan.

③The departments participating in the emergency operations are responsible for organizing and guiding the environmental emergency team to maintain the emergency equipment, so that they are always in a good technical condition.

X. Emergency drills and emergency technical training

For environmental management personnel and relevant operators, a system of “first training, post-employment”, “regular training safety and environmental protection regulations, knowledge and emergency treatment technology” should be established. The emergency response agency shall conduct emergency technical training and assessment on the relevant personnel in the organization on a regular basis, and conduct a simulation exercise every quarter to improve the actual combat capability of the emergency team and accumulate experience.

After each exercise, the company should check the contents of the emergency response plan and identify the deficiencies and shortcomings. The inspection mainly includes the following contents:

①Whether the communication system can operate during the accident;

②Whether the personnel can evacuate safely;

③Whether the emergency service organization can participate in the accident rescue in time;

④Whether can effectively control the accident to further expand;

⑤The enterprise shall promptly propose solutions to the problems in the exercise and revise and improve it;

⑥The enterprise shall promptly revise the emergency response plan when the dangerous facilities and hazard sources changed;

⑦The relevant personnel should be notified in time for the revision of the emergency response plan.

XI. Public education and information

Publicize and educate the public on environmental risk protection involved in this project, strengthen awareness of accident prevention, and publicize first-aid measures related to natural gas poisoning and evacuation precautions.

10.6.3.2 Formulation and implementation of emergency plans

The project shall be based on the "Management Measures for the Emergency Response Plan for Emergency Responses of Enterprises and Institutions (Trial)" (Huanfa [2015] No. 4), and the environmental risk emergency plan shall be formulated in combination with the characteristics of this project.

10.6.3.3 Emergency plan drill plan

After the project is run, an emergency plan drill plan shall be formulated. The drill plan shall be regularly conducted, and it should be revised and improved according to the problems found during the exercise.

10.6.4 Emergency force regional linkage

10.6.5 Construction of emergency system and linkage mechanism

（1）The construction company implements the implementation of the emergency plan of the government and Tianjin Port and relevant departments, and promptly contact them to ensure that the accident information can be feedbacked in the first time when an accident occurs, and request the help of local government in the event of an uncontrollable major accident.

(2）After the accident, the construction company shall immediately establish the on-site command department and the commander of the relevant departments according to the requirements of “unified command, territoriality and professional disposal” after receiving the report of the emergency command center. Coordinate emergency teams in the public security, transportation, fire protection, environmental protection and medical emergency departments to carry out rescue operations, evacuate the masses, control the scene, rescue and other rescue operations, and control the situation;

(3）After the accident, the emergency department of the Tianjin Municipal Government should organize an emergency response team according to the development trend of public emergencies to assist in the emergency disposal of the incident after receiving the report, and to launch the municipal plan. It is necessary to closely follow the development trend of the incident, grasp the situation of the government's emergency response work in the incident area, timely convey the city leaders' instructions and requirements, and do a good job in comprehensive coordination and supervision and implementation;

(4）When a special accident occurs and the general disposal measures cannot control and eliminate its serious harm, the municipal government requests the relevant state to provide support;

(5）When implementing an emergency response, the Tianjin Municipal Government and relevant departments (companies) must increase the emergency response force in a timely manner, increase the protection of technology, equipment, materials, and funds, strengthen command and coordination, and strive to control developments of the accident;

(6）Cooperate with Tianjin Environmental Protection Bureau to conduct leakage monitoring; monitor water quality in polluted sea areas; organize shoreline removal of pollution accidents; discharges recovered from emergency response, and onshore disposal of pollutants (including temporary storage Selection of locations, determination of treatment methods, supervision and management, etc.); restoration and monitoring of ecological environment in polluted sea areas;

(7）Contact the Tianjin Public Security Bureau and ask them to assist in public safety work in areas affected by pollution and emergency response; alert work on contaminated sites and related areas; maintenance of traffic order during emergency response;

(8）Contact Tianjin Meteorological Bureau and ask for assistance in providing timely meteorological information and forecast information for emergency response work;

(9）In the regular drills, it is necessary to cooperate with the Tianjin Municipal Government and the Tianjin Port Emergency Plan to determine and complete the tasks in the plan to avoid rescue conflicts and rescue omissions in the event of major accidents;

(10）Incorporate the emergency plan into the training and learning arrangement and include it in the implementation of the accident emergency drill.

(11）The personnel list and contact information of the executive departments of the emergency plan and the Tianjin Municipal Government and the Tianjin Port Emergency Plan are explicitly included in the emergency plan.

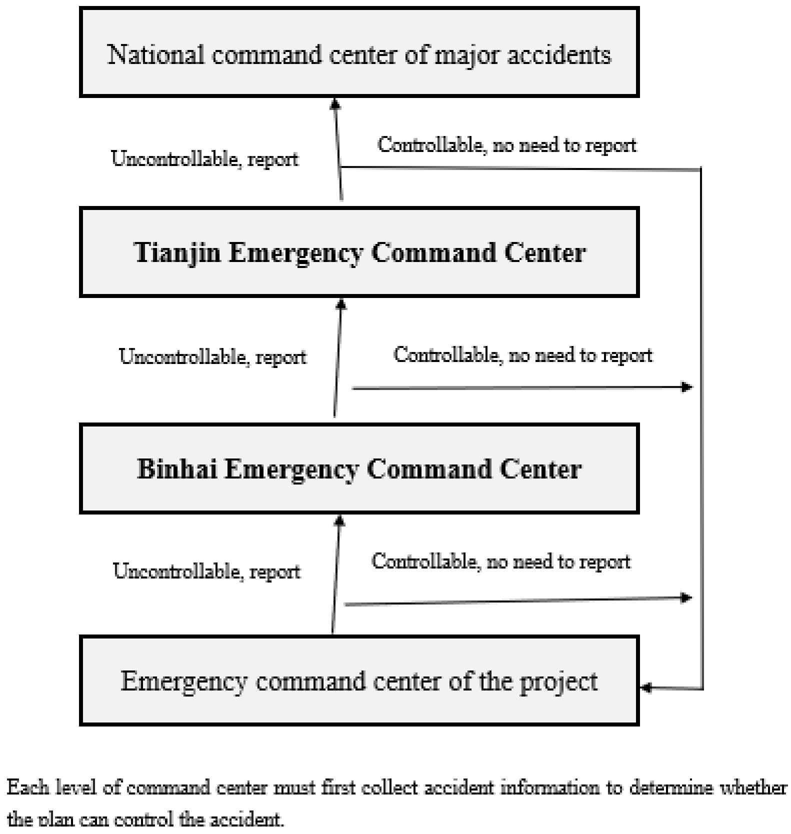


Figure 10.6-3 Procedures for Command Centers at All Levels

10.6.6 Emergency Monitoring Plan

In order to grasp the fuel oil leakage of the transportation ship, the leakage of the LNG in the Receiving terminal, the scope and extent of the pollution caused by the environmental risk, and timely take effective measures, this evaluation proposes a monitoring plan under the risk accident state. In the event of an accident, the monitoring plan should be determined according to the scope of the accident. The monitoring personnel should enter the processing site for sampling with the necessary protective measures and safety. In addition, the monitoring plan should be adjusted and arranged by the headquarters according to the specific circumstances of the accident.

10.6.6.1 Oil spill risk accident emergency monitoring plan

(1）Monitoring points and monitoring projects

The contents of emergency monitoring under the risk accident status are shown in Table 10.6-5.

Table 10.6-5 List of emergency environmental monitoring contents in the state of oil spill risk in the sea area

Type of accident	Location of Monitoring (Investigating) station	Monitoring (Investigating) factors	Goals
Leak of Fuel oil	Area of the accident	pH、COD_{Mn}、petro、Marine organisms	Grasp the extent of impact of the accident on water environment, ensure the safety of water quality
	The nearest breeding area		
	Water area of the nearby pier		

(2）Monitoring Frequency

The monitoring time is determined according to the duration of the accident, and the frequency of monitoring is determined according to the severity of the accident. Monitor as soon as possible after the accident. When the accident is not effectively controlled, samples are taken for monitoring every hour; as the accident control is weakened, the frequency of monitoring is appropriately reduced until the impact of the accident is completely eliminated.

10.6.6.2 Receiving terminal Risk Emergency Monitoring Plan

(1）Monitoring point

The monitoring points shall be arranged in time according to the location of the pollutant accident occurred in the plant and the type of the spill. It is usually set at a certain scene of the accident scene and the downwind direction. If it is a large accident, it should also add monitoring points to the environmental protection targets and environmentally sensitive targets.

(2）Monitoring project

The types of pollutants include total hydrocarbons, sulfur dioxide, nitrogen oxides, CO

(3）Monitoring Frequency

The frequency of monitoring is set according to the level of accidents, and high-frequency monitoring (at least 1 time/hour) is carried out for large accidents or poison spills in response to relevant locations, and is handled along with the accident.

10.6.7 Recommendations

In order to prevent pollution of the surrounding environment caused by risk accidents, the construction company shall establish a special accident emergency plan before the completion of the project, and incorporate it into the overall emergency response system of Tianjin Port. In the preparation process of the plan, the connection with the government-related emergency plan should be fully considered, and the emergency response system of the project should be integrated into the emergency response system of the whole region to establish a regional emergency response mechanism. The emergency plan shall be reported to the relevant competent authorities for review and approval to ensure that the environmental impact of the accident is controllable and the impact on the environment is minimized. At the same time, entrust relevant company to prepare safe operation procedures for ships entering and leaving the port, solicit opinions from competent authorities such as maritime affairs, and operate in strict accordance with the safe operation rules of ships entering and leaving the port. When the ship enters the port, the maritime department dispatches personnel and the terminal duty personnel to monitor the whole process of the ship berthing to ensure the safety of the ship's berthing and loading and unloading operations. It is recommended that the construction company, the transportation department, and the maritime department reach an agreement in advance on regional linkage and emergency drills to ensure the implementation of relevant emergency measures during the operation period.

10.7 Conclusion

10.7.1 Offshore risk

(1) Fuel oil leakage prediction

Under the action of unfavorable wind direction NNW (10.8m/s), the oil spill occurred in the low tide during the 72-hour sweeping area was 120.32km2, and the oil spill occurred in the high-level tide 72 hours. The sea-sweeping area was 161.32km2. Oil accidents not only cover a large area of sea, but also have a short time to reach environmentally sensitive sea areas. Under the action of normal wind to S wind in summer, it mainly affects Gaoshaling East Coastal Wetland and Gaoshaling Tourism and Recreation Area; under the influence of normal wind to NNW in winter, it mainly affects the agricultural and fishery area in southeastern Tianjin and Dagang coastal wetland.

The environment in which the project is located is sensitive, and there are environmentally sensitive targets such as agricultural and fishery areas and special marine protection areas. Once an oil spill occurs, it will inevitably have a serious impact on sensitive surrounding targets. To this end, it is necessary to strengthen risk prevention and prevent spillage. An oil accident occurred.

(2) Analysis of LNG leakage into the sea

The gasification of LNG into the sea and the seawater will cause the local water temperature to drop rapidly, forming a low temperature area, resulting in a certain range of biological death or frostbite, which has a temporary adverse impact on marine life. Since the LNG liquid will rapidly vaporize after being leaked, the range of the mixed gas formed by condensation is generally within 200 to 300 m, and the influence on the marine environment is small, and as the gasification proceeds, the LNG will quickly evaporate until it disappears. The marine environment has less impact.

10.7.2 Onshore risk

When a full tank leak occurs at the Receiving terminal, the maximum concentration of methane axis can meet the requirements of toxicity end point concentration -1 and toxicity end point concentration -2. The maximum concentration of carbon monoxide in the secondary pollutants can meet the corresponding toxicity end point concentration of -1, and the toxicity end point concentration of -2 can be met at 660 meters in the downwind direction. There is no residential area in this range, given the time of the accident. Short, in the event of an accident, the staff of the enterprise should be guarded and evacuated in time. This evaluation considers that the environmental risk of the Receiving terminal is acceptable.

10.8 Suggestions

1) The project has potential accident risks. Although the probability of the largest credible accident is small, the intrinsic safety design of the project should be strengthened in the next step, and the construction quality and operation period management should be strengthened. This is the fundamental measure to ensure the avoidance of risk accidents.

2) The construction unit shall regularly maintain and timely update the risk prevention facilities to ensure the effectiveness of risk prevention measures and minimize the occurrence of risk accidents.

3) In the event of an accident, urgent engineering emergency measures should be taken. If necessary, social emergency measures should be taken to control the accident and reduce the harm to the environment.

4) In accordance with the principle of “self-rescue, territoriality, grading response, regional linkage”, combined with the characteristics of this project, formulate emergency plans for sudden environmental accidents, and achieve effective connection with emergency plans for local environmental emergencies with local governments or relevant administrative departments. .

5) The construction unit must attach great importance to it, so that the risk prevention alarm is often sounded, the safety production management is always unremitting, the various risk prevention measures are strictly implemented, and the risk management system and emergency plan are continuously improved.

11 Environmental Protection and Mitigation Measures and Techno-economic Demonstration

11.1 Environmental protection measures during construction period

11.1.1 Environmental protection measures for water environment during construction period

(1) Strict construction operation system, carry out environmental supervision during construction period

①The construction operation shall formulate reasonable construction plan in advance, arrange the construction position and progress, strengthen the management, supervision and strictly implement the prescribed construction process methods.

②Operation season and operation cycle: avoid fish migration period and oviposition incubation period (mainly spring and summer), avoid rainy season construction, avoid runoff and sewage influence water area during construction period, at the same time, collect real standard samples, and monitor the changes of turbidity and suspended particles, dissolved oxygen and salinity.

③In severe weather conditions beyond its safety factor, the operation shall be stopped and no hazardous work shall be carried out in order to catch up with the task. Delimit the ecological impact area of the construction zone at sea and on land, mark clearly, and restrict the scope of the zone in and out of the construction personnel, equipment and materials. Avoid the construction of big wave season, reduce the pollution effect to the sea area. The construction period shall be well prepared for the protection under severe weather conditions and the operation shall be stopped by strong winds above level 6. Keep an eye on the weather forecast.

(2) Measures for prevention and control of water pollution from construction waste

1) The dumping of pollutants into the sea area shall be strictly prohibited, and arrangements shall be made for the recovery of sewage and waste water produced by construction machinery of various types, and liquid wastes of construction machinery shall be recovered regularly and transported to the relevant departments for centralized treatment.

2) The road on the construction site shall be kept smooth and the drainage system shall be in good working condition, so as not to accumulate water on the construction site.

3) Sediment settling tank shall be set up at the construction site for the treatment of construction mud waste water. For on-site mixing operation, a sedimentation tank must be set up at the front desk of the mixer and the cleaning place of the transport vehicle.

4) All construction machinery shall prevent oil leakage and shall not discharge oil pollution to sea area during operation.

5) During the construction period, the machinery maintenance site must be designated, and the oily sewage generated from the maintenance of the construction machinery shall be properly collected and treated, and the oily sewage shall be sent to the designated unit for treatment.

6) Construction of mobile toilets at construction sites for the collection, storage and initial treatment of domestic sewage from land-based construction, and regular collection by tanker to be sent to Nankang sewage treatment plant for treatment ; Domestic sewage from ships is collected from the land area and sent to the South Port Sewage Treatment Plant for treatment ; The oily water in the engine room of the ship shall be received and treated by qualified units.

7) Rational planning of temporary water supply and drainage facilities in the construction site and taking effective measures to eliminate water running, water running, water dripping and water leakage. Strictly manage and save water for construction and domestic use.

8) Supervision and management of pollutant discharge from construction ships shall be incorporated into the ship supervision and management system of Tianjin Maritime Bureau.

11.1.2 Ecological Environment Protection and Mitigation Measures during Construction Period

(1) Ecological Compensation

The impacts of marine construction on marine ecological environment are mainly manifested in the loss of phytoplankton, zooplankton, benthic fauna and their existing habitats, and on fish and other aquatic organisms. It is estimated that the compensation for marine ecological losses caused during the construction period is ten thousand yuan. Strict bioremediation and compensation measures are needed to mitigate the impacts of project construction on marine ecology.

(2) Ecological compensation methods and compensation varieties

The ecological restoration and compensation measures adopted in this project are artificial release propagation technology of marine organisms. Since the 80 's, China has been stocking the offshore marine resources represented by Chinese prawns in Bohai Sea, Yellow Sea and East Chaos . At present, the species of large-scale excrete and experimental excrete have been extended to more than 10 species of Japanese prawns, pike crab, scallop scallop, quince, sea cucumber, abalone, barracuda, sea bream, black sea bream, etc . has played an active role in the restoration of marine life off the coast.

(3) Biological recovery and compensation measures

1) In order to mitigate and mitigate the adverse effects of the project on the aquatic organisms in the marine ecological environment, it is suggested that the construction

units take measures for ecological restoration and compensation of artificially released local biological species.

2) The species of artificial excrete are mainly economic shellfish, fish and shrimp.

3) The construction units of fishermen affected by the construction of the proposed project and the scope of fishery production operation reduced shall be given certain economic compensation.

11.1.3 Air Pollution Control Measures During Construction Period

（1）A continuous and closed enclosure is arranged around the construction site to reduce the spread of construction dust. Scientific management shall be carried out on the construction site, the construction waste soil and construction materials shall be piled uniformly, and protective facilities shall be set up for dust control or fence, to avoid dumping easily dust and materials in the open air for a long time, and to reduce dust or dust pollution.

（2）The construction site shall be hardened and the thickness and strength of the site shall meet the requirements of construction and driving. The site and road are smooth and unobstructed, so as to reduce the bumping and leaking materials of road transport vehicles on construction site.

（3）Part of the construction site that fails to harden shall be regularly compacted, watered and cleaned to reduce dust pollution.

（4）Vehicles for transporting materials and garbage to and from the site shall use closed wagons. If there is no closed hopper, the highest point of the loading height shall not exceed 40 cm along the upper edge of the tank side of the vehicle and the two edges shall be 10 cm below the upper edge of the groove side. The bucket shall be covered with a cloth covering at least 15 cm below the edge of the cloth covering the upper edge of the groove.

（5）Cement and other fine granular dispersion materials which are easy to fly shall be stored in temporary warehouses or tightly covered . During transportation, leakage and flying shall be prevented.

（6）Construction waste shall be cleaned and transported in time and sprinkled with appropriate amount of water in order to reduce dust.

（7）Whenever possible, construction vessels shall use vessels with low fuel consumption and low exhaust gas. When the construction ship uses diesel oil as power, the oil quality conforming to the requirements shall be adopted.

（8）Management of the entry construction machinery, inspection of qualified machines before entering the operation, as far as possible to reduce the fuel waste generated by the construction machinery.

11.1.4 Measures for preventing and controlling noise pollution during construction period

（1）Priority shall be given to the selection of construction machinery and transport vehicles with low noise and low vibration to enhance the maintenance and maintenance of machinery and vehicles so as to maintain their normal operation at all times ;

（2）Make good dispatch and traffic guidance of construction machinery and transport vehicles, reasonably guide vehicles entering the construction area, forbid vehicles to whistle and reduce traffic noise.

（3）The speed of the sand-gravel transport vehicle passing through the village shall be limited, and the speed of the vehicle shall be controlled within 20 km/h.

（4）Construction noise shall be strictly controlled in accordance with the " Noise Limits at Construction Plant Boundaries " (GB 12523-2011).

11.1.5 Prevention Measures of Solid Waste Pollution during Construction Period

（1）The spoil and harmless construction waste of the project shall be balanced in excavation and filling of the earth and rock at the construction site, and the remaining common spoil shall be piled up to the designated temporary stacking point, which shall be comprehensively utilized after unified planning.

（2）After collection of household garbage and machine repair oil cotton yarn, it shall be handled uniformly by the municipal sanitation department.

（3）Waste welding rod and slag shall be recycled by the manufacturer.

（4）Waste oil, waste oil, paint residue and barrel shall be accepted and treated by qualified units.

（5）The recovery and utilization of recyclable solid waste from part of the construction process shall be carried out according to the requirements of reuse of resources.

（6）To set up dustbin and sanitation responsibility area in the application area and determine the responsible person and the cycle of regular cleaning.

（7）After the completion of construction, the construction site shall be cleaned in time and temporary buildings such as temporary work sheds shall be demolished.

11.2 Environmental Protection Measures in Operation Period and Technical and Economic Demonstration

11.2.1 Measures of Atmospheric Environmental Protection in Operation Period and Technical and Economic Demonstration

11.2.1.1 Atmospheric environmental protection measures

During the operation of the proposed project, the waste gas is divided into two categories: organized emission and unorganized emission.

The main pollutants are SO2, NOX, soot and so on, which are the combustion flue gas produced by the burning natural gas from the submerged combustion gasifier of the Receiving terminal, the boiler flue gas and the flare burning natural gas.

The unorganized emission of exhaust gas is the unorganized leakage of natural gas.

The waste gas under abnormal working conditions is mainly the exhaust gas from LNG tank and ORV exhaust . The main pollution factor is total hydrocarbon and the main component is methane.

The atmospheric environmental protection measures of the project are as follows :

Use of clean fuel

The proposed project will mainly use natural gas (BOG) as fuel and diesel oil as backup fuel for power generation under accident condition. A BOG produced by liquefied LNG consisting of natural gas. Natural gas has very low sulfur content. In the proposed project, the submerged combustion gasifier, flare, boiler and station heating furnace will meet the requirements of the national and local standards for emission of waste gas pollutants by using clean fuel, with a small amount of sulfur dioxide in the flue gas and a small amount of soot emissions.

Setting up evaporative gas recovery system

During unloading, loading and loading of LNG and loading of tanker, BOG will be produced. The BOG is mainly caused by the input of external energy, such as pump operation, the introduction of external heat, atmospheric pressure change, environmental impact and the change of LNG volume in the tank when the LNG is injected into the tank.

The proposed project has set up a evaporative gas recovery system, which will recycle LNG vapour through natural gas compressor, reduce resource waste and exhaust emissions, and greatly reduce the BOG emission.

Setting up station yard emptying system

Low temperature pipeline safety valve emptying and LNG equipment emptying return directly to the tank through the emptying pipeline, and the emptying main pipe is connected with the LNG tank gas phase space, which provides a buffer space to maintain the pressure stability of the emptying pipeline.

After the gasifier after the pipeline or equipment of natural gas venting after flare treatment, will not be directly discharged into the air.

Directly into the atmosphere. Under normal operation, no gas is sent to flare or vent.

Setting up the flare system

The flammable gas component of flare fuel is natural gas, the main component is methane. The content of hydrogen sulfide in the natural gas of this project is small, so the main components of the flue gas after flare burning are carbon dioxide and water.

This project establishes the flare area in the Receiving terminal engineering area, and uses the flare to deal with the abnormal discharge of the natural gas collected in an organized way.

Reduction of emissions of unorganized waste gases

The main sources of unorganized emission are volatilization loss in the process of dock unloading, storage tank handling and transportation. The following measures were adopted to reduce the unorganized emission of natural gas.

Closed handling

After the LNG carrier is moored and butted with the unloading arm, the LNG is transported to the LNG tank through the conveying pump on the transport ship through the unloading arm.

Purge of terminal discharge arm

A purge and replace system is set up in the loading and unloading area of the terminal, and the purge gas is nitrogen.

After the ship is discharged, connect the nitrogen pipeline arranged on the terminal to the nitrogen interface of the discharge arm, and use nitrogen to purge the remaining LNG in the discharge arm to the LNG carrier and BOG main pipe.

Use safety valve to reduce venting

The safety valve is used to automatically control the internal and external pressure of the pressure vessel, reduce the loss of the evaporation gas in a certain range, and protect the pressure vessel from the damage of overpressure, and play a safe pressure relief role.

The pressure protection of the tank in the Receiving terminal works is based on the gauge pressure . When the tank pressure reaches 29 kPa (g), the top pressure safety valve of the tank is opened and the overpressure part of the gas is discharged directly into the atmosphere.

Closed loading and unloading process for tank truck loading

The tank truck loading and unloading station truck loading skids are equipped with liquid loading arm and gas return arm, which can carry out loading operation at the same time. The tank truck loading and unloading system is provided with a LNG circulating pipeline to maintain the unloading main pipe at low temperature during the non-loading and unloading operation, so as to avoid generating too much BOG gas to enter the tank truck to reduce the loading and unloading rate. The vapour replaced during loading is returned to the evaporator main pipe by pressure difference.

Loading operation procedure of tank car: parking and fixing of tank car ; Ground ; The connection of the liquid arm and the gas arm, including the required nitrogen purge ; Open the gas valve so that the tank car pressure and downstream steam system pressure to achieve a balance ;

Open the liquid charging valve and start charging at low flow rate ; Gradually increase the charge flow to reach the normal charge flow ; When the LNG charge setting value is reached, the reduction of the charge flow and the stop of the charge will occur automatically.

After closing the valve, drain, exhaust and purge nitrogen from the liquid and gas arms and disconnect them.

The tank truck is loaded with closed loading and unloading technology, and the evaporation gas can be returned to BOG main pipe . After the loading is completed, nitrogen purge can be used to avoid the LNG volatilization loss during the loading process.

Strengthen process management to reduce operating loss

In the process of LNG storage and transportation, enhanced management and improved operation technology can also reduce the excess pressure loss of LNG. According to the requirements of routine inspection and maintenance, regular inspection and maintenance, and irregular inspection and maintenance, the project shall carry out inspection and maintenance during the operation of the storage tank.

The high efficiency low nitrogen combustion process is adopted in the SCV gasifier, boiler and station heating furnace

Low nitrogen burner is a burner with low NOx emission during fuel combustion. Conventional natural gas boiler burners usually emit about 120-150 mg/m^3 of NOx. The NOX emission of low nitrogen burner is about 30-80 mg/m^3.

At present, the low nitrogen burner can be divided into the following categories according to the principle :

Stage burner

The stage burner is designed according to the principle of staged combustion, which makes the fuel and air mixed in stages.

Self recirculation burner

One is the use of combustion-supporting air pressure head, part of the smoke inhalation back into the burner, mixed with air combustion. Because of the recirculation of flue gas, the heat capacity of combustion flue gas is large, the combustion temperature is lower and the NOx is reduced.

Another kind of self-recycling burner is to put part of the flue gas directly into the burner to re-cycle and add the combustion process.

Bias burner

The principle is that one part of the fuel is overburned and the other part of the fuel is underburned, but the overall air volume remains constant. Since both parts are burning at a deviation from the stoichiometric ratio, NOX is very low, which is also called off-combustion or non-stoichiometric combustion.

Segmented flame burner

The principle is to divide a flame into several small flames, because of the large area of small flame radiation, low flame temperature, so that the " thermal reaction NO " decreased. In addition, the small flame shortens the residence time of oxygen and nitrogen in the flame, and has the obvious inhibition effect to the " thermal reaction NO " and " fuel NO ".

Mixed promotion burner

The residence time of flue gas in the high temperature zone is one of the main factors affecting the NOX production . Improving the mixture of combustion and air can reduce the thickness of the flame surface and shorten the residence time of the flue gas in the high temperature zone under the same combustion load. The mixed-boost burner is designed on this principle.

Low nitrogen precombustion chamber burner

The precombustion chamber is a kind of high efficiency and low nitrogen staged combustion technology developed and studied in China in recent 10 years . The precombustion chamber is composed of primary air (or secondary air) and fuel injection system . The fuel and primary air are mixed rapidly, and a fuel-rich mixture is formed in the primary combustion area of the precombustion chamber . the fuel precipitates volatiles in the primary flame zone with low oxygen and flame temperature, thus reducing the formation of NOx.

Any kind of low nitrogen combustion technology is essentially a technology to control the combustion process. According to the 20 years experience of low nitrogen burner in Europe and America, it is not enough for industrial boiler to replace or reconstruct the low nitrogen burner.

In this project, the low nitrogen combustion technology of stage burner is used to control the emission of exhaust gas. The process takes 80% to 85% fuel to the main combustion zone, the fuel produces NOX in the main combustion zone, 15% to 20% fuel reenters the reburning zone, the excess air coefficient of the reburning zone is less than 1.0 , has a strong reducing atmosphere, and the NOX produced in the main combustion zone is reduced. The reburning zone can not only restore the generated NOx, but also inhibit the new NOx formation. A certain amount of air is supplied in the burndown zone to ensure that the incomplete combustion products from the reburning zone are exhausted. According to the research results of Zhuo Jiankun, chief engineer of the National Engineering Research Center for Clean Coal Combustion of Tsinghua University, the advantages of the staged combustion process are simple control, and the emission value is between 30 and 80 mg/m3, which can effectively reduce NOx emission.

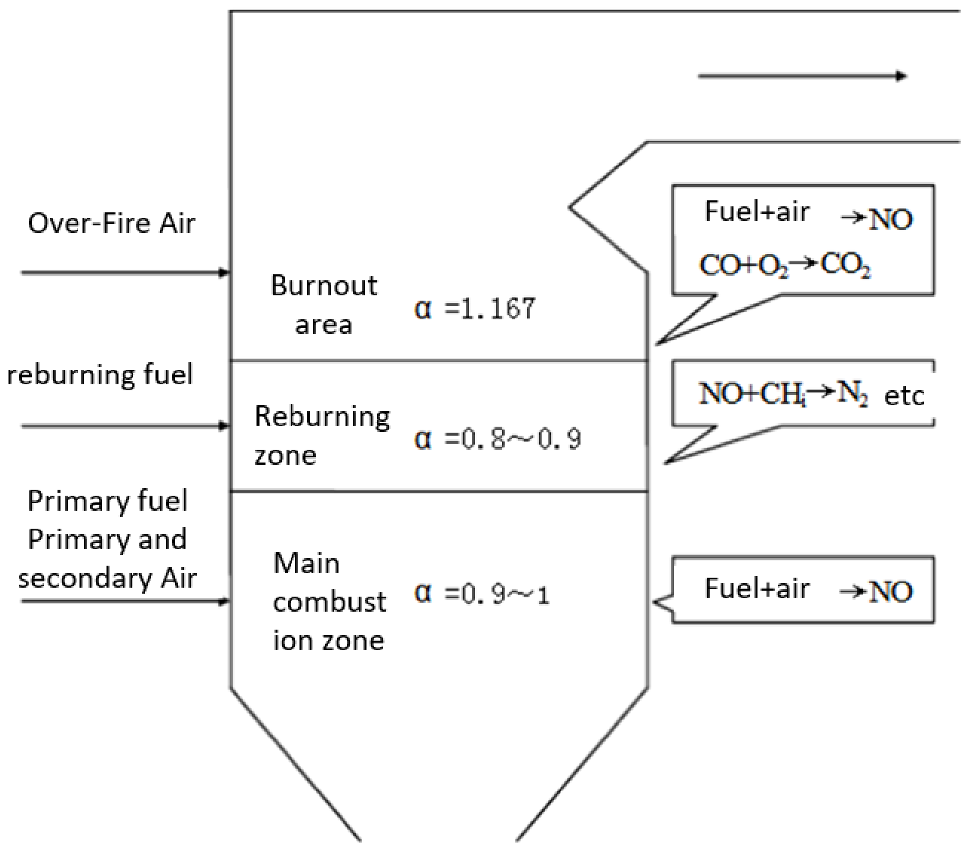


Figure 11.2-1 Stage burner principle

Other measures for the protection of the atmospheric environment

Design and use quality reliable equipment, pipes, valves and pipe accessories to ensure quality during construction.

Strict and perfect management and maintenance measures are set up in production to minimize running, running, dropping and leakage.

11.2.1.2 Techno-economic demonstration

The air environment protection measures to be taken in this project have been applied in similar projects, all of which are technically reliable and economically feasible. Long operating experience shows that the atmospheric environmental protection measures can greatly reduce the emission of pollutants and contribute to environmental protection.

11.2.2 Measures of Water Environmental Protection in Operation Period and Technical and Economic Demonstration

11.2.2.1 Water environment protection measures

Domestic sewage, machinery repair oil sewage, washing wastewater, initial rainwater

The domestic sewage of the proposed project, mechanic oil sewage, washing waste water, initial rainwater and marine domestic sewage are collected and discharged into the project's own sewage treatment station to be treated, and the non-heating season after the treatment reaches the standard of " municipal wastewater reuse water quality " (GB/T 18920-

2002) is used for greening of the Receiving terminal, road spraying and ground washing water. The heating season is treated by the self-built sewage treatment station and discharged to the south port sewage treatment plant. The domestic sewage produced by each station yard is pretreated by septic tank and treated by integrated sewage treatment device.

Marine engine room oil sewage

In accordance with the relevant regulations of the International Maritime Organization, the greasy dirt water in the engine room of a ship arriving at Port shall be treated by the self-provided sewage treatment device of the ship, and discharged as required after the completion of the standards . If the treatment device fails during the time of the ship being in Port , an application shall be made in advance and shall be accepted by a qualified unit for treatment without direct external discharge.

Process cold drainage

The cold drainage of the proposed project will only be used for heat exchange . After heat exchange, the temperature will be reduced and the water quality will not be polluted.

In a word, all kinds of waste water in operation period are collected effectively, treated by quality, reused after treatment up to standard or disposed by outside committee.

11.2.2.2 Techno-economic demonstration

Feasibility Analysis of Wastewater Treatment

The self-built sewage treatment station of the proposed project has a treatment capacity of 10 m3/h, which adopts the treatment process of " oil-water separation + air-float oil removal " and " MBR biochemical reaction ". It can meet the needs of domestic sewage, mechanic oil sewage, washing wastewater and initial rainwater treatment.

Reliability Analysis of Wastewater Treatment

General situation

The treatment capacity of the new comprehensive sewage treatment station is 10 m3/h, and the treatment process of " oil-water separation + air-flotation deoiling " and " MBR biochemical reaction " are adopted.

Sewage treatment process flow

Oily wastewater (machinery sewage, washing wastewater of working platform, ground washing wastewater of possibly polluted site, etc.) is deoiling by " oil-water separation " and " air-float deoiling ", and the effluent is further treated by the domestic sewage treatment system.

The domestic sewage is treated by MBR biochemical reaction after adjusting the homogenization of the tank.

Water quality index of inlet and outlet of design

The design water quality of the new integrated sewage treatment station is detailed in Table 11.2-1.

Table 11.2-1 List of imported and exported water quality units for new integrated sewage treatment plants: MG/L

Processing unit	Indicators	Concentration of water in and out of each control index (mg/L)		
		CODCR	Petroleum	Ammonia nitrogen

Oil-water separator	Water inlet	300	50-200	A.
	Water outlet	240	From 25 to 100	A.
	Removal rate	20%	50%	A.
Air-floatation oil-removing	Water inlet	240	From 25 to 100	A.
	Water outlet	96	From 2.5 to 10	A.
	Removal rate	60%	90%	A.
MBR reactor	Water inlet	96	From 2.5 to 10	45
	Water outlet	48	From 2.5 to 10	10
	Removal rate	50%	0%	78%
Standard for Reuse of Municipal Wastewater for Reuse of Urban Mixed Water Quality (GB/T 18920-2002)		/	/	≤ 10
Reception Standards for South Port Sewage Treatment Plants, Level III Standard for Integrated Sewage Discharge Standards (DB12/ 356-2018)		≤ 500		≤ 45

As can be seen from Table 10.2-1, the effluent quality of the constructed sewage treatment station can meet the reception standard of the Nankang Sewage Treatment Plant (the " Integrated Sewage Discharge Standard " (DB12/ 356-2018) and be discharged to the Nankang Sewage Treatment Plant for treatment.

Critical reliability analysis

The domestic sewage of land and ship workers is simple in water quality and the concentration of CODCR and NH3-N are 300 mg/L and 40 mg/L respectively. After the treatment of oil removal, the COD concentration of sewage from machine repair oil, washing water and initial rainwater was greatly reduced. Therefore, it is reliable to treat domestic sewage, machinery repair oil sewage, washing wastewater and initial rainwater discharge into the self-built sewage treatment station.

11.2.3 Control Measures of Noise Pollution in Operation Period

Reasonable layout of high noise equipment (flare, etc.) in design to reduce noise impact.

In the construction of the project, the low-noise mechanical equipment conforming to the national noise standard shall be selected, the maintenance and maintenance of the equipment shall be strengthened, and the equipment shall be maintained at a lower noise level so as to reduce the influence of the noise equipment on the surrounding environment.

For the larger pump motor to take sound control, set the sound isolation chamber.

The machine pump, compressor of all kinds are installed in rows and rows outside, and the muffler of inlet and outlet and local sound insulation cover are installed to improve the surrounding sound environment.

The large compressor adopts vibration damping measures and is relatively centrally arranged away from the main control room where the operator is concentrated.

The proposed project is located in the LNG operation area of Dagang Port Area of Tianjin Port, away from the acoustic environment sensitive targets. The noise reduction measures such as selecting low noise equipment, vibration reduction, sound insulation, noise elimination and gas flow rate control are adopted, which greatly reduces the influence of the project on the environment, and the proposed measures have the characteristics of maturity, reliability and economic rationality. Therefore, the noise control measures adopted in this project are technically feasible and economically reasonable.

11.2.4 Prevention Measures of Solid Waste Pollution in Operation Period

11.2.4.1 General solid waste

Land domestic waste, sediment from initial rain tank, filter material from seawater intake pump house and sludge from sewage treatment station belong to general solid waste, which are uniformly handled by municipal sanitation department. The small amount of solid powder produced by the cleaning operation and the maintenance of the separator shall, with the consent of the local ecological environment authority, reasonably choose the appropriate place for regular landfill disposal, and shall strengthen the management, and shall not be thrown or stacked at will.

Units that use water areas or coastlines prevent garbage from entering the water area and are responsible for removing domestic garbage and solid flotsam within the water area used by the units.

11.2.4.2 Marine domestic garbage

To urge ships in Port to strictly implement the " Pollution Control Standards on Ships " (GB 3552-2018).

The ship garbage from the epidemic area shall be treated by the competent health inspection and quarantine department after the quarantine ; Ship wastes in non-epidemic areas shall be accepted and disposed by qualified units.

11.2.4.3 Hazardous waste

The mechanic oil cotton yarn produced by the proposed project belongs to the hazardous waste category HW49 and is listed in the " Hazardous Waste Exemption Management List ".

The waste oil sludge and engine oil produced by the proposed project belongs to the hazardous waste and the dangerous waste category HW08, which is entrusted to the qualified units for safe disposal.

Hazardous wastes may have an environmental impact if they are not properly stored. The following measures shall be taken for the collection, storage and transportation of hazardous wastes :

Measures for Preventing and Curing Pollution in Storage Sites

The enterprise shall timely contact the disposal unit for recycling, collect centrally, manage by special person, store centrally, and store all kinds of dangerous wastes according to their different nature during the period when the plant is not shipped.

The construction of the hazardous waste temporary storage in the hazardous waste room shall meet the requirements of the Hazardous Waste Storage Pollution Control Standard (GB 18597-2001) after the publication of the revised list in 2013, and shall be collected and stored in special containers which meet the requirements of the standard and are not easily damaged, deformed and aged, and can effectively prevent leakage and diffusion. The containers containing hazardous waste are also labeled with a detailed description of the name, weight, composition, characteristics of the hazardous waste and emergency measures and remedies in case of leakage, diffusion pollution accidents.

The new hazardous waste storage room of the proposed project must meet the requirements of the Hazardous Waste Storage Pollution Control Standard. The storage site shall be windproof, rainproof and sunproof, and shall design and build a runoff diversion system, a leakage liquid collection device, a gas outlet and a gas purification device.

The new hazardous waste storage room of the proposed project will avoid inflammable, explosive dangerous goods warehouse and high-voltage transmission line protection area.

The foundation shall be impermeable, and the impermeable layer shall be at least 1 m thick clay layer (permeability coefficient ≤10-7 cm/s), or 2 mm thick high-density polyethylene, or at least 2 mm thick other artificial material with permeability coefficient ≤10-10 cm/s.

Waste oil sludge and waste oil are stored in drums with an opening diameter of not more than 70 mm and vent holes, which meet the requirements of the Hazardous Waste Storage Pollution Control Standard (GB 18597-2001).

The basic situation of the solid waste storage site of the proposed project is detailed in Table 11.2-1

Table 11.2-1 Basic Situation of Solid Waste Storage Sites in Proposed Works

Storage site	Hazardous waste Name	Hazardous waste Object class	Hazardous waste Code	Position	Occupy Area	Storage Mode	Storage Capability	Storage cycle
Hazardous Waste Storage Room	Waste oil sludge	HW 08	900-210-08	Maintenance vehicle Middle west side	Fifty m^2	Barrel loading	1.5 t	Three months
	Waste engine oil		900-214-08			Barrel loading	3.5 t	Three months

Measures for Preventing and Curing Pollution in Transport Process

The transfer and transport of hazardous wastes shall be approved for the transfer plan of hazardous wastes in accordance with the provisions of the Measures for the Administration of Transfer of Hazardous Wastes Joint Orders. Complete the transportation registration of each time the waste is removed and disposed of, carefully fill in the hazardous waste transfer slip (each waste fill out a joint slip), and seal the company's official seal, and after the transport unit verifies and accepts the signature, leave the first joint copy of the joint on file, the second joint of the joint transfer out of the local environmental protection administrative department, the third and the remaining joint delivery of the transport unit with the hazardous waste transfer operation. The fourth joint shall be transferred to the recipient unit and the fifth joint shall be submitted to the environmental protection bureau.

The construction unit shall timely contact the qualified unit for recovery . During the period when the plant is not shipped, it shall collect centrally, manage by special person, store centrally, and store all kinds of dangerous wastes according to their nature.

Transport personnel of waste disposal units must have knowledge of the safety of the transport of hazardous chemicals, understand the nature of the hazardous chemicals carried, the hazard characteristics, the use of packaging containers and emergency measures in case of accidents. The transport vehicle must have a vehicle dangerous goods transport license. The driver must be a skilled person with a driving licence.

The disposal unit shall be equipped with escort personnel when transporting hazardous waste, and shall be under the supervision of the escort at any time, shall not overload or overload, and shall drive in strict accordance with the driving hours and driving routes prescribed by the city where the disposal unit is located, and shall not enter the area where the dangerous chemical transport vehicle is prohibited from passing.

The construction unit may jointly study the transport of hazardous waste with the Hazardous Waste Disposal Centre to ensure the safety and reliability of the transport of hazardous waste and to reduce or avoid secondary pollution in the transport process and possible environmental risks.

Therefore, the improved solid waste prevention and control measures are both targeted and operable, technically and economically reasonable.

11.3 Summary

Table 11.3-1 List of Major Environmental Measures

Project phase	Categories	Environmental measures taken	Desired effect	Investment Ten Thousand Yuan	Implementation body	Subject of responsibility
Construction period	Exhaust gas	A continuous and closed enclosure shall be arranged around the construction site; The construction site shall be hardened ; Part of the construction site that fails to be hardened shall be periodically compacted, watered and cleaned to reduce dust pollution ; Strictly implement the provisions on the sealing transportation of building materials, such as powder dust and concrete, which are easy to dust and other building materials. At the same time, the speed control reduces the handling drop ; Reasonable arrangement of concrete mixing plant, cement unpacking in the shelter; Dust-prone building materials should be covered with a cloth or placed in an indoor warehouse ; Timely cleaning of spills and proper sprinkling of water on roads to reduce dust ; Whenever possible, construction vessels shall use vessels with low fuel consumption and low exhaust gas.	Have less impact on the surrounding environment	35	Construction unit	Construction unit
	Waste water	Reasonable arrangement of the number of construction vessels, location and control of construction progress to minimize the disturbance intensity of construction operation to the bottom ; At the same time, the environmental supervision unit shall carry out tracking and monitoring of the suspended matter ; Centralized disembarkation of pollutants from construction ships shall be entrusted to qualified units for receiving and disposing of the pollutants ; Mobile toilets are used for collection, storage and initial treatment of construction domestic sewage, and the collected domestic sewage is regularly transported by tanker to the sewage treatment plant for disposal ; A sediment settling tank shall be set up to deal with the waste water of sand and gravel washing and the production and maintenance of concrete prefabricated parts ; The washing waste water of oil repair machinery and construction machinery equipment is separated by oil-water separator and discharged into the sedimentation tank set up at the construction site.		60	Construction unit	Construction unit

	Noise	Selection of construction machinery and transport vehicles with low noise and low vibration to enhance the maintenance and maintenance of machinery and vehicles so that they remain in normal operation ; The contents of high-noise operation shall not be arranged at night or during lunch break to avoid the influence of construction noise on the sensitive points around ; Make good dispatch and traffic guidance of construction machinery and transport vehicles, reasonably guide vehicles entering the construction area, forbid vehicles to whistle and reduce traffic noise ; The speed of the sand-gravel transport vehicle passing through the village shall be limited, and the vehicle speed shall be controlled within 20 km/h.		30	Construction unit	Construction unit
	Solid waste	The waste soil of the project and the harmless construction waste shall be piled up at the designated temporary stacking point for comprehensive utilization after unified planning ; After collection of domestic garbage and machine repair oil cotton yarn, the municipal sanitation department shall handle it uniformly ; Waste welding rod and slag shall be recycled by the manufacturer ; Waste oil, waste oil, paint residue and barrel shall be accepted and treated by qualified units.		50	Construction unit	Construction unit
Operating period	Exhaust gas	Clean fuel shall be used: engineering immersion combustion gasifier, flare, canteen stove and natural gas clean fuel ; Set up evaporative gas recovery system: The project set up evaporative gas recovery system to recycle LNG vapour through natural gas compressor, reduce resource waste and exhaust emissions, and greatly reduce the BOG emission. The station yard emptying system shall be set up: the low temperature pipeline safety valve emptying and the LNG equipment emptying shall return directly to the tank through the emptying pipeline. Under normal operation, no gas is sent to flare or vent. Setting up the flare system: setting up the flare zone, using the flare to deal with the abnormal discharge of natural gas collected in an organized way, is a very effective method for the collection of non-useable flammable gases. Adopt closed handling technology to reduce the volatilization of LNG, adopt safety valve to reduce the emptying, tank truck to load the vehicle to use the closed handling technology, strengthen the process management, reduce the operation loss and other measures to reduce the emission of non-organized waste gas. Strict and perfect management and maintenance measures shall be put in place in production to minimize the phenomena of running, running, dropping and leaking.	Discharge up to standard, pollutant concentration up to standard	2800	Construction unit	Construction unit

	Waste water	The process cold drainage shall only be used for heat exchange, and the water quality shall not be polluted. Domestic sewage, machinery repair oil sewage, washing wastewater and initial rainwater are collected and discharged into the self-built sewage treatment station of the proposed project, and treated to meet the " Quality of Municipal Wastewater Reuse " (GB/T 18920-2002) reuse water quality, the acceptance standard of South Port Sewage Treatment Plant and the " Standard of Integrated Sewage Discharge " (DB12/ 356-2018) ; Part of the non-heating season is used for greening of the Receiving terminal, road spraying and ground washing water, and the rest is discharged into the domestic sewage collection tank, which is received and treated by the Nangang Sewage Treatment Plant ; The heating season is treated by the self-built sewage treatment station and discharged to the south port sewage treatment plant. In accordance with the relevant regulations of the International Maritime Organization, the greasy dirt water in the engine room of a ship arriving at Port shall be treated by the self-provided sewage treatment device of the ship, and discharged as required after the completion of the standards.	Have less impact on the surrounding environment	800	Construction unit	Construction unit
	Noise	Reasonable planning of the vehicle route of the terminal and approach bridge, and the vehicle and ship number shall comply with the relevant provisions ; The shock pad is arranged on the base plate of the large mechanical operation equipment such as BOG, and the BOG compressor is arranged in the compressor room ; Reasonable layout of high noise equipment (flare, etc.) in the design ; Selection of low-noise mechanical equipment that meets the national noise standards, strengthening the maintenance and maintenance of the equipment, and maintaining the equipment at a lower noise level ; For the larger machine pump motor to take sound control, set the sound isolation chamber ; Machine pumps installed in rows outside the room, various compressor mounting inlet and outlet muffler and local sound insulation cover ; The large compressor adopts vibration damping measures, relatively centralized arrangement, away from the main control room where the operator is concentrated, and the workshop adopts sound-absorbing material.	Factory noise can be up to standard and has little effect on the surrounding environment	450	Construction unit	Construction unit
	Solid waste	General solid wastes such as domestic refuse in the land area, sediment in the initial rain tank, filter matter in the seawater pumping station and sludge in the sewage treatment station shall be uniformly disposed of by the municipal sanitation department. The ship wastes from the epidemic area shall be handled by the competent health inspection and quarantine department after the quarantine inspection and quarantine department ; Ship wastes in non-epidemic areas shall be accepted and disposed by qualified units. Hazardous wastes such as waste oil sludge and waste oil are entrusted to qualified units for safe disposal.	All safe disposal, non-exclusive	380	Construction unit	Construction unit

	Risk	Sea risk : Emergency equipment allocation, refer to the provisions of " Port Terminal Oil Spill Emergency Equipment Requirements " for the purchase of oil spill emergency prevention and control equipment ; Implement all risk prevention measures and safety measures ; Make emergency plan, immediately interrupt the operation of the site staff, inform the company safety department quickly, and report to the headquarters at the same time, organize the personnel of the safety department to lay the oil fence, and set the impact circle to a minimum ; Regular exercises. Land risk : Reasonable arrangement of the master plan and functional zoning of the Receiving terminal, reasonable fireproofing distance and safe distance of the LNG tank. To ensure the normal operation of automatic control systems such as automatic monitoring, alarm, emergency shut-off and parking systems, electrical and telecommunication safety and protection facilities. Do the daily fire control work management and training, as far as possible to deal with the safety accident in the shortest time.	By taking corresponding emergency measures, the probability of accident can be greatly reduced, and if an accident occurs, strong measures can be taken quickly to reduce environmental pollution. Potential accident risks are preventable	350	Construction unit	Construction unit

12 Supplementary Measures and Suggestions for Occupational Health and Safety

12.1 Supplementary Measures for Protection against Occupational Hazards

12.1.1 Supplementary Measures for Protection of Occupational Hazards

(1) Conspicuous position of terminal, LNG storage tank area, loading area, external transmission pipeline station yard, and the three-stage area through which the pipeline passes shall be provided with weather vane at appropriate position ;

(2) Spray/eyewash or tap water devices shall be installed at the sewage treatment station of the send-out pipeline station.

(3) The sewage treatment station of Receiving terminal, maintenance workshop and sewage treatment station of send-out pipeline station, where there may be strong corrosive substances such as poison or acid and alkali, shall have flushing facilities . The floor of the workshop shall be smooth and slippery, easy to clean and clean.

(4) The Receiving terminal or station shall be equipped with at least 3 hand-held combustible gas indicators ;

(5) Portable toxic gas alarm devices (including for hydrogen sulfide and ammonia) are provided for dredging operations, and oxygen content detection devices are provided for nitrogen station operators, Receiving terminal maintenance workers, etc.

(6) Provide portable weather vane for welding operations, corrosion protection operations and other positions in contact with toxic and harmful substances ;

(7) The minimum wind direction of Anji Station and Yongqing Station is west, the emptying area of Yongqing Station is located on the south side of the plant area, and the emptying area of Anji Station is located on the northeast wind direction of the plant area. In the next design, further verification should be made as to whether the vent area of each substation site is located in the upper wind direction of the lowest wind frequency wind direction throughout the year.

(8) In order to reduce the influence on substation and laboratory, the nitrogen plant should adopt effective measures of noise elimination, sound absorption, sound insulation, vibration damping and vibration prevention.

12.1.2 Individual protection supplement

According to the analogy engineering situation, the operators of this project should complete the personal protective equipment according to Table 12.1-1, in addition to the basic safety helmet, anti-static working clothes and working shoes.

Table 12.1-1 Reference Table for Personal Protective Equipment

Evaluation Unit	Evaluation subunit	Job title	Number of contacts	Risk factors of occupational disease	Personal protective articles and main parameters
Quay	/	Dock operator	16	Methane, Noise, High Temperature, Low Temperature	Antifreeze gloves: suitable for people working in cold environment to wear, soft feel, high flexibility, strong touch Goggles: can be directly covered with general myopia glasses A mask, tunic, or long-sleeved protective garment.
		Terminal technician	12	Methane, Noise, High Temperature, Low Temperature	
Receiving terminal process area	Storage tank area	Tank operator	28	Methane, Noise, High Temperature, Low Temperature	Antifreeze gloves: suitable for people working in cold environment to wear, soft feel, high flexibility, strong touch Goggles: can be directly covered with general myopia glasses A mask, tunic, or long-sleeved protective garment.
	Process device area	Process operator	36	Methane, Noise, High Temperature, Low Temperature	
	Truck loading station	Tanker operator	12	Methane, Noise, High Temperature, Low Temperature	Antifreeze gloves: suitable for people working in cold environment to wear, soft feel, high flexibility, strong touch Goggles: can be directly covered with general myopia glasses A mask, tunic, or long-sleeved protective garment.
	Laboratory	Analytical operator	4	Methane, Noise, Low Temperature, High Temperature	Goggles: Analytical, can be directly covered with general myopia glasses Chemical gloves: 100% anti-liquid, excellent anti-skid performance A mask, tunic, or long-sleeved protective garment.
Receiving terminal auxiliary production area	Seawater intake area	Auxiliary construction technician	12	Noise, hydrogen sulfide, ammonia, high temperature	Earplug: reusable, SNR>25 Goggles: can be directly covered with general myopia glasses Chemical gloves: 100% anti-liquid, excellent anti-skid performance Gas mask: dual filter cartridge low-maintenance type Antifreeze gloves: suitable for people working in cold
	Chlorine making room			Chlorine, hydrogen chloride, noise	
	Pump			Noise	

Evaluation Unit	Evaluation subunit	Job title	Number of contacts	Risk factors of occupational disease	Personal protective articles and main parameters
	house				environment to wear, soft feel, high flexibility, strong touch A protective garment or long-sleeved blouse.
	Sewage treatment station			Hydrogen sulfide, ammonia, sodium hydroxide, other dust, noise	
	Diesel generator room			Carbon monoxide, nitrogen oxides, sulfur dioxide, noise	
	Boiler house	Stoker	3	Carbon monoxide, high temperature, noise, methane	Gas mask: positive pressure air respirator (emergency use) Goggles: can be directly covered with general myopia glasses
	Nitrogen station	Nitrogen patrol	8	Noise, Low Temperature, High Temperature	Ear plugs or earmuffs: noise-free earplugs, reusable, SNR>25 Goggles: can be directly covered with general myopia glasses Antifreeze gloves: suitable for people working in cold environment to wear, soft feel, high flexibility, strong touch A mask, tunic, or long-sleeved protective garment.
	Substation	Receiving terminal technician	8	Noise, power frequency electric field, sulfur hexafluoride	Insulating gloves: insulating rubber or latex material, with anti-electricity, waterproof, acid and alkali, chemical defense, oil prevention functions Goggles: can be directly covered with general myopia glasses
	Maintenance shop	Receiving terminal maintenance man	6	Electric welding fume, nitrogen oxide, manganese and its compounds, ozone, benzene, toluene,	Gas mask: dual filter cartridge low-maintenance type Antifreeze gloves: suitable for people working in cold environment to wear, soft feel, high flexibility, strong touch Panel: Protection against particles, chemicals splash, heat and shock damage Goggles: UV protection Goggles: can be directly

Evaluation Unit	Evaluation subunit	Job title	Number of contacts	Risk factors of occupational disease	Personal protective articles and main parameters
				xylene, carbon monoxide, solvent gasoline, other dust, noise, ultraviolet radiation	covered with general myopia glasses Dust mask: APF>10 (over N 95) Protective clothing for welding: 100% flame retardant cotton fabric or FYRBAN IUS Earplug: reusable, SNR>25 Welding gloves: made of heat-insulated rough leather, the palm and back of the hand are reinforced with soft leather, anti-wear, anti-combustion, anti-heat conduction Shock absorbing gloves: gloves with foam plastic, latex and air sandwiched synthetic rubber or foam rubber A protective garment or long-sleeved blouse.
Send-out pipeline system	Station yard	Station operator	20	Carbon monoxide, high temperature, methane, noise, low temperature, other dust, sodium hydroxide, hydrogen sulfide, ammonia	Antifreeze gloves: suitable for people working in cold environment to wear, soft feel, high flexibility, strong touch Goggles: can be directly covered with general myopia glasses Dust mask: APF>10 (over N 95) Gas mask: dual filter cartridge low-maintenance type
		Station technician	28	High temperature, methane, noise, low temperature, carbon monoxide, nitrogen oxides, sulfur dioxide	
	Pipeline	Line inspector	12	High temperature and low temperature	Sunbonnet: UV protection Protective glasses: protection against ultraviolet radiation Anti-mosquito bite: Anti-mosquito Water Anti-mouse, anti-chigger mite: siamese clothing or wearing light-colored long clothes, cuff,

Evaluation Unit	Evaluation subunit	Job title	Number of contacts	Risk factors of occupational disease	Personal protective articles and main parameters
					trouser leg tight ; Avoid sitting on the grass

In accordance with the Basic Requirements for Personal Protective Equipment (GB/T 29510-2013), Selection, Use and Maintenance of Respiratory Protective Equipment (GB/T 18664-2002), or Selection Guide for Hearing Protector (GB/T 23466-2009), the operator shall determine the release cycle and type of protective equipment according to its own conditions.

12.1.3 Emergency rescue supplementary measures

The chlorine room and chemical warehouse should be equipped with on-site first-aid supplies, emergency evacuation routes and necessary spill zones.

（1） The operating unit shall set up medical kit, emergency medicine, protective clothing not exposed to LNG, positive pressure respirator and other emergency materials, and place them in convenient access places such as terminal, LNG gasification area, tanker loading area, send-out pipeline station, and store them in conspicuous places and set warning signs.

（2） Installation of flushing equipment such as spray eyewash or flowing water tap in the chlorine-making room and sewage treatment room, and installation of clear marking to enhance personnel training and maintenance so as to ensure that operators can get flushing in time in case of accidents.

（3） The air suction outlet of the accident exhaust of the nitrogen production station and substation shall be located at the place where the material discharge volume may be the largest or the most concentrated, and the leakage alarm device with the interlocking of the accident exhaust system shall be installed in the substation.

（4） The ventilator for accident ventilation shall be provided with an electric switch in the room and on the outer wall near the outer door respectively.

（5） In case of conditions, an on-site medical service agreement can be signed with the Binhai Hospital of Peking University, a green medical passageway can be set up, and a medical clinic can be set up in the Receiving terminal for the use of medical personnel stationed in the hospital. The main contents of the medical clinic are on-site first aid, diagnosis and treatment of common diseases (to provide routine drugs ; Treatment and dressing of the wound ; To regularly assign qualified personnel to the Receiving terminal and the personnel of the send-out pipeline for first-aid training, timely delivery of critically ill patients, medical care guidance and health consultation, etc.

（6） Gas protection cabinet equipment reference: Acousto-optic alarm, equipped with positive pressure air breathing apparatus, Su Sheng device, safety helmet, safety belt, body protective clothing, acid and alkali proof rubber trousers, insulation bar, insulating boots, gloves, bedding, stretcher, explosion-proof lighting and other rescue appliances.

In addition, before the project is officially operational, it is necessary to set up and perfect emergency plans and on-site treatment plans for occupational hazards such as heatstroke, frostbite, asphyxiation, sulfur hexafluoride leakage accident, hydrogen sulfide acute poisoning, LNG leakage, nitrogen leakage, acid and alkali corrosion caused by chemical leakage in chlorine-making room and chemical warehouse, and carry out emergency rescue plans. See Table 12.1-2 for specific emergency relief measures.

Table 12.1-2 Supplementary measures for emergency relief

Job title	Possible emergency	Emergency rescue facilities and quantities	Set Location	Remark
Dock operator	Frostbite, suffocation, heatstroke	Pneumatic positive pressure air respirator 4 , First aid kit , Portable combustible gas detector 1 , Protective clothing 3 sets	Terminal control room	First aid kit should be equipped with: medical alcohol, 0. 9% saline, absorbent cotton swab, medium adhesive tape, bandages, scissors, tweezers, medical gloves, face mask, frostbite paste, band-aid, ice bag, tourniquet, eye lotion, heatstroke prevention cooling medicine, thermometer, first aid instructions, etc
Terminal technician				
Tank operator	Frostbite, suffocation, heatstroke	Pneumatic positive pressure air respirator 6 , First aid kit , One stretcher , Portable combustible gas detector 2 , Protective clothing 6 sets	Central control room	
Process operator	Frostbite, suffocation, heatstroke			
Nitrogen patrol	Frostbite, suffocation, heatstroke			Nitrogen or liquid nitrogen leakage
Tanker operator	Frostbite, suffocation, heatstroke	Four positive pressure air breathing apparatus, one first aid kit, one portable combustible gas detector, three sets of protective clothing	Loading control room	First aid kit configuration
Auxiliary construction technician	Sodium hydroxide and other chemicals splash into the eye , Hydrogen sulfide acute poisoning accident	Spray eyewash device 1 set , Pneumatic positive pressure type air respirator 2	Sewage treatment station	The pumping station of sewage treatment station shall be provided with a mechanical ventilation system not less than 6 times/h

Job title	Possible emergency	Emergency rescue facilities and quantities	Set Location	Remark
	Chlorine poisoning, sodium hypochlorite, hydrochloric acid and other drugs splash into the eye, hydrogen explosion	Spraying eyewash device 1 set	Chlorine making room	Leakage ditch (weir) should be set up between chlorine production
Stoker	Carbon monoxide poisoning	Pneumatic positive pressure type air respirator 1	Workroom	The exhaust capacity shall meet the requirements of 12/h ventilation times
Receiving terminal technician	Sulfur hexafluoride leakage	The leakage alarm device for setting the connecting lock of the emergency exhaust system , Positive pressure air respirator (shared with central control room)	Substation 110 kV	The exhaust capacity shall meet the requirements of 12/h ventilation times
Station operator, station technician	Frostbite, asphyxia, heatstroke, sodium hydroxide and other drugs splash into the eye , Acute hydrogen sulfide poisoning accidents, carbon monoxide poisoning	Pneumatic positive pressure air respirator 4 , First aid kit , One stretcher , Portable combustible gas detector 2 , Six sets of protective clothing , Spray eyewash device 1 set , Setting leakage alarm device for connecting lock of emergency exhaust system	Production area	The number of emergency relief facilities refers to the requirements of a single station

12.1.4 Supplementary measures for warning signs

The research report on the Receiving terminal and terminal of this project refers to the establishment of safety signs in places and equipment that are prone to accidents or endanger life safety, as well as in places that require the attention of operators ; It is mentioned in the feasibility study report of the send-out pipeline that the signs such as mileage pile, corner pile, cross pile, encrypted pile, warning plate and warning belt are set up, but they are not specified. Notice boards shall be set up in the office to publicize the rules and regulations for the prevention and control of occupational diseases, the relevant operating procedures for occupational health, emergency measures for occupational hazards, the results of the examination of occupational hazards and the results of occupational health examination.

The warning signs and bulletin boards can refer to Table 12.1-3 and Table 12.1-4. Inform the card and warning signs that they should be checked at least once every half a year and that they should be repaired or replaced in time if they are found to be damaged, deforming, discoloration, loss of graphic symbols, and aging of brightness.

Table 12.1-3 Alert ID settings

Set Up Locations	Main occupational hazard factors	Warning ID	Instruction identification	Inhibit identification
Quay	Noise, High Temperature	Noise is harmful . Watch out for heatstroke	Wearing ear protectors, emergency rescue telephone, marking the location of first-aid kit, marking the location of emergency relief materials	/
Storage tank area				
Seawater intake area	Noise, hydrogen sulfide, ammonia	Noise is harmful, beware of poisonous gases	Wear ear protectors, ventilation and protective gloves	/
Pump house	Noise	Noise harmful	Ear protector	/
Chlorine making room	Hydrogen chloride, chlorine	Watch out for gas, watch out for corrosion	Wear protective gloves, pay attention to ventilation, wear protective glasses, wear gas mask	/
Sewage treatment station	Hydrogen sulfide, ammonia, sodium hydroxide	Watch out for gas, watch out for corrosion	Wear protective gloves, pay attention to ventilation, wear protective glasses	/
Diesel generator room	Noise	Noise harmful	Ear protector	Do not start (set when generator is repaired or suspended)
Boiler house	Carbon monoxide, high temperature	Watch out for gas, heat stroke, heat	Pay attention to ventilation, emergency exits, rescue calls	/
Nitrogen station	Noise	Noise harmful	Ear protector	Do not start (set when nitrogen plant is repaired or suspended)
Maintenance shop	Noise, toxic gas, ultraviolet radiation	Harmful noise, gas, arc light	Wear earmuffs, respirator, ventilation, protective gloves and goggles	/
Station yard	Noise	Noise harmful	Ear protector	/

complex				
Station yard sewage treatment system	Hydrogen sulfide, ammonia, sodium hydroxide	Watch out for gas, watch out for corrosion	Wear protective gloves, pay attention to ventilation, wear protective glasses	/
Depot maintenance workshop	Noise, toxic gas, ultraviolet radiation	Harmful noise, gas, arc light	Wear earmuffs, respirator, ventilation, protective gloves and goggles	/

Table 12.1-4 Bulletin Board, Notification Card Setup

Set Location	Facilities	Content
Receiving terminal, station entrance	Bulletin board	Rules and regulations for the prevention and control of occupational diseases, operating procedures, emergency measures for occupational hazards, monitoring results of occupational hazards, and regular testing and evaluation results
	Notification card	To set up a notification card for methane and noise ; Name of occupational-disease-inductive factors, physical and chemical characteristics, health hazards, protective measures, emergency treatment, operation and storage precautions, disposal methods, emergency and emergency telephone etc
Tanker loading station, terminal, storage tank area	Notification card	Establishment of a methane notification card ; Name of occupational-disease-inductive factors, physical and chemical characteristics, health hazards, protective measures, emergency treatment, operation and storage precautions, disposal methods, emergency and emergency telephone etc
Seawater intake area	Notification card	Noise, hydrogen sulfide and ammonia are installed at the entrance. The contents of the card should include the name of the hazard, physical and chemical characteristics, health hazards, emergency treatment measures, protective measures, emergency telephone etc
Pump house	Notification card	A noise card is set at the entrance. The contents of the card should include the name of the hazard, physical and chemical characteristics, health hazards, emergency treatment measures, protective measures, emergency telephone etc
Chlorine making room	Notification card	A hydrogen chloride, chlorine and hydrogen notification card is set at the entrance. The contents of the card should include the name of the hazard, physical and chemical characteristics, health hazards, emergency treatment measures, protective measures, emergency telephone etc
Sewage treatment station	Notification card	Hydrogen sulfide, ammonia and sodium hydroxide are installed at the entrance. The contents of the card should include the name of the hazard, physical and chemical characteristics, health hazards, emergency treatment measures, protective measures, emergency telephone etc
Diesel generator room	Notification card	The entrance shall be provided with a notification card for noise and toxic gases. The contents of the card should include the name of the hazard, physical and chemical characteristics, health hazards, emergency treatment measures, protective measures, emergency telephone etc
Boiler house	Notification card	The entrance shall be provided with a notification card for noise and toxic gases. The contents of the card should include the name of the hazard, physical and chemical characteristics, health hazards, emergency treatment measures, protective measures,

		emergency telephone etc
Nitrogen station	Notification card	A nitrogen and noise information card is set at the entrance. The contents of the card should include the name of the hazard, physical and chemical characteristics, health hazards, emergency treatment measures, protective measures, emergency telephone etc
Maintenance shop	Notification card	The entrance shall be provided with a notification card for noise, toxic gas and ultraviolet radiation. The contents of the card should include the name of the hazard, physical and chemical characteristics, health hazards, emergency treatment measures, protective measures, emergency telephone etc
Station yard complex	Notification card	A noise and methane notification card is set at the entrance. The contents of the card should include the name of the hazard, physical and chemical characteristics, health hazards, emergency treatment measures, protective measures, emergency telephone etc

12.1.5 Supplementary measures for architectural hygiene and auxiliary room design

According to the Design and Sanitation Standard for Industrial Enterprises (GBZ1-2010), the sanitary signs of this project shall be graded to 3 levels, and the auxiliary use rooms such as clothesroom, washroom, bathroom, rest room, dining place and toilet shall meet the following requirements :

（1） The auxiliary room should avoid the influence of harmful substances, pathogens, high temperature and other occupational-disease-inductive factors. The internal structure of the building shall be easy to clean and the sanitary facilities shall be easy to use.

（2） The total number of people working in a single class shall be designed as auxiliary use room according to the following standard: the shower bath shall be arranged according to the needs of 1 shower per 9 people, the number of toilet taps shall be allocated according to the needs of 31-40 people per faucet, the toilet shall not be too far from the work place, and shall have measures for deodorizing and fly prevention. The toilet in the workshop should generally be flush type, at the same time should be set up wash basin, wash dirty pool, cold area should be set indoors. In addition to special needs, the squatting number of toilets should be designed according to the number of users. Men's toilets: the number of male workers and staff with less than 100 workers in the workplace can be set by 25 people a squatting position ; A squatting position is added for every 50 additional persons in the workplace of more than 100 persons. The number of urinals is the same as the number of squatting places. Women's toilets: the number of women workers and staff in the workplace less than 100 people can be set by 15 people 1-2 squatting position.

（3） The casual clothes rooms and work clothes rooms can be designed according to the principle of separate storage in the same cabinet, and the dressing rooms and rest rooms can be combined.

（4） The toilet facilities should be centrally located in different districts. The washroom inside the workshop shall be well drained of ground, and the toilet facilities outside the workshop shall be provided with awning and anti-freezing.

（5） Clean drinking water facilities shall be provided in the lounge. In the case of more women workers, maternity rest rooms or rest areas should be set up in the clean and quiet areas of the administrative building.

（6） The canteen shall set up a sufficient number of hand washing facilities according to the number of people who eat. The dining area and the food provided shall meet the relevant sanitary requirements.

（7） The indoor temperature of the auxiliary room shall be as follows: the bathroom and dressing room shall not be less than 25℃ ; The office, lounge and canteen shall not be below 18℃ ; Toilets and toilets shall not be below 14℃.

（8） Natural ventilation shall be provided with inlet, outlet or sash with small resistance coefficient and easy to switch and repair. Mechanical switches or adjustment devices shall be provided for inlet, outlet or sash that are not convenient for personnel switches or need to be constantly adjusted.

（9） The lower edge of the air inlet for natural ventilation in summer should not be more than 1.2 m. The air inlet for natural ventilation in winter shall take measures to prevent the cold wind from blowing to the work place when the lower edge of the air inlet is less than 4 m from the indoor ground.

（10） The position of the air inlet of the mechanical air supply system at the power distribution place shall comply with the following provisions :

1. Should be set directly in the outdoor air cleaner place ;

2.When there is air outlet in close distance, it should be lower than air outlet ;

3. The lower edge of the air inlet shall not be less than 2m from the outdoor terrace, and shall not be less than 1m when it is set in the greening zone ;

4. Avoid short circuit of air inlet and exhaust.

（11） Mechanical ventilation shall be provided in substation, boiler house, heating furnace area, diesel generator room (ventilation times ≥12 times/h), maintenance workshop (ventilation times ≥6 times/h) and sewage treatment room (ventilation times ≥6 times/h) of Receiving terminal and send-out pipeline station. Make sure the normal exhaust cooling facilities and accident exhaust requirements of boiler room and heating furnace area. There is a sodium hypochlorite generator in the chlorine making room . The hydrogen produced should be excluded during operation.

（12） The installation of the fine chemical room in the heating furnace area of the Receiving terminal boiler house and station yard.

（13） According to " Lighting Luminance and Measurement Method of Port Loading and Unloading Area " JT/T 557-2004 and " Architectural Lighting Design

Standard " GB 50034-2013, the site and pipeline illumination standards of send-out pipeline shall be refined.

（14） The next step of the ventilation design of the laboratory shall take into account the air flow in the room, especially the negative pressure design of the fume hood shall not be affected.

12.1.6 Supplementary Measures for Occupational Hazards Protection During Construction and Equipment Installation and Commissioning

12.1.6.1 Dust control measures

Adopt construction technology, construction equipment and tools that do not or do not produce dust as much as possible, and eliminate construction technology, construction equipment and tools that are seriously damaged by dust ; The use of non-hazardous or less hazardous construction materials ; Use of mechanical, automated or closed isolation operations ; Take wet work ; Set up local dust control facilities and purification and discharge devices.

12.1.6.2 Antitoxic measure

Priority is given to the selection of non-toxic, low-toxic materials to replace toxic, high-toxic materials ; As far as possible to choose the production process without or little toxic substances in the construction process and construction technology ; The process of production, transportation, pulverization and packaging shall be closed ; Use of mechanical, automated or closed isolation operations ; Setting up effective ventilation devices ; The presence of toxic chemical chemicals near the construction site to set up toilet equipment, equipped with personal special trunks ; Showers should be provided in workplaces where high toxic substances are used ; Emergency eyewash and shower should be set up near the operation site when exposed to toxic substances with high risk of percutaneous absorption and local action.

12.1.6.3 Anti-noise control measures

As far as possible, low-noise construction facilities and construction technology are used instead of high-noise construction equipment and construction technology ; The noise-generating equipment shall be installed with a vibration-damping foundation, and measures such as sound insulation, noise elimination, vibration isolation and noise reduction shall be taken for the high-noise construction equipment. Try to isolate the noise source from the living area, low noise area or workers ; Minimize the density of high noise equipment operating points.

12.1.6.4 Anti-vibration measure

Strengthening the renovation and transformation of construction technology, equipment and tools ; The metal parts of the pneumatic tool are replaced with plastic or rubber or with additional padding to reduce vibration due to impact. The hand-held vibration tool shall be provided with an anti-vibration handle ; Take rotating operation mode to reduce the time of contact vibration of workers.

12.1.6.5 High temperature control measures

The construction units shall strictly implement the relevant provisions of the Measures for the Management of the Measures for the Prevention of Summer Cooling (No. 89 of the General Security Administration [2012]).

Summer high temperature season should reasonably adjust the schedule, avoid noon high temperature time construction ; Reduce the labor intensity of workers, take a rotation of the way to increase the number of workers rest and rest time ; Air conditioning shall be provided in the operation room and cab of various mechanical and transport vehicles ; In summer, workers are provided with a cool drink containing salt. When the maximum temperature of the day reaches above 40℃, outdoor outdoor operations shall be stopped on that day.

12.1.6.6 Anti-low temperature control measures

Avoid or reduce the use of low-temperature operation of the construction process ; Adopt mechanization, automation technology as far as possible, reduce low temperature operation time ; Do the measures of cold-proof and warm-keeping, set the heating room and the rest room near the construction site.

12.1.6.7 Power frequency electric field prevention measures

The radiation source is shielded by shielding net, shield or shielding chamber . The electrical equipment and lines are shielded by metal grid and grounding measures and reinforced concrete. A reliable grounding is provided, and the shielding grounding is not replaced by the protective earthing of general electric energy, so as to avoid the shield becoming the secondary radiation source. The electrical equipment is installed in the cabinet with radiation protection function . The operators should keep away from the radiation source as far as possible and reduce the radiation injury.

12.1.6.8 Ultraviolet radiation protection measures

The use of automatic or semi-automatic welding equipment to increase the distance between workers and radiation sources ; Use opaque or translucent baffles to separate construction sites that produce ultraviolet radiation from other construction areas.

12.2 Occupational Health Management Recommendations

(1) The operating units shall set up occupational health management institutions and administrative systems in accordance with the relevant provisions of the Occupational Disease Prevention and Control Law of the People's Republic of China, the Regulations on Occupational Health Supervision and Management in the Workplace and the Measures on Supervision and Administration for Occupational Disease Protection in Construction Projects at the same time . the relevant systems include the liability system for prevention and treatment of occupational hazards, the warning and notification system for occupational hazards, the declaration system for occupational-disease-inductive items, the training system for occupational-disease-prevention publicity, the maintenance and inspection system for occupational-

disease-prevention facilities, the management system for occupational-disease-prevention products, the monitoring and evaluation system for occupational hazards, the occupational health monitoring and file management system for construction projects, the treatment and reporting system for occupational-disease-prevention and other occupational health regulations, and carry out according to the system.

(2) The operating units shall clearly identify the occupational health management institutions or organizations, provide full-time occupational health management personnel, and formulate occupational disease prevention plans and implementation programmes.

(3) In accordance with the requirements of the Occupational Disease Prevention and Control Law of the People's Republic of China that " the cost of the occupational-disease-prevention facilities of the construction project shall be included in the project budget of the construction project, and the funds for all occupational-disease-prevention facilities shall be separately allocated ", the send-out pipeline shall be improved for the occupational-disease-prevention measures and the estimated investment of the facilities.

(4) The occupational-disease-prevention facilities shall be designed in accordance with the requirements of the relevant laws, regulations, rules and standards for the prevention and control of occupational diseases prior to the construction, including: design basis, general situation and engineering analysis of the construction project, analysis of occupational-disease-inductive factors and prediction of the degree of harm, name, specifications, type, quantity and distribution of the occupational-disease-prevention facilities and emergency rescue facilities to be adopted . it also analyzes the prevention and control performance, the setting of auxiliary rooms and sanitary facilities, the explanation of the occupational-disease-prevention facilities to be adopted in the pre-evaluation report, the adoption of protective measures and countermeasures, the detailed investment budget of occupational-disease-prevention facilities and emergency rescue facilities, the expected effects of occupational-disease-prevention facilities and emergency rescue facilities.

(5) After the completion of the design of the occupational-disease-prevention facilities, the business unit shall organize the professional health professionals to review the occupational-disease-prevention facilities design and form an evaluation opinion.

(6) After the project is put into operation, a sound occupational health file shall be established in accordance with the requirements of the Occupational Health Records Management Code (Security and Safety of the Office of the Director-General [2013] No. 171). The occupational health archives shall include the construction project occupational health " three simultaneous " files, occupational health management files, occupational health publicity and training files, occupational-disease-inductive factors monitoring and evaluation files, occupational health monitoring and management files of the employing unit, and workers's personal occupational health monitoring files.

(7) Before the project is put into operation, workers engaged in occupational-disease-inductive work shall be organized to carry out pre-employment occupational health

examination, and the results shall be communicated to the workers in writing ; In case of emergency, the company should also organize emergency occupational health examination, and emergency occupational health examination into the occupational health monitoring file management. The occupational health examination shall be undertaken by the medical and health institutions that have filed a record with the provincial health authorities.

(8) The operator shall, in addition to the pre-post medical examination and departure medical examination, conduct regular occupational health examination every year and inform the operator in writing of the results of the examination.

(9) When entering into a labor contract with workers (including employment contract), the occupational-disease-inductive factors of the work process and the consequences thereof, occupational-disease-inductive measures and treatment (post allowance, inductrial injury insurance, etc.) shall be specified in the labor contract. At the same time, the labor dispatch personnel shall be informed in writing. If the text of the form contract is incomplete, the occupational-disease-inductive notification shall be signed in the form of an annex to the contract. When the laborer is engaged in the occupational-disease-inductive work that is not disclosed in the labor contract with the laborer due to the change of the work position or the content of the work during the performance of the labor contract, the employing unit shall perform the duty of truthful notification to the laborer and negotiate the modification of the relevant provisions of the original labor contract.

(10) Workers should be provided with pre-employment occupational health training and regular occupational health training during the on-job period, so that workers are aware of occupational hazards in the workplace, grasp the regulations, operating procedures, emergency relief measures, occupational-disease-prevention facilities and personal protective products of the correct use of maintenance methods and the meaning of relevant warning signs, and after passing written and practical operational tests.

(11) The operating unit shall formulate emergency plans and on-site solutions for occupational hazards such as heatstroke, asphyxia, carbon monoxide poisoning, acute hydrogen sulfide poisoning, sulfur hexafluoride leakage, asphyxiation or explosion caused by hydrogen leakage, chlorine poisoning, etc., establish emergency rescue teams for occupational hazards, define the responsibilities and work of emergency relief agencies. In addition, the operating units shall be equipped with first-aid protection equipment, medicine boxes and commonly used medicines, formulate management systems, and conduct regular evacuation, first aid, fire drill and training. Its rescue system, organization and personnel should be able to meet the requirements of relevant national standards.

(12) If there are female workers among the workers, they shall also, in accordance with the relevant provisions of the Special Provisions on the Labour Protection of Female Workers (State Council Order [2012] No. 619), strengthen the labour protection of female workers and workers, take measures to improve the occupational health

conditions of female workers and provide vocational health training for female workers.

(13) During the trial operation of the project, the occupational-disease-prevention facilities shall be put into operation at the same time as the main works. The trial run time shall be no less than 30 days and no more than 180 days. During the trial operation, the operation of the occupational-disease-prevention facilities and the occupational-disease-inductive factors in the workplace should be tested, and the effects of occupational-disease-inductive control should be evaluated.

(14) During the loading process of LNG, there will be a connecting process between the loading arm and the tank car . These operations are liable to cause natural gas leakage. In addition to the installation of vehicle interlocking, operating procedures shall be formulated to urge operators to use cold-proof gloves and protective glasses.

(15) In the course of the operation of this project, if there is an outsourcing committee, such as emergency repair and daily maintenance operations relying on the Central Petroleum Emergency Response Center, the occupational health management responsibilities of the employees of the external contractors and the responsibility for the prevention and control of occupational diseases shall be fully clarified (see Section 4.3.10 for details). The operating unit shall not outsource the occupational-disease-inductive work to the units and individuals without occupational-disease-inductive protection conditions, and shall fulfill the obligations of the employing unit stipulated in the Occupational Disease Prevention and Control Law.

(16) In the next design of this project, we will improve the estimation of the investment for the protection measures and facilities for occupational diseases by the terminal and the send-out pipeline.

(17) In abnormal condition or during overhaul, maintenance or sealing operation, management shall be strengthened, operation procedures shall be strictly enforced, toxic gas concentration and air oxygen content shall be monitored, personnel shall be placed under supervision, personal protective articles shall be worn as required, and local ventilation shall be observed.

(18) To establish and improve the responsibility system for occupational safety and health production before the operation of this project, establish, improve and strictly implement various occupational safety and health rules and regulations (management system, operating procedures, equipment maintenance and education and training, etc.), and strengthen the prevention, control and treatment of accidents, property losses and hidden dangers of accidents.

12.3 Suggestions on occupational health management during construction and equipment installation and commissioning

(1) The operating unit shall clearly define its responsibility for the occupational health management and prevention of occupational diseases for the employees of the construction unit, and shall not outsource the occupational-disease-inductive

operations to units and individuals without occupational-disease-inductive protection conditions.

(2) The construction units shall set up occupational health management institutions and related systems to provide effective occupational-disease-prevention facilities in accordance with the requirements of the " occupational-disease-prevention facilities for construction projects " (Decree No. 90 of the State Administration of Safety Production Supervision and Administration), the " Occupational Hazards Prevention and Control Code for Construction Industry " (GBZ/T 211-2008) and the " Technical Specification for Occupational Hazards Prevention and Control of Construction Enterprises " (AQ/T 4256-2015) make reasonable labor system, strengthen construction process occupational health management and education training, set up corresponding occupational disease protection facilities and warning signs, and equip workers with qualified personal protective articles, organize workers to carry out pre-job, on-job and off-duty occupational health inspection.

(3) After the construction plan is determined, the construction unit may entrust the professional health technical service organization with corresponding qualifications to supplement the relevant pre-evaluation contents. During the construction, the management unit shall supervise the occupational-disease-prevention measures taken by the contractor in accordance with the prevention and control requirements of occupational-disease-inductive factors in the Code for the Prevention and Control of Occupational Hazards in the Construction Industry (GBZ/T 211-2008), and inspect the construction operation and find problems in time to require the contractor to correct them. The construction unit shall provide the construction unit with a summary report on the prevention and treatment of occupational hazards in the construction process after the completion of the project.

(4) The construction unit shall, in cooperation with the contractor, establish emergency relief agencies or organizations during the construction period ; The construction site shall be equipped with trained first aid workers, first aid kits, stretchers, blankets and other first aid items.

(5) During the construction phase of the project, the construction unit shall require the construction unit to design a special article according to the occupational-disease-prevention facilities and simultaneously construct the main part of the project.

12.4 Labor rights protection

Implement the principle of distribution according to work, adjust and improve interpersonal relationships, and mobilize the enthusiasm and creativity of workers. It is strictly forbidden to use child labor and forced labor; to protect the rights and interests of women workers, equality between men and women, and equal pay for equal work; to establish and improve labor management systems and measures, including assessment of reward and punishment systems, training systems, wage and welfare systems, labor protection, and file management.

12.5 Complaints and complaints mechanism

The complaints complaints mechanism will be open to all workers, including vulnerable groups such as women. Any affected person can appeal through the telephone, letter, email and other media. Before the project starts, the contact person (contractor, environmental management personnel, etc.) of each complaint acceptance link will be identified. The specific contact information (such as phone number, address, email address, etc.) will be published on the information bar of the construction site or On the local government's website.

The Department of Environmental and Social Management of the Project Department will establish a tracking and recording system for public complaints and complaints mechanisms, including:

(1) Establish tracking and tracking procedures to collect information from project personnel and the complainant;

(2) Develop a special person to update the database information regularly;

(3) Establish an information analysis system, identify the cause of the complaint, improve the transparency of the appeal handling process, and regularly assess the overall operation of the mechanism;

(4) Establish procedures to notify interested parties of the situation;

(5) Report the handling of appeals to the project department, the implementation unit and the AIIB on a regular basis.

13 Environment and Economic Cost-Benefit Analysis

13.1 Analysis of social and economic benefits

（1）The project is in line with China's long-term energy planning strategy and is an important measure to optimize the energy consumption structure and promote energy conservation and emission reduction in the Beijing-Tianjin-Hebei region.

The next five years and even longer are the key period for China's energy transition. Air pollution control and climate change pressures urgently need to be supported by clean low-carbon energy. Renewable energy is constrained by various factors such as technology, cost, and energy storage techniques. Objectively, a considerable amount of flexible power supply is needed to match it. Gas-fired power plants have excellent regulation and response capabilities, as well as rapid start-stop and flexible operation. The combination of gas-electricity and wind power or photovoltaic power generation with “co-complementary” or “pho-complementary” combined units can effectively solve the current abandonment. The problem of wind and light is to increase the total output level of the generator set and the reliability of the grid operation. Therefore, cooperating with natural gas has become an important way for China to develop wind power and photovoltaic power in large scale in the future.

As an efficient, clean and low-carbon high-quality energy source, natural gas itself has abundant resources, sufficient supply, relatively low cost, convenient use, and remarkable energy saving and emission reduction effects. The thermal efficiency of natural gas on power generation and industrial fuel is about 10% higher than that of coal. The heat supply efficiency of natural gas cold and heat electricity is nearly double that of coal-fired power generation; the carbon dioxide emissions of natural gas are 59% of coal and 72% of fuel oil; large gas-steam The concentration of sulfur dioxide in the combined cycle unit is almost zero. The sulfur dioxide emissions from industrial boilers are 17% of coal and 25% of fuel oil. The nitrogen oxide emissions of large gas-steam combined cycle units are 73% of ultra-low emission coal-fired units. Natural gas emissions from industrial boilers are 20% of coal; at the same time, natural gas has no dust emissions compared with coal and fuel oil.

The design capacity of the LNG Receiving terminal is 5 million tons/year, equivalent to 6.937 billion square meters of natural gas, which can replace the standard coal of 8.9994 million tons, reduce the sulfur dioxide emissions by 27225.4102 tons/year, reduce the emission of soot by 67699.86 tons/year, and reduce the carbon dioxide emissions by 7,504,300 tons. / Year, can reduce nitrogen oxides by 78,841.03 tons / year.

（2）The project is an important facility for the " interconnection " of the Beijing-Tianjin-Hebei region and the national natural gas pipeline network.

According to statistics, as of the end of 2017, the total length of the national natural gas pipeline network reached 68,000 kilometers, and the total gas transmission capacity was about 290 billion cubic meters per year, which formed the West-East Gas Transmission System, Shaanxi-Beijing System, Sichuan-East Gas Transmission System, and Southwest Pipeline. The system is a nationwide gas supply network that spans the east and west and runs through the north and south and connects to the overseas. However, due to the different ownership of the natural gas pipelines and the imperfect regional network, the pipelines are not completely interconnected, and it is difficult to play the role of peak regulation and supply at critical moments.

In addition, at present, most LNG receiving terminal in China supply gas nearby, only a few connected to the large pipe network system, the coastal transmission line has not yet formed. If two intersecting or parallel pipelines can be connected, and one of the pipelines is stopped by the upstream accident, the upstream of the other pipeline can be urgently increased, thereby ensuring the basic gas demand of the downstream users of the accident pipeline and enhancing the pipeline emergency support capability. After the completion of the project, it will improve the peaking capacity of the Beijing-Tianjin-Hebei region, ensure the safety of gas consumption in Beijing, play a positive role in maintaining the stability of the natural gas market, and contribute to the sustainable development of the national economy.

The indirect economic benefits of the project mainly include the use of natural gas, natural gas power generation, savings in coal-fired power plant investment, coal freight savings, ease of railway and road transport pressure, and improvement of the environment to improve the quality of life of residents. The project's internal rate of return is 8.88%, which is greater than 8% of the social discount rate. The economic net present value is 75.19 million yuan (i=8%), which is greater than zero. The investment recovery period is 15.43 years (including the construction period) and has a good internal rate of return.

13.2 Environmental benefit analysis

13.2.1 Positive environmental benefits of project construction

13.2.1.1 Conducive to environmental governance

Natural gas is currently the cleanest fuel. The problem of other fuel oil and coal burning relative to gas is that SO2 and soot pollution are more obvious. The replacement of coal in this project is conducive to the improvement of local ambient air quality.

13.2.1.2 Estimation of Pollutant Reduction for Natural Gas Alternative to Other Fuels

LNG is clean energy, and SO2, NOx and CO2 emissions from LNG gas combustion are 19.2% and 42.1%, respectively, of coal and fuel emissions. The use of LNG to optimize the energy structure has greatly alleviated the pressure brought by air pollution, and it is of great significance to improve the ecological environment and achieve sustainable development. The design capacity of the LNG Receiving terminal is 5 million tons/year, equivalent to 6.937 billion square meters of natural gas, which can replace the standard coal of 8.4994 million tons, reduce the sulfur dioxide emissions by 27,225.4102 tons/year, reduce the emission of soot by 67,699.86 tons/year, and reduce the carbon dioxide emissions by 7,504,300 tons./Year, can reduce nitrogen oxides by 78,841.03 tons / year.

1． Basic data

(1) The heat loss value of the Receiving terminal G1: 34.01 MJ/m3

(2) Receiver station rich gas heat value G2: 37.81MJ/m3

(3) Standard coal calorific value G3: 7000.00Kcal/kg (29307.6kJ/kg)

(4) Ordinary coal calorific value G4: 5000.00Kcal/kg (20934kJ/kg)

(5) The density of natural gas is: $\rho1$=0.6692kg/m3 to $\rho2$=0.7724kg/m3

2. Calculation of natural gas volume conversion V at the Receiving terminal and conversion of standard coal quantity M

(1) The natural gas calorific value of the Receiving terminal G= (G1+G2)/2=35.91MJ/m3

(2) Average value of natural gas density ρ= ($\rho1$+$\rho2$)/2= (0.6692+0.7724)/2=0.7208kg/m3

(3) LNG Receiving terminal design capacity 5 million tons / year

Natural gas volume V=500*10000*1000/ρ=6936736958.93m^3=6.937 billion m^3

Natural gas calorific value Q=G×V=249098224195.34MJ

Standard coal M1=Q/G3/10000= 8.4994 million tons

Equivalent to ordinary coal M1=Q/G4/10000=11.8992 million tons

3. Calculation of emission reduction (since the chain furnace is the most widely used, the following values are based on the chain furnace)

(1) Calculation of emission reduction of sulphur dioxide

The mass of sulphur dioxide produced by ordinary coal combustion is calculated by the following formula :

$$M_{SO_2} = B \bullet C\left(1 - \frac{\eta_{SO_2}}{100}\right)\frac{S_{ar}}{100}\frac{64}{32}$$

in which ***B*** coal consumption (ton / year) value 11,899,217.74; C sulfur coal produced in the chain furnace after the generation of SO_2 quota value of 0.8; ηso2 desulfurization efficiency boiler room is 89; Sar fuel base sulfur content value of 1.30 . Thus, the quality of sulfur dioxide produced by ordinary coal combustion is M_{SO2} = 27,225.4102 tons / year.

M_{SO2}	Boiler SO2 Emissions (T/A)
B	Consumption of coal (10000 t/a)
C	SO2 fraction from combustion of sulfur-containing coal
	Chain furnace: 0.8
	Power Plant Pulverizer: 0.9
MSO2	Desulfurization efficiency :
	Boiler House: 89%
S_{ar}	Fuel received base sulfur content (%) 0.6-1.5

LNG is a clean energy source with very low sulfur content and can be neglected. Therefore, the emission reduction of sulfur dioxide is 27,225.4102 tons/year.

(2) Calculation of smoke and dust emission reduction

The mass of smoke dust produced by ordinary coal combustion is calculated by the following formula :

$$M_{Ai} = B \cdot \left(\frac{A_{ar}}{100} + \frac{q_4}{100} \bullet \frac{Q_{ar.net}}{4.187 \times 8100} \right) a_{fh} \cdot \eta$$

in which *B* consumption of coal (ton/year) value 11899217.74 ; A_{ar} fuel received base ash content value 16.3 ; η of Boiler room value 12 ; The low calorific value (KJ/kg) of Q_{arnet} fuel is 20931 KJ/Kg; The fly ash share of A_{fh} boiler is 0.2 ; q_4 mechanical incomplete combustion heat loss chain furnace value 12. The resulting sulfur dioxide mass produced by ordinary coal combustion is M_{ai} = 67,699.86 tons/year.

Mai	Boiler TSP Emissions (T/A)
q4	Mechanical incomplete combustion heat loss
	Chain furnace: 12%
	Power Plant Pulverizer: 5%
Black sheep	Discharge ratio after dedusting device
	Thermal Power Plant: 0. 5%
	Peak-shaving boiler house: 12% before and 1% after reconstruction
	Dispersed Boiler House: 12% Present Situation, 1% New
A_{ar}	Fuel received base ash content 16.3 (%)
Q_{arnet}	Low calorific value of fuel (kJ/kg) 20931
A_{fh}	Fly ash fraction from boiler exhaust
	Chain furnace: 0.2 pulverized coal furnace: 0.9
b	Consumption of coal (T/A)

LNG is a clean energy source, combustion does not produce soot, so the emission reduction is 67699.86 tons per year.

(3) Calculation of carbon dioxide emission reductions

①The quality of carbon dioxide produced by coal-fired boilers is calculated by the following formula :

$$M_{co2}=B*44/12*a*b*c/1000000$$

in which B consumption of coal (10,000 tons/year) value 1189.9218 ; A CO2 emissions per unit heat of coal burning (tC/TJ) 27.49 ; b is Coal calorific value (kJ/kg) 20931; c is Carbon oxidation rate with a value 0.85 . The resulting carbon dioxide mass from ordinary coal combustion is M_{CO2} = 21,339,000 tons/year.

MCO 2	Boiler CO2 Emissions (10000 T/A)
B	Average coal consumption (10000 t/a)
a	CO2 emissions per unit heat of coal burning: 27.49 TC/TJ
b	Calorific value of ordinary coal: 20931 kJ/kg
c	Carbon Oxidation Rate: 0.85

②The quality of carbon dioxide produced by gas boilers is calculated by the following formula :

$$Mco2=B*44/12*a*b*c/10000000$$

in which ***B*** is the consumption (10,000 Nm^3/year) value 693673.70 ; ***a*** is the calorific value of natural gas (GJ/10000 Nm3) is 359.10 ; ***b*** is the carbon content (T/GJ) is 15.3; ***c*** is the Carbon oxidation rate is 0.99 . The resulting combustion of natural gas produces a carbon dioxide mass of M_{CO2} = 13,834,666.27 tonnes/year.

MCO 2	Boiler CO_2 Emissions (10000 T/A)
B	Annual gas consumption (10000 Nm3)
a	Calorific value of natural gas (GJ/10000 Nm3) 359.10
b	Carbon content (T/TJ) 15.3
c	Carbon Oxidation Rate: 0.99

Therefore, the carbon dioxide emission reduction after the use of LNG is 7.5043 million tons/year.

(4) Calculation of NOx emission reduction

①The mass of nitrogen oxides produced by coal-fired boilers is calculated by the following formula :

$$Nox=1.63*B*(N*\beta+0.000938)$$

in which **B** consumption of coal (ton/year) value 11899217.74 ; The value of beta conversion rate was 0.25 ; N The nitrogen content in fuel is 0.015 . The mass of nitrogen oxides produced by ordinary coal combustion is N_{OX} = 90,927.16 t/year.

NOX	Nitrogen oxide content
B	Consumption of coal (T/A)
β	Conversion rate (%) ; Related to fuel nitrogen content N. Under normal combustion conditions, the coal layer combustion furnace is 25- 50% , the fuel boiler is 32- 40% , and the coal powder furnace is 20- 25%
N	Nitrogen content in fuel (%), coal average 1. 5%

②The mass of nitrogen oxides produced by gas boilers is calculated by the following formula :

$$Nox=B*N*12/10^5$$

in which ***B*** consumption (10,000 nm 3/year) value 693673.70 ; N The nitrogen content in fuel is 150 . The resulting nitrogen oxide mass from natural gas combustion is N_{OX} = 12486.13 t/year.

Therefore, the NOX emission reduction after using LNG is 78,441.03 tons/year.

13.2.1.3 Resulting environmental benefits

Replacing coal and fuel with natural gas can reduce SO2 emissions with the following environmental benefits :

1) Savings in SO2 processing costs

According to statistics, the cost of SO2 treatment is 1.0 yuan/kg, after the completion of the project can directly save SO2 governance costs 592,680,000 RMB per year.

2) Reduction of diseases caused by environmental air pollution

According to the environment statistics at home and abroad, chronic tracheitis, asthma and lung cancer are the main diseases caused by environmental air pollution. The incidence rate of chronic tracheitis is 9.4 ‰ in polluted area (considered according to SO2 above the national secondary standard) and 11 ‰ in clean area.

3) Reduction of environmental pollution due to transport

Pipeline transportation is a safe, stable and efficient mode of transportation. Because natural gas is transported in closed pipeline, there will be no pollution to the environment during transportation. However, the use of coal or oil requires transportation by car and ship, which will produce a certain amount of air pollutants, such as automobile exhaust and secondary dust. Therefore, the use of natural gas can avoid the environmental pollution caused by transportation, protect the ecological environment and have better environmental benefits.

13.2.2 Environmental protection investment

The environmental protection investment of the terminal and Receiving terminal of the project is 55.58717 million RMB.

Table 13.2-1 Estimated Environmental Investment for Terminals and Terminals

Sequence number	Project Name	Scale	Investment (10,000 yuan)
Construction period			
I	Waste gas pollution prevention and control		
1	Sprinkler (Rent) and Operation	2	2
2	Bag-type dust collector on top of cement bin	Four, 15 m each	5
3	Construction site surrounding block, construction of temporary warehouse, etc.		10
4	Prevention and control of fugitive dust in building wastes		2
II	Waste water pollution prevention and control		
1	Mobile toilet	1	5
2	Construction production wastewater sedimentation tank	200 M^3	5
3	Oil-containing wastewater separator	1 set	0.5
4	Tank Car (Rent) and Operating Expenses		0.5
III	Noise pollution prevention		
1	Noise impact protection cost		5
IV	Solid waste treatment		
1	General Solid Waste Treatment Costs		30
2	Ship solid waste treatment cost		5
3	Hazardous waste disposal costs		5
V	Marine ecological protection		
1	Compensation for ecological loss		207.4169
VI	Environmental supervision during construction period		
1	Environmental supervision during construction period		45
VII	Environmental monitoring during construction period		
1	Environmental monitoring during construction period		30
Subtotal			357.4169
Operating period			
I	Waste gas pollution prevention and control		
1	BOG recovery system	1 set	2500

2	Low nitrogen burner	1 set	45
3	Flare system	1 set	300
4	Safety drain system	1 set	150
5	Cooking fume purifying device	1 set	2
6	Dining hall chimney	One, 15 m each	2
II	Waste water pollution prevention and control		
1	Integrated sewage treatment station and wastewater collection system		600
2	Initial rainwater collection system		300
3	Sprinkler truck	2	20
III	Noise pollution prevention		
1	Sound insulation room and cover		20
2	Equipment inlet and outlet muffler		10
3	Sound-absorbing material		20
IV	Solid waste treatment		
1	General Solid Waste Treatment Costs		5
2	Ship solid waste treatment cost		5
3	Hazardous waste disposal costs		5
4	Hazardous Waste Storage Room	50 m2	50
5	Mobile gridding cleaning machine	1	1.5
6	Rotary filter screen	One set	0.5
V	Ecological protection		
1	Green area	52000 M^2	50
VI	Operation period environmental monitoring		
1	Acquisition of monitoring equipment		30
2	Operation period environmental monitoring		20
VII	Environmental risk prevention		
1	Alarm and automatic control system		50
2	Liquid collecting tank and diversion ditch		100
3	Gasification plant area cofferdam		5
4	Accident pool and collection system		600
5	Marine oil spill emergency equipment		300.3
6	Exercise		10
Subtotal			5201.3
Total			5558.717

14 Environmental Management and Monitoring Program

14.1 Environmental Management Program

14.1.1 Environmental management system

In accordance with the spirit of the Environmental Protection Law of the People's Republic of China, the Marine Environment Protection Law of the People's Republic of China and the Law on Enterprises, it is one of the important duties of enterprises and institutions to prevent pollution and protect the ecological environment in production and operation. Environmental management is an important measure to control pollution and protect the environment . In accordance with the requirements of the Regulations on Environmental Management of Construction Projects and other regulations, environmental management organizations shall be established and environmental management plans formulated. According to the characteristics of this project, the relevant environmental supervision plans and suggestions are put forward . The construction unit and the construction unit shall attach great importance to the environmental protection work, and special institutions shall be set up to carry out the environmental management work.

A good environmental management and monitoring system is conducive to the project to comply with environmental laws and regulations, prevent pollution, protect the environment, and achieve the coordination and unification of social, economic and environmental benefits. Under the leadership of the administrative department of environmental protection, the main contents of the environmental management of the project are :

(1) The project construction unit shall establish an internal environmental management body, which shall be composed of the head of the unit and the environmental protection professionals. Responsible for the environmental management of each construction process, protect the normal operation of environmental protection facilities, ensure the implementation of environmental protection measures.

(2) The project construction unit shall set up an environmental protection department to supervise, manage and guide the whole construction process of the construction unit in coordination with the said environmental protection authority. According to the environmental requirements of this project, determine the relevant laws and regulations that the construction party should comply with, identify the main environmental factors, take the environmental management of the terminal as an indispensable part of the environmental management of the whole plant, according to the operating characteristics of the terminal, formulate the applicable environmental management system, clarify the organization and respective responsibilities of environmental management, and make the environmental management system work.

14.1.1.1 Mechanism settings

In accordance with the requirements of the environmental management system, an environmental management body shall be established under the supervision and administration of the top leader of the enterprise, the local environmental protection department and the maritime institution, responsible for all environmental protection work of the enterprise, so as to combine environmental management with the production, administration and quality management of the enterprise.

(1) Environmental management department

The administrative department of environmental protection is responsible for the environmental management, environmental monitoring, pollution prevention and control of the project. The local maritime administrative department shall be responsible for the monitoring of water areas, the supervision and management of the waters polluted by ships and their related operations, and the handling of major pollution accidents in the waters.

The environmental management department of enterprises and construction units shall be responsible for the implementation of environmental protection measures and the allocation of environmental protection facilities, and shall cooperate with the environmental law enforcement and supervision and administration of environmental and maritime institutions.

(2) Management organization of construction unit

The construction unit shall establish an internal environmental management organization, which shall be composed of the main responsible persons and professional and technical personnel of the construction unit, specially assigned to be responsible for the environmental protection work, implement the post responsibility system, be responsible for the environmental management of each construction process, ensure the normal operation of the environmental protection facilities and the implementation of environmental protection measures during construction period. The management contents of the construction unit are as follows :

1) To formulate, supervise and implement relevant regulations and regulations for environmental protection management, to implement environmental protection control measures, to manage pollution control facilities and to make detailed records for inspection ;

2) To report the pollution factors, problems, pollution control measures and implementation status related to the construction of the project to the environmental protection authority or the unit leader in a timely manner, and put forward suggestions for improvement ;

3) Prepare detailed plans for the implementation of environmental protection measures during construction period in accordance with the environmental protection measures proposed in this report, clarify the location of construction sites, environmental impacts, environmental protection measures, implementing responsible institutions (persons), etc.

(3) Enterprise management

In order to effectively protect the environmental quality of the area where the proposed site is located, the project construction unit shall also set up a special team to supervise the implementation of the environmental protection measures by the construction unit, and, before selecting the construction unit, shall include the main environmental protection measures in the bidding documents, shall take the ability of each construction unit to implement the major environmental protection measures as a consideration factor in the winning bid of the project construction unit, and shall include the necessary environmental protection measures in the contract signed with the winning bid unit, invite qualified construction supervision organization to follow up the implementation of environmental protection measures in construction units, and cooperate with the competent environmental protection department to supervise, manage and guide the project construction.

The responsibilities of the environmental management organization of the project construction unit are as follows :

1) To publicize and implement relevant national environmental regulations, regulations and standards, and to supervise the implementation of relevant departments ;
2) Be responsible for the environmental management of the project, and supervise the implementation and implementation of all environmental protection measures ;
3) At the construction site, the project environmental supervision personnel shall follow up the management on the construction site and supervise the installation and implementation of environmental protection facilities ;
4) The project environmental supervision shall be incorporated into the project supervision and shall be subject to the guidance and supervision of the environmental protection department in order to better perform its duties ;
5) To complete various environmental management statements as specified and required by the environmental protection department :
6) To coordinate and deal with all kinds of complaints arising from environmental problems arising from this project and to reach corresponding understanding measures ;
7) The environmental monitoring work and the implementation of the monitoring plan shall be carried out by the environmental protection organization of the construction unit, and qualified environmental monitoring stations may be commissioned to assist in the absence of conditions.

In order to manage the project effectively, corresponding production management agencies, administrative agencies and auxiliary production agencies need to be set up. In view of the characteristics of the actual construction of the project, it is suggested that the construction unit set up a safety and environmental protection team during the construction period, establish and implement the HSE management system, be responsible for the environmental supervision and management during the construction period and the daily environmental management during the operation period.

14.1.1.2 Construction of HSE Management System

HSE management system is a common management mode in international petrochemical enterprises, which has the characteristics of systematization, scientization and scale.

HSE of this project includes HSE management during construction and operation period, establishment of main HSE organizational structure, preparation of rules and regulations and operation rules, establishment of emergency measures, training of personnel, determination of responsibilities and accident prevention, etc.

(1) Establishment procedure

This project establishes an environment management system leading group, the team member is in charge of administration, safety and environmental protection and technical personnel, and appoints 1-2 part-time HSE site supervisors, by familiar with HSE technology, after specialized HSE management training and has certain management ability personnel. After the establishment of HSE management team, the company gives HSE management personnel rights and responsibilities, and provides necessary material conditions and support for HSE management activities. The construction procedure of HSE management system is as follows.

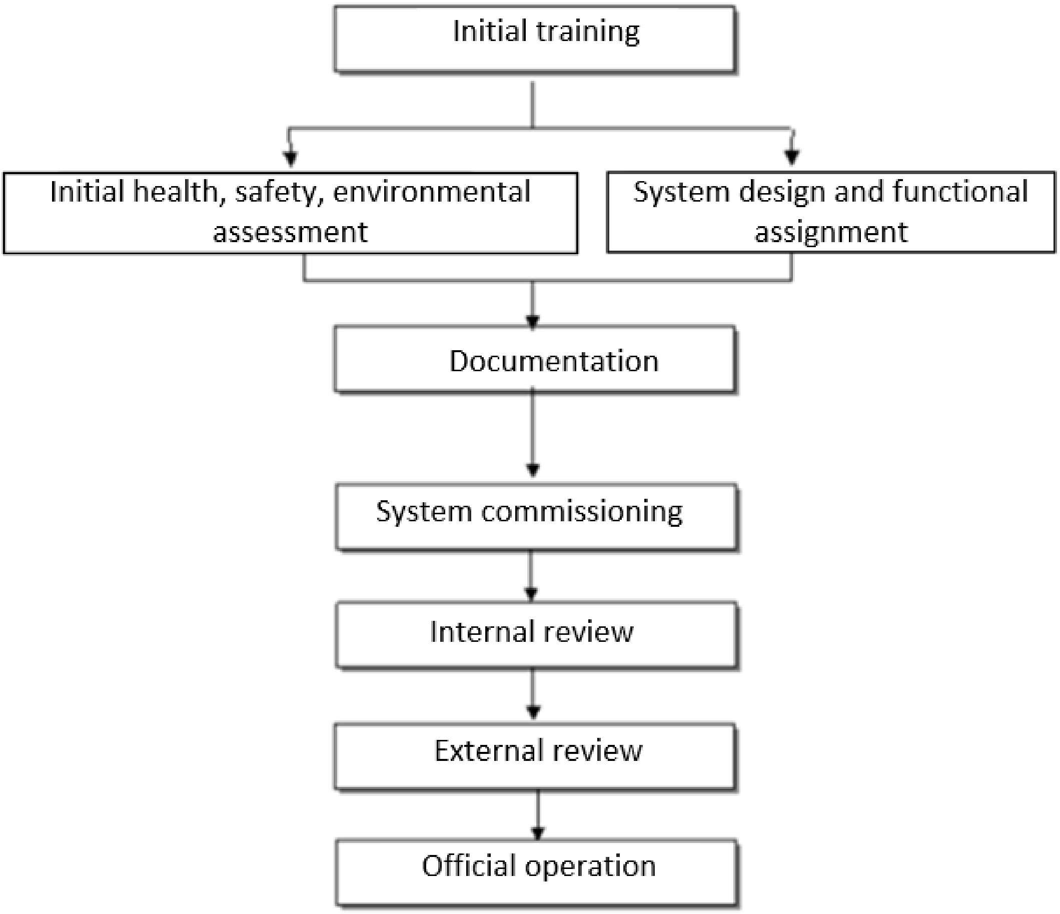


Figure 14.1-1 Establishment Procedure of HSE Management System

(2) Preparation of HSE Management Documents

When setting up HSE management system for this project, HSE management manual, procedure management documents, management operation documents and operation procedures shall be compiled. The HSE management team shall, within the framework of the management system, select the necessary rules and regulations and operating procedures for HSE management and safe operation of the project during the construction period and after the project is put into operation. Includes :

1) Safety operating procedures during construction period ;

2) Safety operation code for pressure test process of cleaning pipe ;

3) Safety operation rules for production process ;

4) Safety operation rules of equipment maintenance process ;

5) Safety operating procedure for normal operation ;

6) Safety operation procedure for abnormal operation process ;

7) Safety operating rules for emergency handling of faults and accidents ;

8) Safety operating rules for various special operations (lifting of pipes, passive soil, fire in dangerous areas, access to equipment sites) ;

9) Regulations for environmental management during construction and operation periods.

These systems and procedures are effective management documents for the construction and production process of the project, some of which are based on the characteristics of the construction period and operation period of the project. These documents should be issued to the post and in time

Prior to the formal induction of work through special training or special interpretation, so that employees understand ; The rules and regulations of different post systems for this project, such as operation posts of production equipment, measuring operation posts, automatic control operation posts, patrol lines and rush repair posts, shall be applied to these posts as soon as possible, and the personnel of the posts shall be trained to master the regulations and management system.

(3) Training and competency assessment of employees

In order to ensure the qualified personnel of the enterprise, a corresponding training assurance system should be set up, and the ability of the staff to complete the task of regular evaluation and evaluation.

The training work includes HSE training before and after the induction and regular HSE training after the induction . The training methods can be divided into theoretical training and on-site drill . The training contents include basic training, skills training and emergency training.

The ability of employees should be regularly assessed through formal procedures and documented. The company should set up evaluation procedures for different personnel, including qualifications, performance, theoretical and operational assessment, etc. Evaluate qualified personnel, issue the certificate of work, work on duty operation. Those not assessed are either removed from their posts or further training is arranged to meet their induction requirements. The review shall be conducted every two years.

14.1.1.3 HSE Management Contents of this Project

In the light of the process flow, pollution and risk source items, hazard and impact degree, and the results of safety evaluation and occupational health evaluation, the following aspects should be emphasized :

1) Process flow analysis ;

2) Analysis of ecological hazards and impacts of pollution ;

3) Analysis of the hazards and risks of leakage accidents ;

4) Schedule maintenance, overhaul and navigation management of LNG ships ;

5) Analysis of natural conditions such as weather, tidal current and storm surge ;

6) Establishment of preventive measures to prevent hazards ;

7) Development of environmental protection measures ;

8) Establishment of the operation manual for authorization and emergency plans ;

9) Risk area linkage plan.

14.1.2 Environmental Management Plan

In order to minimize the adverse effects of construction activities on the ecological environment along the line, reduce the occurrence of accidents during the operation period, ensure the safe operation of pipelines, establish a scientific and effective environmental management system, and implement various environmental protection and safety measures are particularly important. According to the requirements of HSE management system and clean production, the environmental management plan of this project is put forward in construction period and operation period according to the environmental characteristics of the area along the line. The contents, implementing departments and supervising agencies of environmental management and supervision at each stage are shown in the following table.

14.1.2.1 Environmental management plan during construction period

The environmental management plan for the construction period of the Receiving terminal, terminal and pipeline projects is shown in the following table.

Table 14.1-1 Environmental Management Plan for Construction Period

Sequence number	Environment management content	Management measures and objectives	Implementing agency
1	Water pollution	Construction vessels: control of oily water and domestic sewage of construction personnel. Construction site: runoff, rain and sewage pollution control.	Project construction contractor
2	Atmospheric pollution	Roads, sites: cleaning and watering. Stacking and storage: covering or watering. Transport of building materials trucks: covering, control of dust.	Project construction contractor
3	Noise	Vehicles passing through urban and major residential areas: control of night construction vehicles passing through. Vehicle machinery: maintenance and maintenance. Construction equipment: selection of low-noise equipment.	Project construction contractor
4	Solid waste	Marine garbage, land construction personnel domestic garbage: cleaning and transportation.	Project construction contractor

5	Ecological environment	Dredger and craft: the process of producing less suspended sediment to avoid spring and summer.	Project construction contractor
		Economic compensation for biological losses caused by construction or commissioning of value added schemes for discharge from fisheries management.	Construction unit
6	Other	To set up a complaint advisory department during the construction period and publish contact information to the outside world to deal with public complaints and disputes during the construction period.	Construction unit Project construction contractor

14.1.2.2 Operating period environmental management plan

(1) HSE Management Contents

In order to ensure the implementation of environmental protection measures and minimize the environmental impact of the project, the main contents of HSE management during the operation period of the project are :

1) Conduct regular environmental safety inspections and meetings ; Training leaders and staff, especially part-time environmental protection personnel, in environmental protection and safety ;
2) Develop a complete job responsibility system, clearly define the responsibilities of all types of personnel, environmental protection responsibilities and safety, accident prevention measures should be included in the job responsibility system ;
3) Develop contingency plans for possible accidents and conduct regular drills ; Equipped with all necessary maintenance, repair equipment and equipment to ensure timely in the event of an accident ;
4) The personnel in charge of environmental protection shall participate in the production scheduling and management work meetings, and make recommendations and technical measures to the competent leaders and production departments on environmental pollution problems in production operations.

The focus of environmental management is: environmental management should not only focus on the daily operation and maintenance of environmental protection facilities

In addition to the protection work, the work shall focus on the prevention and treatment of major accidents such as pipeline rupture, natural gas leakage fire and explosion, site accident discharge, oil spill from ships and so on. The major environmental pollution accidents are different from the general environmental pollution . There is no fixed discharge way and discharge way. To this end, it is necessary to formulate corresponding contingency plans.

(2) Environmental Management Plan of the Project

During the operation period, the environmental management of this process shall, in addition to strengthening the daily operation and maintenance of various environmental protection facilities in the Receiving terminal, terminal and pipeline area, focus on the prevention and treatment of accidents such as fire and explosion caused by natural gas leakage in the Receiving terminal, terminal and pipeline area, and oil spills from ships. Timely monitoring, sampling and analysis of leakage and fire accidents will provide basic data for accident treatment.

The operating period management plan for the Receiving terminal and terminal works is shown in the table below.

Table 14.1-2 Operation Period Management Plan for Terminal and Terminal Works

Sequence number	Environment management content	Management measures and objectives	Implementing agency
1	Water pollution	Plant sewage: installation of sewage collection facilities, plant wastewater collection after centralized discharge into the sewage treatment plant. Marine sewage: control the oily water at the bottom of the ship's cabin to be disposed of on shore. Domestic sewage collection facilities shall be set up and discharged into the sewage treatment plant together with the land sewage.	Construction unit
2	Atmospheric pollution	Receiving terminal handling: standard operation to reduce volatilization. Immersion gasifier: minimize the combustion of the gasifier. Flare: Keep the ignition ready. Equipment at all stations: enhance equipment maintenance to prevent leakage.	Construction unit
3	Noise	Each noise source: The equipment selection meets the requirements of relevant noise standards, and its use is normal.	Construction unit
4	Solid waste	Domestic and production wastes from ships, land areas: garbage bins or mobile garbage trucks at piers ; Centralized collection, unified transport to the city dump.	Construction unit
5	Accident emergency	The accident emergency response system is sound and personnel arrangements are in place. Emergency control equipment: sufficient quantity and in normal working condition. Communication and monitoring personnel are responsible for ensuring smooth communication. Abnormal discharge systems such as safety valves are normal, and warning devices are normal. Organize regular exercises.	Construction unit

14.1.3 Environmental supervision system during construction period

14.1.3.1 Work Content

According to the documents of the Ministry of Environmental Protection and the local environmental protection authorities, the main contents of the environmental supervision work are :

(1) Treatment Measures for Production Wastewater and Domestic Sewage Environmental Supervision on the Source of Production and Domestic Sewage , Monitor the discharge, water quality index, construction process and treatment effect of treatment facilities, and check and monitor whether the approved discharge standards have been met.

(2) Solid waste treatment measures Environmental supervision Solid waste treatment including production, domestic waste and production waste treatment, to ensure that the site of the project clean and tidy and the requirements of environmental pollution.

(3) Measures for prevention and control of air pollution The main sources of air pollution in the construction area are waste gas and dust generated during construction and production. The pollution source shall be discharged to the

standard, and the construction area and its affected area shall meet the specified environmental quality standards.

(4) Noise Control Measures The environmental supervision shall, in order to prevent the noise hazard, prevent and control the pollution source which produces strong noise or vibration according to the design requirements, and require the noise environmental quality of the construction area and its affected area to meet the corresponding standards. The focus is on units operating close to living camps and residential areas, and noise must be avoided.

(5) Measures to ensure the safety and reliability of drinking water, prevent infectious diseases, provide necessary welfare and sanitary conditions, etc.

(6) The environmental protection measures, environmental supervision and environmental monitoring measures proposed and not proposed in the environmental impact report shall be implemented and the necessary monitoring data shall be provided for the environmental supervision. The environmental protection measures proposed in other environmental impact reports should be implemented effectively, and the environmental protection measures not mentioned in the environmental impact reports should be supplemented and effectively implemented.

This project is a new project, according to the project implementation plan, the specific environmental supervision works are as follows :

(1) Risk analysis of pollution accidents during construction period and implementation of emergency measures ;

(2) Implementation of ecological environmental protection measures during construction period ;

(3) Implementation of environmental protection measures and countermeasures for construction units ;

(4) Implementation of environmental protection measures and countermeasures during the operation period ;

(5) Implementation of the Action Plan for Environmental management and Supervision ;

(6) Implementation of environmental monitoring plans ;

(7) The requirements for approval of the environmental assessment report by the environmental protection authorities such as the State Ministry of Environmental Protection and the implementation of the environmental protection requirements put forward by the environmental protection authorities at all levels for the project, etc.

14.1.3.2 Responsibilities and Key Points of Environmental Supervision

(1) To examine and approve the pollution prevention scheme and the special clauses of environmental protection in the construction contract before construction. In the course of construction, the focus of supervision over noise pollution sources is to

avoid excessive noise . The environmental supervision engineer shall inform the contractor to take necessary noise reduction measures or adjust the time of construction machinery operation to ensure that the living environment of the residents along the line is not affected.

(2) The key point of water environment quality supervision is to supervise and check whether the road is smooth, whether the drainage system is in good working condition, whether the construction site is stagnant water, whether the motor ship has domestic sewage treatment device or storage, whether the large construction ship is equipped with oil-water separator, the operation condition of the oil-water separator of the large ship, and the oil pollution water produced by the small ship and the hand-over of the collection ship and the sewage and the washing machine is discharged to the standard. To monitor the collection of domestic sewage of water construction personnel . If there is illegal construction, the environmental supervision engineer shall inform the contractor in time and take necessary measures to reduce the pollution effect on the water quality.

(3) The supervision of solid waste shall supervise and inspect whether domestic waste at construction sites is properly disposed of in accordance with the provisions, daily collection, classification storage and treatment of domestic waste on construction ships, and all kinds of sewage at construction sites are not directly discharged into water bodies, control the time of excavation ponds, underwater riprap stones and bank revetments, and supervise the discharge of suspended matter from dredged vessels and surrounding waste outlets.

(4) Check the implementation of ecological restoration and pollution control measures at the later stage of construction. Participate in environmental engineering acceptance activities, assist construction units to organize environmental protection training, responsible for the project environmental supervision work plan and summary.

14.2 Environmental monitoring program

14.2.1 Monitoring and evaluation of normal operating conditions

Under normal operating conditions, the monitoring plan for the construction and operation periods of the project is shown in Table 14.2-1.

Table 14.2-1 Contents of Environmental Monitoring (Investigation) During Normal Operation Period

Monitoring content	Monitoring project	Site layout	Monitoring frequency	Monitoring and implementing mechanism
Seawater quality	SS, petroleum, COD, inorganic nitrogen, etc.	Three to five sections will be set in the construction operation area, each section will be 5 to 6	During the construction period, large and small tidal periods are monitored during the periods of abundant water, flat water and dry water ; After the completion of construction to conduct a post-	Commissioning Monitoring Units with National Metrolo

		stations.	assessment monitoring ;	gy Certification Qualification
Marine sediment	Particle size, petroleum, heavy metals		Once at the beginning of the construction ; Annual monitoring during construction period ;	
Marine organism	Phytoplankton, zooplankton, benthos		During the construction period, the periods of abundant water, level water and dry water are each one	

Table 14.2-2 Contents of Environmental Monitoring (Investigation) during Operation Period under Normal Conditions

Monitoring content	Monitoring project	Site layout	Monitoring frequency	Monitoring and implementing mechanism
Seawater quality	Temperature, residual chlorine, COD, inorganic nitrogen, petroleum, etc.	The project area will be divided into 3-5 sections with 5-6 stations on each section.	Annual monitoring of large and small tidal periods is carried out in the periods of abundant water, flat water and dry water	Commissioning Monitoring Units with National Metrology Certification Qualification
Marine sediment	Particle size, petroleum, heavy metals		Monitored every two years	
Marine organism	Phytoplankton, zooplankton, benthos		Once a year, the flood season, the flush season and the dry season	

Table 14.2-3 Contents of Environmental Monitoring (Investigation) on Sedimentation

Monitoring content	Monitoring project	Site layout	Monitoring frequency
Topographic Monitoring of Water Depth in Pool and Channel	Depth of water	Placement of 6 sections in the pool and waterway	The monitoring of the background shall be carried out before construction and shall be carried out annually during the operation period

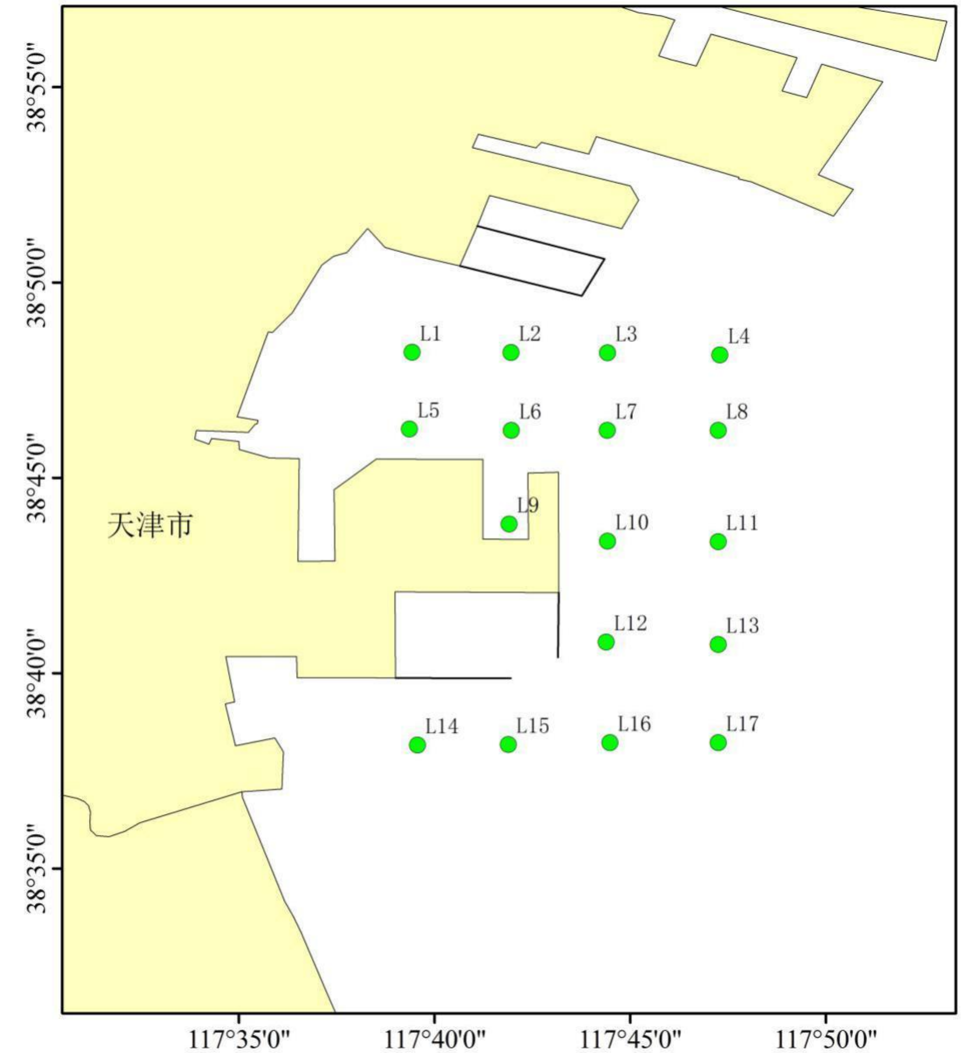


Figure 14.2-1 Scouring and Silting Section Monitoring Site Schematics

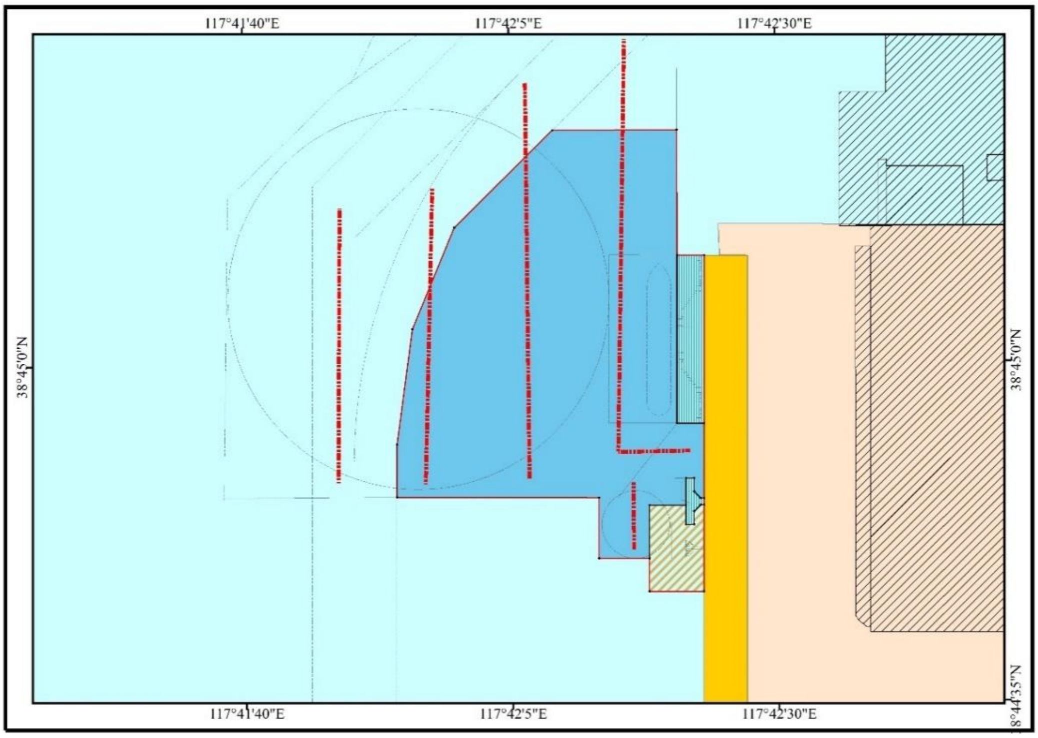


Figure 14.2-2 Schematic diagram of monitoring station for scouring and silting section

Table 14.2-4 Summary of Tracking Stations

Standing position	Longitude	Latitude	Monitoring project
L 1	117 ? 39 ' 25.673 " E	38°48 ' 12.701 " N	Hydrometeorological, water quality, sediment, biological
L 2	117 ? 41 ' 57.310 " E	38°48 ' 12.280 " N	Hydrometeorological, water quality, sediment, biological
L 3	117 ? 44 ' 25.080 " E	38°48 ' 12.050 " N	Hydrometeorology, Water Quality
L 4	117 ° 47 ' 17.640 " E	38°48 ' 8.900 " N	Hydrometeorological, water quality, sediment, biological
L 5	117 ? 39 ' 21.683 " E	38° 46 ' 14.713 " N	Hydrometeorology, water quality, sediment, biology, hydrodynamics
L 6	117 ? 41 ' 57.551 " E	38° 46 ' 13.000 " N	Hydrometeorological, water quality, sediment, biological
L 7	117 ? 44 ' 25.000 " E	38° 46 ' 13.000 " N	Hydrometeorology, water quality, sediment, biology, hydrodynamics
L 8	117 ° 47 ' 15.000 " E	38° 46 ' 13.000 " N	Hydrometeorology, Water Quality
L 9	117 ? 41 ' 54.438 " E	38° 43 ' 48.790 " N	Hydrometeorological, water quality, sediment, biological
L 10	117 ? 44 ' 25.080 " E	38° 43 ' 22.800 " N	Hydrometeorology, Water Quality
L 11	117 ° 47 ' 15.000 " E	38° 43 ' 22.000 " N	Hydrometeorological, water quality, sediment, biological
L 12	117 ? 44 ' 23.310 " E	38°40 ' 47.630 " N	Hydrometeorological, water quality, sediment, biological
L 13	117 ° 47 ' 15.000 " E	38°40 ' 44.000 " N	Hydrometeorology, Water Quality
L 14	117 ? 39 ' 33.955 " E	38° 38 ' 9.574 " N	Hydrometeorology, Water Quality

L 15	117 ? 41 ' 53.268 " E	38° 38 ' 10.088 " N	Hydrometeorological, water quality, sediment, biological
L 16	117 ? 44 ' 29.000 " E	38° 38 ' 13.000 " N	Hydrometeorology, Water Quality
L 17	117 ° 47 ' 15.000 " E	38° 38 ' 13.000 " N	Hydrometeorological, water quality, sediment, biological

14.2.2 Emergency monitoring and evaluation of abnormal working conditions

There are sudden accidents such as LNG leakage, fire and explosion, oil spill of ship, etc. In order to understand the scope and extent of the impact of leakage accidents at receiving terminal and terminals and to take effective measures to deal with them in a timely manner, this report proposes a monitoring plan for the period of accidents in abnormal working conditions . The monitoring programme is shown in Table 14.2-5.

Table 14.2-5 Contents of Environmental Monitoring (Investigation) for Abnormal Conditions

Type	Monitoring (investigation) site	Monitoring factor	Target
Fuel oil leakage	Accident area	Petroleum	Master accident location, oil leakage, diffusion range, oil film thickness, etc.
LNG Leak	Accident area	Water temperature	Grasp the effect of accident on water quality in sea area
	Wind direction up and down at the accident point	NO 2, SO 2, total hydrocarbon	Understanding the Impact of Accidents on Environmental Air Quality

15 Public participation and information disclosure

According to the 'Technical guidelines for environmental impact assessment General principle' (HJ2.1-2016) and the “Public Participation Measures for Environmental Impact Assessment” (Order of the Ministry of Environmental Protection [2018] No. 4) issued by the Ministry of Environmental Protection, Beijing gas Refco Group Ltd should publicize the relevant project information of the environmental impact and solicit public opinions.

The Receiving terminal of the project is located in Nangang Industrial Park, Tianjin. According to the access requirements in the “Implementation Plan for Structural Adjustment, Transformation Promotion and Efficiency Enhancement in Petrochemical Industry in Tianjin” (November 2017), ‘the new petrochemical project must within the Nangang Industrial Park’. The planning and environmental assessment have been carried out at the time of the establishment of the park.

The jetty project is located in the LNG operation area of Dagang Port Area of Tianjin Port. According to the “Adjustment of the planning in Tianjin Dagang Port Area LNG Operation Area”, the location of the basin has been determined in the planning stage.

Table 14.2-1 List of relevant government departments and public participation

Time	Location	Host	Participants	Theme	Comments
2018. 12.10	Tianjin	Tianjin Nangang Planning and Construction Bureau	Tianjin Nangang Industrial Park Development Co., Ltd., Sinopec Tianjin Natural Gas Pipeline Company, Sinopec Tianjin LNG Co., Ltd., Tianjin Nangang Public Utilities Bureau, Beijing gas Refco Group Ltd	Working with the relevant stakeholder s in the sea application	All relevant stakeholders expressed support for project construction
2018. 12.24	Tianjin	Tianjin Nangang Industrial Park Development Company	Beijing gas Refco Group Ltd	About the opinions of the usage of the sea	Agreed to the application for the usage of sea
2018. 12.24	Tianjin	Tianjin Nangang Public Utilities Bureau	Beijing gas Refco Group Ltd	About the application for the usage of the sea	Agreed to the construction of the project
2019. 1.3	Tianjin	Tianjin Nanhuan Railway Co., Ltd.	Beijing gas Refco Group Ltd	About the application for the usage of the sea	Support the construction of the project
2019. 1.16	Tianjin	Tianjin Economic and Technological Management Committee	Beijing gas Refco Group Ltd	About pre-project promotion meeting	Support construction, coordinate and implement relevant work as soon as possible

2019. 1.23	Tianjin	Tianjin Economic and Technological Management Committee	Beijing gas Refco Group Ltd	About pre-project promotion meeting	Support the construction of the project
2019. 2.18	Tianjin	Sinopec Tianjin Natural Gas Company Limited	Beijing gas Refco Group Ltd	About the application for the usage of the sea	Support the construction of the project
2019. 3.25	Tianjin	Ministry of Agriculture and Rural Fisheries and Fisheries Administration	Beijing gas Refco Group Ltd	Application Suggestions on the Impact of the Project on the National Aquatic Germplasm Resources Conservation Area of Laizhou Bay, Bohai Bay, Liaodong Bay	Agreed to the construction of the project
2019. 4.10	Tianjin	Sinopec Tianjin LNG Co., Ltd.	Beijing gas Refco Group Ltd	About the application for the usage of the sea	Agreed and Support the construction of the project
2019. 5.28	Tianjin	Tianjin Bohua Chemical Development Co., Ltd.	Beijing gas Refco Group Ltd	About the application for the usage of the sea	Agreed to the application for the usage of sea
2019. 6.11	Tianjin	Tianjin Nangang Industrial Park Management Committee	Beijing gas Refco Group Ltd	About the application for the usage of the sea	Agree to go through the sea procedures in Nangang Industrial Park as required
2019. 2.20	Tianjin	National Energy Board	National Development and Reform Commission, Ministry of Natural Resources, Tianjin Development and Reform Commission, Tianjin Planning and Nature	Coordination of sea, dredged material disposal, and send-out pipeline problems	Support construction, request to improve evaluation and report it as soon as possible

			Bureau, Beijing gas Refco Group Ltd		
2019. 5.8	Tianjin	Beidagang Wetland Protection Center	Project Department	Seek advice from the competent authorities	Support
2019. 5.22	Tianjin	Beijing gas Refco Group Ltd	Tianjin Maritime Safety Administration, Nangang Management Committee, Nangang Port Company, China Communications First Navigation Engineering Survey and Design Institute Co., Ltd., Tianjin Water Transport Engineering Research Institute and Ministry of Transport	Review Meeting of Ship Maneuver Simulation Simulation Report of Project Supporting Dock Engineering	The meeting agreed to pass the research conclusion of the "Project Control Dock Engineering Ship Maneuvering Simulation Research Report"
2019. 8.30	Tianjin	Tianjin Maritime Safety Administration	Beijing gas Refco Group Ltd / Project Department	Sea-related meeting	Support

15.1 The first information disclosure of environmental impact assessment

According to Article 9 of the 'Technical guidelines for environmental impact assessment General principle' (Order of the Ministry of Environmental Protection [2018] No. 4): " After the determination of the organization for environmental impact reporting , the construction company should publicize the information through its own website, the local public media website or the local government website (hereinafter collectively referred to as the network platform) within 7 working days and solicit opinions related to the environmental impact of the construction project.

At the same time, Article 31 of 'Public Participation Measures for Environmental Impact Assessment' (Order No. 4 of the Ministry of Environmental Protection [2018]) states:

"For construction projects approved by law within the industrial park, if the industrial park has carried out the public participation in the planning environmental impact assessment according to law, and the nature and scale of the construction project are in line with the planning environmental impact report reviewed and approved by the competent department of ecological environment. When the construction company carries out public participation in environmental impact assessment of construction projects, it can be simplified as follows:

(1) Exempting from the public procedures stipulated in Article 9 of these Measures, and the contents that should be disclosed can be disclosed in Article 10 of these Measures;

(2) The deadline of 10 working days can be reduced to 5 working days as stipulated in the second paragraph of Article 10 and the first paragraph of Article 11;

(3) Exempting from the way of posting announcements as stipulated in the third item, the first paragraph of Article 11.

According to the above-mentioned measures and the original “Public Participation Interim Measures for Environmental Impact Assessment”, the construction company publicized the project environmental assessment on the YiHuanPing website on June 18, 2019, with a public notice date of 10 working days.

15.1.1 Public content and date

On June 18, 2019, the construction company conducted the first environmental impact assessment publicity on the YiHuanPing website (http://www.yihuanping.cn/32529.html). The publicity contents are as follows:

15.1.2 Disclosure

On June 18, 2019, the first environmental impact assessment publicity was carried out on the YiHuanPing website (http://www.yihuanping.cn/32529.html). The public notice date was 10 working days, which met the relevant requirements.

15.1.3 Public comments

During the publicity period, neither the construction company nor the YiHuanPing website received feedback.

燃气环评

北京燃气天津南港LNG应急储备项目环境影响评价第一次公示

公示编号:	AEIA2019061832529	公示类型:	环评公示
建设单位:	北京市燃气集团有限责任公司	建设地点:	天津
公示时间:	2019 年 6 月 18 日	环评单位:	天科院环境科技发展（天津）有限公司

北京燃气天津南港LNG应急储备项目环境影响评价第一次公示

根据《中华人民共和国环境影响评价法》及《环境影响评价公众参与办法》（生态环境部令第4号）相关要求，将北京燃气天津南港LNG应急储备项目的环境影响情况进行公示，公众如有意见可联系环境影响评价单位、建设单位或环境主管部门。

1、项目概况

（1）项目名称：北京燃气天津南港LNG应急储备项目

（2）项目申请单位：北京市燃气集团有限责任公司

（3）项目建设性质：新建

（4）项目建设地点：天津南港工业区位于天津市滨海新区所属大港区独流减河入海口，地处天津市东南，东临渤海湾，东北与塘沽区相连，西与静海县接壤，北与津南区毗邻，南与河北省黄骅市交界，是天津市滨海新区的重要发展区域。

北京燃气天津南港LNG应急储备项目位于天津市南港工业区，接收站站址位于南港区东港池东侧，中石化LNG接收站南侧空地；场区西侧边界距西防浪堤319m，场区东侧边界距东防浪堤264m。码头位于南港工业区东港池东突堤东侧岸线的北端。

（5）建设内容及规模：

本工程建设接收站一座，建设规模500×104t/a，建设10座20×104m3LNG储罐及配套工艺设备，以及辅助公用工程设施，远期预留2座20×104m3LNG储罐用地；建设取、排水口各一个；建设可靠泊1～26.6万方LNG船的专用泊位1个，工作船泊位1个；建设外输管线229公里，其中海域段19.04公里。项目建成后，LNG 装车能力为170×104t/a，最大气化外输能力为6000×104Nm3/d。

本项目接收站部分建设投资为1380990万元，码头及栈桥为208708万元，外输管道为564373万元。施工工期约44个月（含施工准备期）。。

燃气环评

北京燃气天津南港LNG应急储备项目环境影响评价第一次公示

公示编号:	AEIA2019061832529	公示类型:	环评公示
建设单位:	北京市燃气集团有限责任公司	建设地点:	天津
公示时间:	2019 年 6 月 18 日	环评单位:	天科院环境科技发展（天津）有限公司

北京燃气天津南港LNG应急储备项目环境影响评价第一次公示

根据《中华人民共和国环境影响评价法》及《环境影响评价公众参与办法》（生态环境部令第4号）相关要求，将北京燃气天津南港LNG应急储备项目的环境影响情况进行公示，公众如有意见可联系环境影响评价单位、建设单位或环境主管部门。

1、项目概况

（1）项目名称：北京燃气天津南港LNG应急储备项目

（2）项目申请单位：北京市燃气集团有限责任公司

（3）项目建设性质：新建

（4）项目建设地点：天津南港工业区位于天津市滨海新区所属大港区独流减河入海口，地处天津市东南，东临渤海湾，东北与塘沽区相连，西与静海县接壤，北与津南区毗邻，南与河北省黄骅市交界，是天津市滨海新区的重要发展区域。

北京燃气天津南港LNG应急储备项目位于天津市南港工业区，接收站站址位于南港区东港池东侧，中石化LNG接收站南侧空地；场区西侧边界距西防浪堤319m，场区东侧边界距东防浪堤264m。码头位于南港工业区东港池东突堤东侧岸线的北端。

（5）建设内容及规模：

本工程建设接收站一座，建设规模500×104t/a，建设10座20×104m3LNG储罐及配套工艺设备，以及辅助公用工程设施，远期预留2座20×104m3LNG储罐用地；建设取、排水口各一个；建设可靠泊1～26.6万方LNG船的专用泊位1个，工作船泊位1个；建设外输管线229公里，其中海域段19.04公里。项目建成后，LNG 装车能力为170×104t/a，最大气化外输能力为6000×104Nm3/d。

本项目接收站部分建设投资为1380990万元，码头及栈桥为208708万元，外输管道为564373万元。施工工期约44个月（含施工准备期）。。

2、环境影响评价工作程序

本项目环境影响评价的工作程序为：天科院环境科技发展（天津）有限公司接受建设单位委托开展前期工作（含资料收集、现场勘察、建设单位进行公众参与调查）→编制报告（含委托监测单位进行环境质量本底调查、收集公众意见）→报送生态环境主管部门审查→专家评审→报告修改→生态环境主管部门出具审批意见。

3、环境影响评价主要工作内容

评价单位将按《中华人民共和国环境影响评价法》等有关国家、地方环保法规的要求，以环评导则为指导，结合本工程的特点，充分利用已有资料，补充必要的现状监测，结合工程设计和预测数据，预测评价本项目的建设期和营运期对项目所在区域大气环境、水环境、海洋生态环境等产生的影响以及对环境可能造成的风险影响，从方案合理、技术可行的角度提出环境保护措施、环境管理与环境监测计划。

4、本工程的主要环境影响

（1）施工期、营运期产生的污废水对附近水域环境的影响。

（2）施工期产生的噪声，粉尘对附近环境的影响。

（3）施工期疏浚悬浮物对水环境、生态环境的影响。

（4）工程占用海域对海洋生物造成的影响。

（5）营运期间作业产生的挥发性有机物对大气环境的影响。

（6）施工期、营运期风险事故的影响。

（7）施工期、营运期产生的固体废物对环境的影响。

5、项目公示期间公众意见受理的通讯方式：

为确保公示期间，公众可以顺畅地将对本项目的意见及时反馈，特公布相关部门意见受理的通讯方式。

建设单位：北京市燃气集团有限责任公司

联系人：孔先生 电话：13332272089

电子邮箱：lgkong06@163.com

6、征求公众意见主要事项

（1）征求公众意见的公众范围

本次征求公众意见的范围是建设项目附近可能受到影响的个人或团体。

（2）公众意见表的网络链接

公众意见表见附件

（3）公众提出意见的方式和途径

若您对项目有什么意见和建议，请于公示之日起10个工作日内，可以通过信函、传真、电子邮件等方式，将填写的公众意见表（见链接）提交建设单位。

（4）公众提出意见的起止时间

本次公示时间为公示之日起10个工作日。

附件

- 建设项目环境影响评价公众意见表

社会法人反馈意见 个人反馈意见 下载《环境影响评价公众参与意见表》

喜欢 (0)

推荐阅读

涪陵新城区北环大道道路工程 环境影响评价第二次公示 10小时前
河南平宝煤业有限公司首山一矿主斜井工程环境影响评价公众参与第一次信息公示 2019-06-17
山东恒联特种纸有限公司年产10万吨特种纸项目环境影响报告书报审前公示 2019-06-17
湖南振强黄金业有限责任公司年产2000kg黄金提纯项目环境影响评价信息公示 2019-06-17
新建铁路天水至陇南线 环境影响评价第一次公示 2019-06-17
攀枝花市危险废物处置中心可视化刚性填埋设施项目环境影响评价服务单位变更公示 2019-06-17

热点公示

莒县中邦新能源有限公司15万吨/年三聚氰胺联产40万吨/年食品级碳酸
2018-11-21 2,218
北京市大兴区旧宫镇工业园区规划环境影响评价公众参与第一次公示
2019-05-07 2,119
衡水市主城区水系生态修复工程环境影响评价公众参与第二次公示
2019-05-07 2,076
长城汽车股份有限公司天津哈弗分公司汽车前围项目环评信息公示
2019-05-16 1,992
北辰区新区污水处理厂工程环境影响评价公众参与第二次公告信息
2019-05-16 1,934

热门标签

高速公路环评 验收公示 验收 食品环评 食品 非金属环评 铁路环评 钢铁环评 金属加工 造纸环评 设备验收 能源环评 纺织公示 矿物油环评 石油环评

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15.2 Publicity of the draft for comments

15.2.1 Publicity content and time

In accordance with the Public Participation Interim Measures for Environmental Impact Assessment and the New Public Participation Measures for Environmental Impact Assessment issued by the Ministry of Ecology and Environment, the construction company carried out the second public announcement on July 22, July 28, July 29 and July 31, 2019, respectively. The publicity time is 10 working days.

15.2.2 Publicity method

According to Articles 10 and 11 of Public Participation Measures for Environmental Impact Assessment (Order No. 4 of the Ministry of Environmental Protection [2018]:

After the formation of the draft of the construction project environmental impact report, the construction company should disclose the following information and solicit opinions related to the environmental impact of the construction project:

(1) The online link of the full text of the environmental impact report and the way and means of accessing the paper report;

(2) The public scope for soliciting opinions;

(3) An online link to the form of public comment;

(4) Ways and means for the public to make comments;

(5) The starting and ending time of the public's comments. The time limit for the construction company to solicit public opinions shall not be less than 10 working days.

The construction company should, in accordance with the provisions of Article 10 of these Measures, disclose the information in the three following ways:

(1) Publicity through online platforms, and the duration of continuous disclosure shall not be less than 10 working days;

(2) It shall be public through accessible local newspapers, and the public information shall not be less than 2 times within 10 working days;

(3) It shall be disclosed by posting notices in places that are easily known to the local public and the duration of continuous disclosure shall not be less than 10 working days. ”

At the same time, according to Article 31 of the ‘Public Participation Measures for Environmental Impact Assessment’ (Order of the Ministry of Environmental Protection [2018] No. 4), the disclosure method of this consultation draft is conducted at the same time on the YiHuanPing website and the China Reform Newspaper.

15.2.2.1 Networking

(1）Compliance analysis of carrier selection

According to the relevant provisions of Articles 10 and 31 of the ‘Public Participation Measures for Environmental Impact Assessment’, Beijing gas Refco Group Ltd is in compliance with the information published on the YiHuanPing website.

(2）Networking publicity time

The networking publicity time is from July 28 to August 10, 2019, for a total of 10 working days.

(3）Publicity website and screenshot

On July 28, 2019, the second environmental impact assessment was publicized on the website of the Environmental assessment company (http://www.tkyhj.com/publicityinfo.aspx?newsID=79&CateId=31). On July 22, 2019, the second environmental impact announcement of the project was again conducted on the YiHuanPing website (http://www.yihuanping.cn/33686.html).

The screenshot of the networking publicity is as follows:


http://www.tkyhj.com/publicityinfo.aspx?newsID=79&CateId=31

环评公示 验收公示 其他公示

北京燃气天津南港LNG应急储备项目 环境影响评价（第二次公示）

发布者： 发布时间：[2019-07-22]

一、环境影响报告书征求意见稿全文网络链接及查阅纸质报告书的方式及途径

环境影响报告书征求意见稿全文网络链接：http://www.tkyhj.com/publicityinfo.aspx?newsID=79&CateId=31

查阅纸质报告书的方式及途径：北京市燃气集团有限责任公司天津液化天然气应急储备项目部（地址：天津市东丽区先锋路61号汇成科技大厦15层）

二、征求公众意见的公众范围

本次征求公众意见的范围是建设项目附近可能受到影响的个人或团体。

三、公众意见表的网络链接

公众意见表的网络链接见：http://www.tkyhj.com/publicityinfo.aspx?newsID=79&CateId=31

四、公众提出意见的方式和途径

若您对项目有什么意见和建议，请于公示之日起10个工作日内，可以通过信函、传真、电子邮件等方式，将填写的公众意见表（见链接）提交建设单位。

五、公众提出意见的起止时间

本次公示时间为公示之日起10个工作日。

六、联系方式

建设单位：北京市燃气集团有限责任公司
联系人：孔先生 电话：13332272089
电子邮箱：1gkong06@163.com
联系地址：天津市东丽区先锋路61号汇成科技大厦15层

公参公示稿-北京燃气天津南港LNG应急储备项目环评-码头及接收站分册.pdf
公参公示稿-北京燃气天津南港LNG应急储备项目环评-外输管道分册.pdf

返回

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首 页 项目公示 知识库 数据查询 环评资讯 专题

北京燃气天津南港LNG应急储备项目 环境影响评价第二次公示

公示编号:	AEIA2019080133686	公示类型:	环评公示
建设单位:	北京市燃气集团有限责任公司	建设地点:	天津
公示时间:	2019年7月28日	环评单位:	天科院环境科技发展（天津）有限公司

北京燃气天津南港LNG应急储备项目环境影响评价第二次公示

一、环境影响报告书征求意见稿全文网络链接及查阅纸质报告书的方式及途径

环境影响报告书征求意见稿全文网络链接：http://www.tkyhj.com/publicityinfo.aspx?newsID=79&CateId=31

查阅纸质报告书的方式及途径：北京市燃气集团有限责任公司天津液化天然气应急储备项目部（地址：天津市东丽区汇城科技大厦1407室）

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公众意见表的网络链接见：http://www.tkyhj.com/publicityinfo.aspx?newsID=79&CateId=31

四、公众提出意见的方式和途径

若您对项目有什么意见和建议，请于公示之日起10个工作日内，可以通过信函、传真、电子邮件等方式，将填写的公众意见表（见链接）提交建设单位。

五、公众提出意见的起止时间

本次公示时间为公示之日起10个工作日。

六、联系方式

建设单位：北京市燃气集团有限责任公司

联系人：孔先生 电话：13332272089

电子邮箱：lgkong06@163.com

联系地址：天津市东丽区汇城科技大厦1407室

邮政编码：300300

15.2.2.2 Newspapers

According to Article 11 of the‘Public Participation Measures for Environmental Impact Assessment’, Opened by publicly accessible newspapers in the location of the construction project, and the public information shall be no less than 2 times within 10 working days for soliciting opinions, it was published on July 29, 2019 and July 31, 2019 in the China Reform Newspaper and in line with relevant regulations.

Screenshot of Newspapers:

CHINA REFORM DAILY

2019.07.29 星期一

本版编辑：彭莎莎 Email：whzk619@163.com

倾

□ 唐勇 郑丽华
□ 本报记者 龙丹

奉献真情 专注扶贫

黑龙江

□ 董宝森

冰城夏都"两季繁荣"

北京燃气天津南港LNG应急储备项目
环境影响评价第二次公示

一、环境影响报告书征求意见稿全文网络链接及查阅纸质报告书的方式及途径

环境影响报告书征求意见稿全文网络链接：http://www.tkyhj.com/publicityinfo.aspx?newsID=79&CateId=31

查阅纸质报告书的方式及途径：北京市燃气集团有限责任公司天津液化天然气应急储备项目部（地址：天津市东丽区汇城科技大厦1407室）

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五、公众提出意见的起止时间

本次公示时间为公示之日起10个工作日。

六、联系方式

建设单位：北京市燃气集团有限责任公司

联系人：孔先生　　电话：13332272089

电子邮箱：lgkong06@163.com

联系地址：天津市东丽区汇城科技大厦1407室

邮政编码：300300

中国改革报

2019.07.31

星期三

科教

北京燃气天津南港LNG应急储备项目
环境影响评价第二次公示

一、环境影响报告书征求意见稿全文网络链接及查阅纸质报告书的方式及途径

环境影响报告书征求意见稿全文网络链接:http://www.tkyhj.com/publicityinfo.aspx?newsID=79&CateId=31

查阅纸质报告书的方式及途径:北京市燃气集团有限责任公司天津液化天然气应急储备项目部(地址:天津市东丽区汇城科技大厦1407室)

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四、公众提出意见的方式和途径

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建设单位:北京市燃气集团有限责任公司

联系人:孔先生　　电话:13332272089

电子邮箱:lgkong66@163.com

联系地址:天津市东丽区汇城科技大厦1407室

邮政编码:300300

15.2.3 1.2.3. Inquiry

During the publicity period of the consultation draft, the public can check the environmental impact report of the project through the online link in the publicity content: http://www.tkyhj.com/publicityinfo.aspx?newsID=79&CateId=31, and the public can call and email to the constraction company for a paper-based report. During the publicity period, no publicly requested paper copies by telephone and e-mail; 20 people visited and looked up the report through the website.

15.2.4 Public comments

During the publicity period of the consultation draft, no comments received.

15.3 Treatment of public comments

During the publicity of networking and newspapers, no feedbacks were received.

15.4 Publicity plan for this report

The construction unit plans to publicize this report and solicit public awareness of environmental and social issues to guide the development and implementation of follow-up projects. The planned publicity time is October 2019.

16 Due Diligence Investigation for Sea Use and Land Use of the Project

The project is composed by three parts, i.e. LNG Receiving terminal, jetty and send-out pipelines. The location of LNG Receiving terminal and jetty project is selected at the north section of eastern jetty of eastern port basin, Nangang Industrial Area, Binhai New District, Tianjin. The land area of eastern jetty of eastern port basin, Nangang Industrial Area was constructed through land reclamation from the sea by Tianjin Nangang Industrial Area Development Co .,Ltd, and the commencement time of land reclamation from the sea was March, 2011, completed in December 2012. Though the sea area where the LNG Receiving terminal is located has already become land through reclamation, the formality of sea area utilization has not been applied yet, therefore, the formality of sea utilization still needs to be re-applied. After this formality is completed, the land use approval formality needs to be applied for the land occupation of the Receiving terminal.

16.1 Sea use and land use condition of the project

The total area of sea use for the project is 129.6984 hectares, in which the area of land reclamation through sea is 75.3580 hectares, without occupying the natural coastline. See figure 16.1-1~10 for the scope of sea use of the project

Table 16.1-1 Project sea area list

<table>
<tr><th>Sea Lot serial number</th><th>Unit sequence number</th><th>Cell name</th><th>Sea use mode</th><th>Unit Area (ha)</th><th>Subtotal (ha)</th></tr>
<tr><td rowspan="8">A</td><td>1</td><td>Receiving terminal and supporting works</td><td rowspan="8">Construction of reclamation land</td><td>71.0387</td><td rowspan="8">75.3580</td></tr>
<tr><td rowspan="7">2</td><td>Send-out pipeline1</td><td>1.4596</td></tr>
<tr><td>Send-out pipeline2</td><td>1.0941</td></tr>
<tr><td>Send-out pipeline3</td><td>0.5199</td></tr>
<tr><td>Send-out pipeline4</td><td>0.0430</td></tr>
<tr><td>Send-out pipeline5</td><td>0.5375</td></tr>
<tr><td>Send-out pipeline6</td><td>0.4905</td></tr>
<tr><td>Valve 1 chamber</td><td>0.1747</td></tr>
<tr><td rowspan="2">B</td><td>3</td><td>LNG jetty</td><td rowspan="2">Permeable structure</td><td>2.3459</td><td rowspan="2">2.5968</td></tr>
<tr><td>4</td><td>Working vessel terminal</td><td>0.2509</td></tr>
<tr><td>C</td><td>5</td><td>LNG Ship and Working Vessel basin</td><td>Harbor basin</td><td>47.9130</td><td>47.9130</td></tr>
<tr><td rowspan="2">D</td><td>7</td><td>Water intake</td><td rowspan="2">Intake and outfall</td><td>2.3363</td><td rowspan="2">3.8306</td></tr>
<tr><td>8</td><td>Outfall</td><td>1.4943</td></tr>
<tr><td>Total</td><td colspan="2"></td><td></td><td>129.6984</td><td>129.6984</td></tr>
</table>

Beijing Gas-Tianjin Nangang LNG Emergency reserve project Sea Lot location map

Figure 16.1-1 Sea lot location map of the project

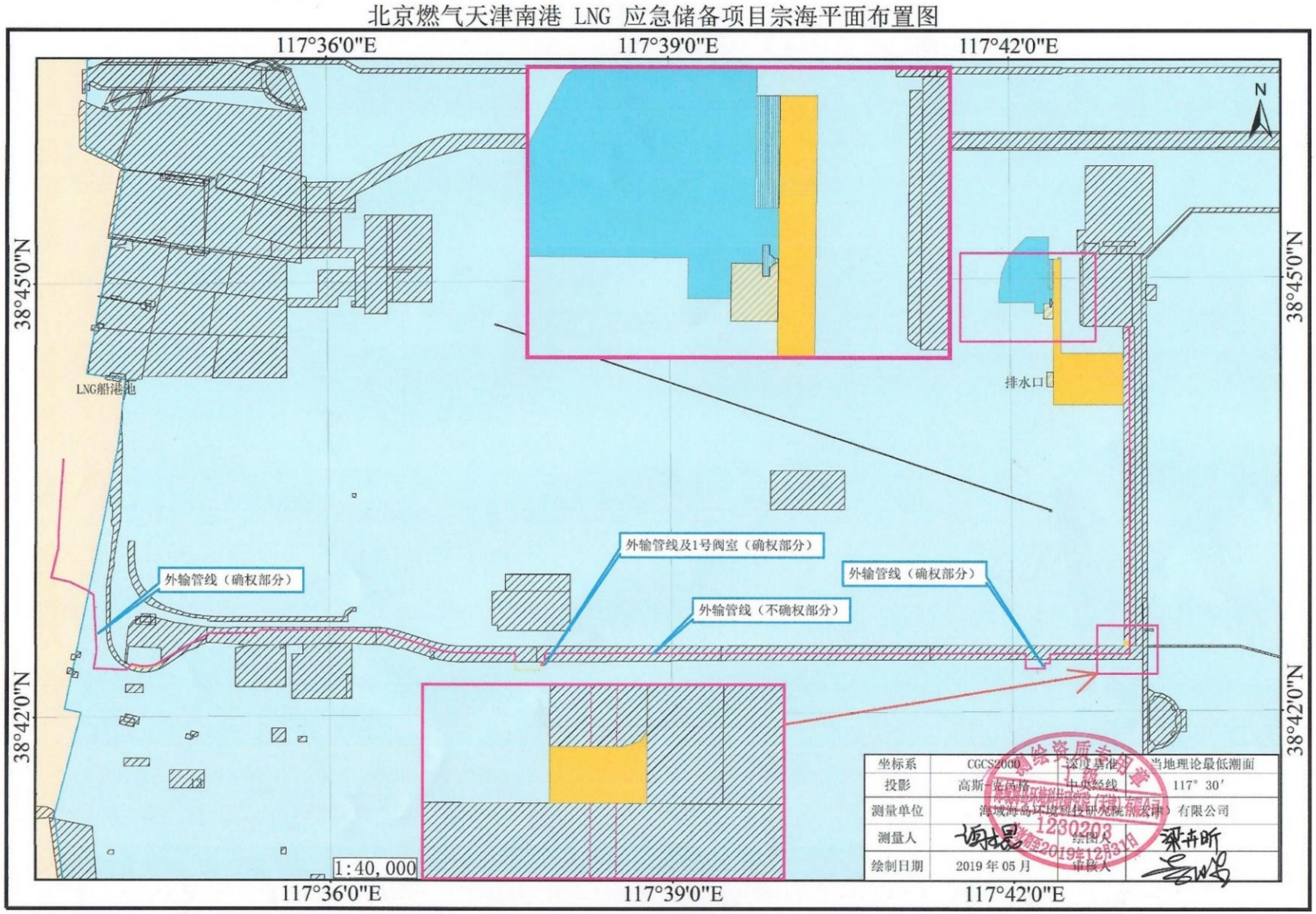
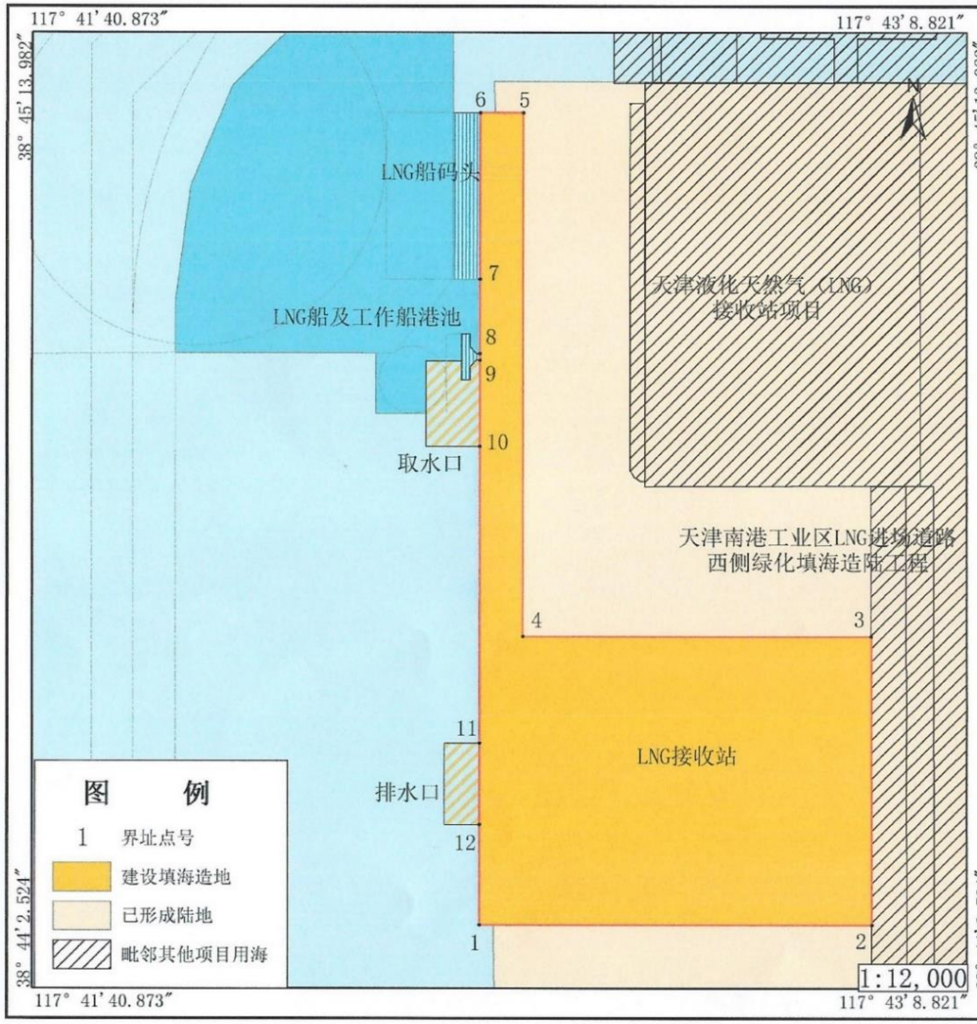


Figure 16.1-2 Layout plan of the project sea lot

北京燃气天津南港 LNG 应急储备项目（填海）宗海界址图

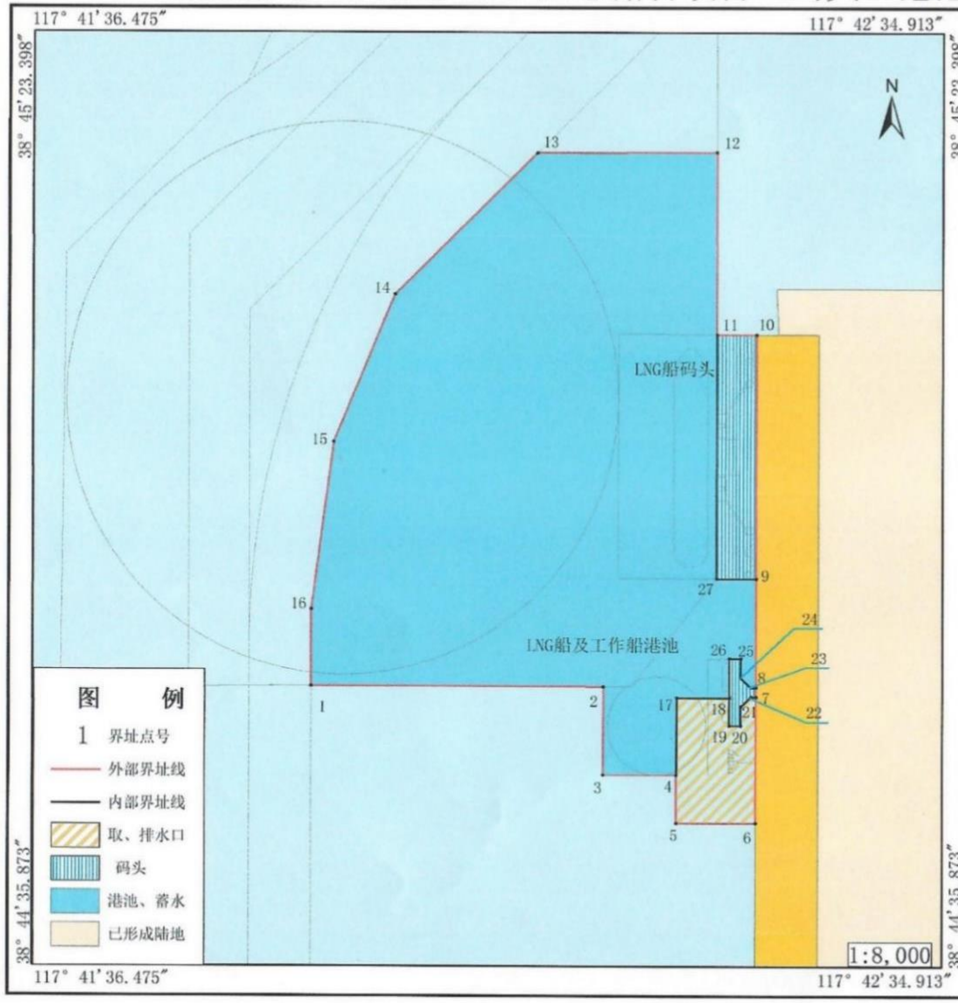


界址点编号及坐标（北纬丨东经）		
1	38° 44' 07.584"	117° 42' 22.549"
2	38° 44' 07.358"	117° 42' 59.679"
3	38° 44' 28.795"	117° 42' 59.835"
4	38° 44' 28.996"	117° 42' 26.836"
5	38° 45' 07.861"	117° 42' 27.219"
6	38° 45' 07.886"	117° 42' 23.144"
7	38° 44' 55.533"	117° 42' 23.021"
8	38° 44' 50.017"	117° 42' 22.967"
9	38° 44' 49.529"	117° 42' 22.962"
10	38° 44' 43.131"	117° 42' 22.899"
11	38° 44' 21.096"	117° 42' 22.682"
12	38° 44' 15.039"	117° 42' 22.622"

内部单元	用海方式	界址线	面积（公顷）
填海	建设填海造地	1-2-3-4-5-6-7-8-9-10-11-12-1	71.0387
宗海		1-2-3-4-5-6-7-8-9-10-11-12-1	71.0387
坐标系	CGCS2000	投 影	高斯-克吕格（117°30'）
高程基准	1985 国家高程基准	深度基准	当地理论最低潮面
测量单位	海域海岛环境科技研究院（天津）有限公司		
测量人		绘图人	
绘制日期	2019 年 05 月	审核人	

Figure 16.1-3 Sea lot boundary map of Beijing Gas-Tianjin Nangang Emergency reserve project (Land Reclamation)

北京燃气天津南港 LNG 应急储备项目（码头、港池、取水口）宗海界址图



界址点编号及坐标（北纬 | 东经）			
1	38° 44' 50.236"	117° 41' 54.124"	
2	38° 44' 50.095"	117° 42' 13.108"	
3	38° 44' 45.633"	117° 42' 13.065"	
4	38° 44' 45.605"	117° 42' 17.798"	
5	38° 44' 43.161"	117° 42' 17.768"	
6	38° 44' 43.131"	117° 42' 22.899"	
剩余界址点编号及坐标（北纬 | 东经）见附页			
内部单元	用海方式	界址线	面积（公顷）
LNG 船码头	透水构筑物	27-9-10-11-27	2.3459
工作船码头	透水构筑物	19-20-21-22-7-8-23-24-25-26-18-19	0.2509
LNG 船及工作船港池	港池、蓄水	1-2-3-4-17-18-26-25-24-23-8-9-27-11-…-15-16-1	47.9130
取水口	取、排水口	5-6-7-22-21-20-19-18-17-4-5	2.3363
宗海		1-2-3-4-5-6-7-8-9-…-15-16-1	52.8461
坐标系	CGCS2000	投 影	高斯-克吕格（117°30'）
高程基准	1985 国家高程基准	深度基准	当地理论最低潮面
测量单位	海域海岛环境科技研究院（天津）有限公司		
测量人		绘图人	
绘制日期	2019 年 05 月	审核人	

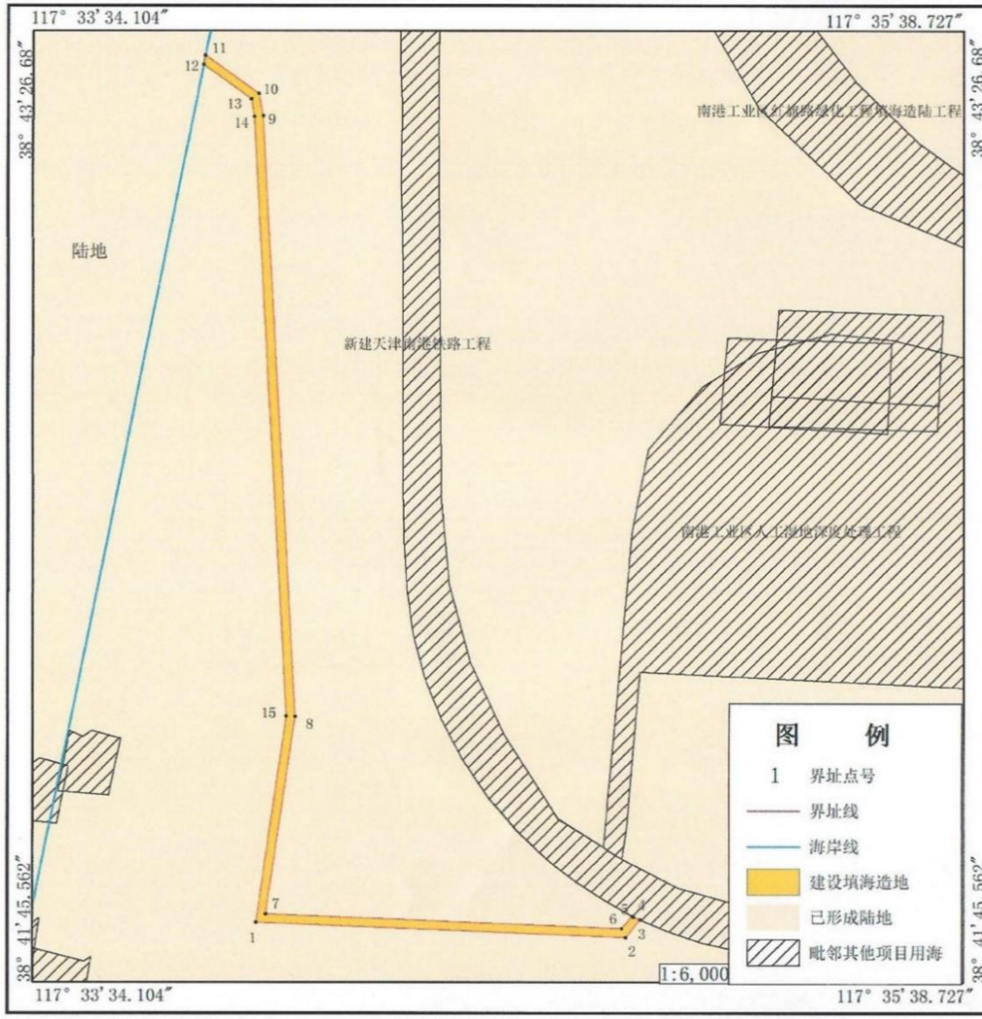
Figure 16.1-4 Sea lot boundary map of Beijing Gas-Tianjin Nangang Emergency reserve project (jetty, basin and intake and outfall)

附页　北京燃气天津南港 LNG 应急储备项目（码头、港池、取水口）宗海界址点（续）

界址点编号及坐标（北纬|东经）					
7	38° 44' 49.529"	117° 42' 22.962"	18	38° 44' 49.496"	117° 42' 21.243"
8	38° 44' 50.017"	117° 42' 22.967"	19	38° 44' 48.082"	117° 42' 21.229"
9	38° 44' 55.533"	117° 42' 23.021"	20	38° 44' 48.077"	117° 42' 21.994"
10	38° 45' 07.886"	117° 42' 23.144"	21	38° 44' 49.050"	117° 42' 22.003"
11	38° 45' 07.901"	117° 42' 20.593"	22	38° 44' 49.532"	117° 42' 22.643"
12	38° 45' 17.122"	117° 42' 20.638"	23	38° 44' 50.019"	117° 42' 22.634"
13	38° 45' 17.156"	117° 42' 8.965"	24	38° 44' 50.509"	117° 42' 22.018"
14	38° 45' 10.041"	117° 41' 59.698"	25	38° 44' 51.482"	117° 42' 22.027"
15	38° 45' 02.595"	117° 41' 55.674"	26	38° 44' 51.486"	117° 42' 21.263"
16	38° 44' 54.112"	117° 41' 54.162"	27	38° 44' 55.549"	117° 42' 20.472"
17	38° 44' 49.517"	117° 42' 17.846"			

测量单位	海域海岛环境科技研究院（天津）有限公司		
测量人		绘图人	
绘制日期	2019 年 05 月	审核人	

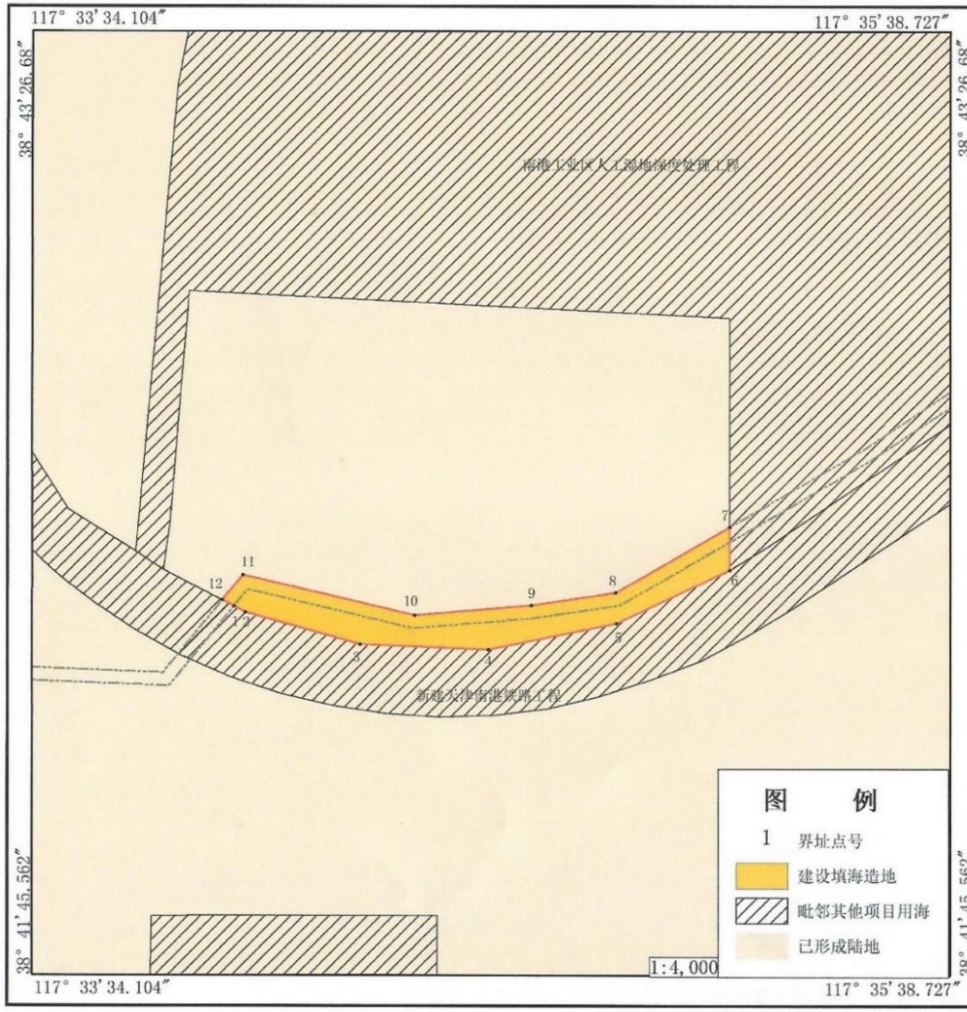
北京燃气天津南港 LNG 应急储备项目（外输管线一）宗海界址图



界址点编号及坐标（北纬丨东经）			
1	38° 42' 20.052"	117° 33' 55.861"	
2	38° 42' 19.402"	117° 34' 13.433"	
3	38° 42' 20.060"	117° 34' 14.132"	
4	38° 42' 20.169"	117° 34' 13.817"	
5	38° 42' 20.201"	117° 34' 13.746"	
6	38° 42' 19.733"	117° 34' 13.247"	
7	38° 42' 20.359"	117° 33' 56.340"	
8	38° 42' 27.726"	117° 33' 57.782"	
9	38° 42' 50.123"	117° 33' 56.437"	
10	38° 42' 50.943"	117° 33' 56.251"	
11	38° 42' 52.396"	117° 33' 53.733"	
12	38° 42' 52.047"	117° 33' 53.640"	
13	38° 42' 50.758"	117° 33' 55.872"	
14	38° 42' 50.095"	117° 33' 56.023"	
15	38° 42' 27.743"	117° 33' 57.367"	
内部单元	用海方式	界址线	面积（公顷）
外输管道用海(一)	建设填海造地	1-2-3-4-…-13-14-15-1	1.4596
宗海		1-2-3-4-…-13-14-15-1	1.4596
坐标系	CGCS2000	投 影	高斯-克吕格（117°30'）
高程基准	1985 国家高程基准	深度基准	当地理论最低潮面
测量单位	海域海岛环境科学研究院（天津）有限公司		
测量人		绘图人	
绘制日期	2019 年 05 月	审核人	

Figure 16.1-5 Sea lot boundary map of Beijing Gas-Tianjin Nangang Emergency reserve project (Send-out pipeline No.1)

北京燃气天津南港 LNG 应急储备项目（外输管线二）宗海界址图



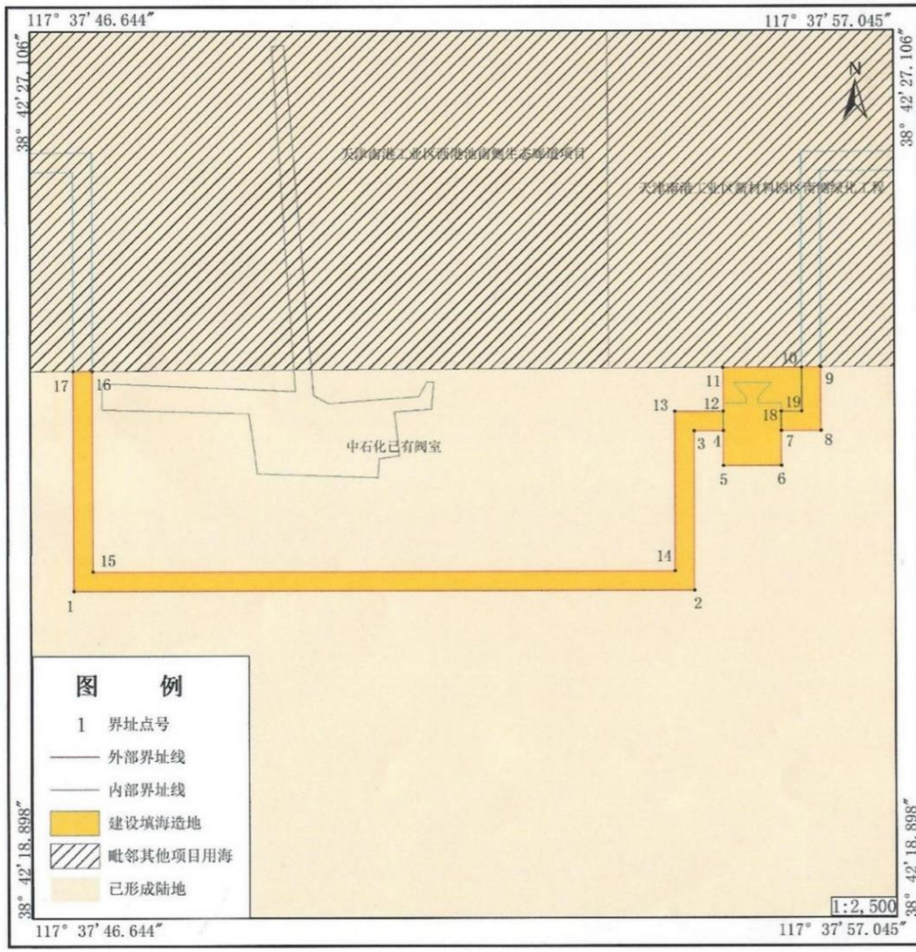
界址点编号及坐标（北纬丨东经）		
1	38° 42' 21.388"	117° 34' 15.545"
2	38° 42' 21.236"	117° 34' 15.917"
3	38° 42' 20.418"	117° 34' 19.589"
4	38° 42' 20.262"	117° 34' 23.716"
5	38° 42' 20.899"	117° 34' 27.840"
6	38° 42' 22.227"	117° 34' 31.486"
7	38° 42' 23.301"	117° 34' 31.491"
8	38° 42' 21.668"	117° 34' 27.826"
9	38° 42' 21.365"	117° 34' 25.114"
10	38° 42' 21.134"	117° 34' 21.350"
11	38° 42' 22.170"	117° 34' 15.837"
12	38° 42' 21.542"	117° 34' 15.170"

内部单元	用海方式	界址线	面积（公顷）
外输管道用海（二）	建设填海造地	1-2-3-4-5-6-7-8-9-10-11-12-1	1.0941
宗海		1-2-3-4-5-6-7-8-9-10-11-12-1	1.0941

坐标系	CGCS2000	投 影	高斯-克吕格（117°30'）
高程基准	1985 国家高程基准	深度基准	当地理论最低潮面
测量单位	海域海岛环境科技研究院（天津）有限公司		
测量人		绘图人	
绘制日期	2019 年 05 月	审核人	

Figure 16.1-6 Sea lot boundary map of Beijing Gas-Tianjin Nangang Emergency reserve project (Send-out pipeline No.2)

北京燃气天津南港 LNG 应急储备项目（外输管线三、四及1号阀室）宗海界址图



界址点编号及坐标（北纬 | 东经）		
1	38° 42′ 18.481″	117° 37′ 37.372″
2	38° 42′ 18.410″	117° 37′ 50.614″
3	38° 42′ 21.065″	117° 37′ 50.637″
4	38° 42′ 21.062″	117° 37′ 51.258″
5	38° 42′ 20.482″	117° 37′ 51.253″
6	38° 42′ 20.475″	117° 37′ 52.494″
7	38° 42′ 21.055″	117° 37′ 52.499″
剩余界址点编号及坐标（北纬|东经）见附页		

内部单元	用海方式	界址线	面积（公顷）
1 号阀室	建设填海造地	4-5-6-7-18-19-10-11-12-4	0.1747
外输管道（三）	建设填海造地	1-2-3-4-12-13-14-15-16-17-1	0.5199
外输管道（四）	建设填海造地	7-8-9-10-19-18-7	0.0430
宗海		1-2-3-4-…-13-14-15-16-17-1	0.7376
坐标系	CGCS2000	投 影	高斯-克吕格（117°30′）
高程基准	1985 国家高程基准	深度基准	当地理论最低潮面
测量单位	海域海岛环境科技研究院（天津）有限公司		
测量人	谢晨	绘图人	梁新昕
绘制日期	2019 年 05 月	审核人	

Figure 16.1-7 Sea lot boundary map of Beijing Gas-Tianjin Nangang Emergency reserve project (Send-out pipeline No.3&4 and Valve 1 chamber)

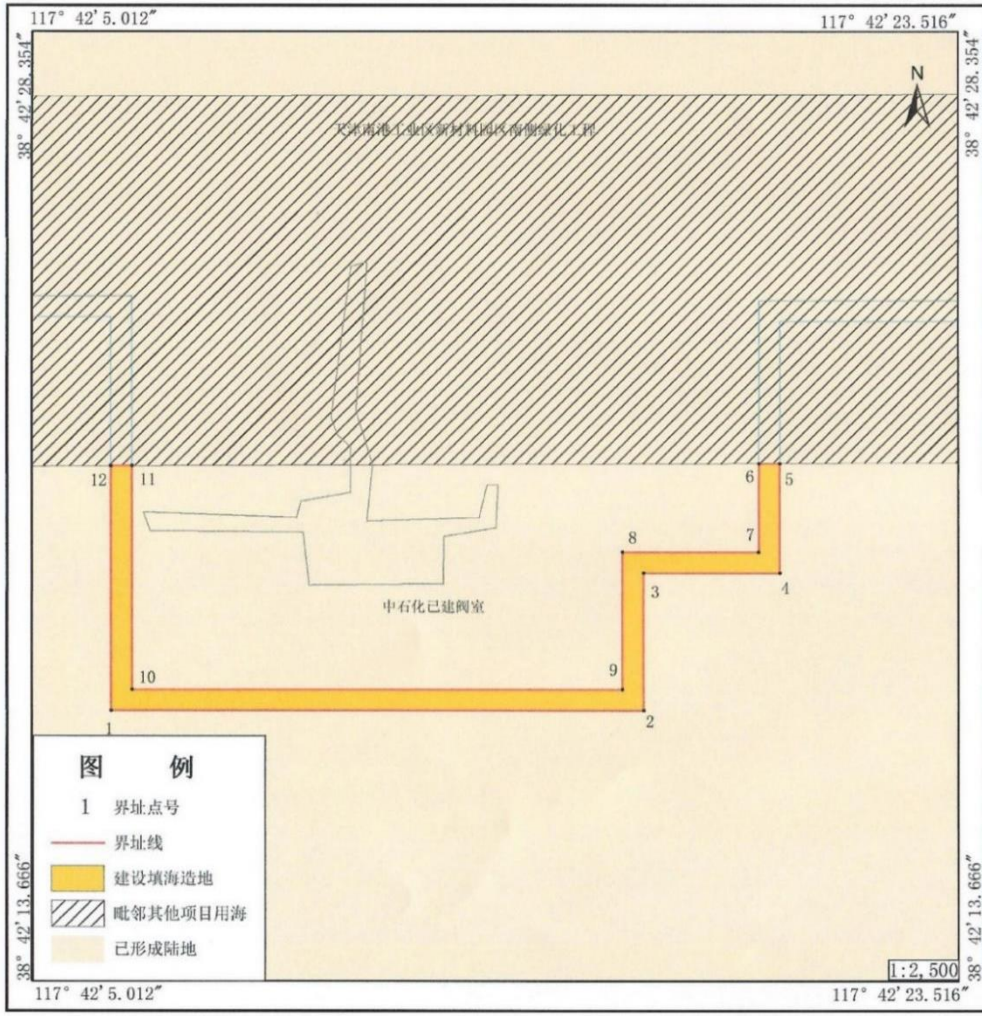
附页　北京燃气天津南港 LNG 应急储备项目（外输管线三、四及 1 号阀室）
宗海界址点（续）

界址点编号及坐标（北纬|东经）					
8	38° 42' 21.051"	117° 37' 53.346"	16	38° 42' 22.145"	117° 37' 37.818"
9	38° 42' 22.107"	117° 37' 53.355"	17	38° 42' 22.146"	117° 37' 37.404"
10	38° 42' 22.108"	117° 37' 52.941"	18	38° 42' 21.380"	117° 37' 52.502"
11	38° 42' 22.113"	117° 37' 51.264"	19	38° 42' 21.377"	117° 37' 52.935"
12	38° 42' 21.386"	117° 37' 51.261"			
13	38° 42' 21.392"	117° 37' 50.226"			
14	38° 42' 18.737"	117° 37' 50.203"			
15	38° 42' 18.804"	117° 37' 37.789"			

测量单位	海域海岛环境科技研究院（天津）有限公司		
测量人		绘图人	
绘制日期	2019 年 05 月	审核人	

海域海岛环境科技研究院（天津）有限公司
测绘资质专用章
丁级
1230203
有效期至2019年12月31日

北京燃气天津南港 LNG 应急储备项目（外输管线五）宗海界址图

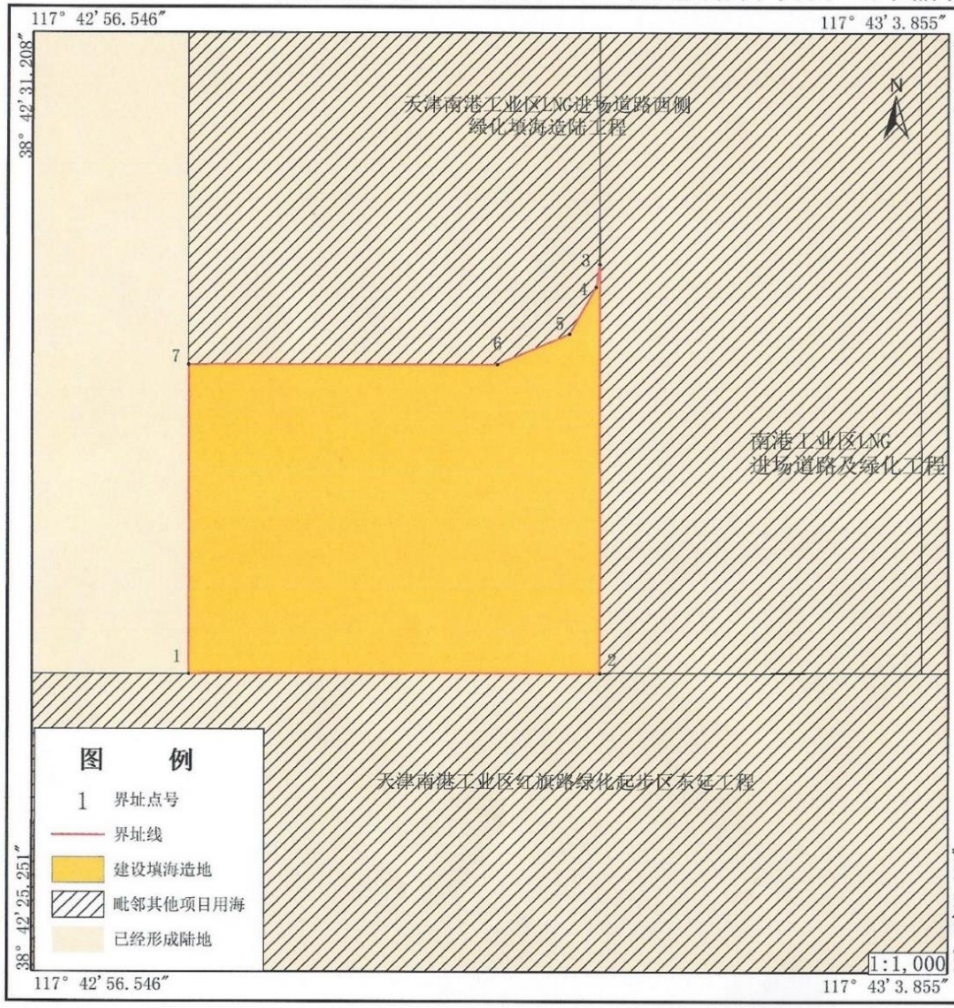


界址点编号及坐标（北纬丨东经）		
1	38° 42' 17.887"	117° 42'06.591"
2	38° 42' 17.823"	117° 42' 17.187"
3	38° 42' 19.967"	117° 42' 17.208"
4	38° 42' 19.950"	117° 42' 19.916"
5	38° 42' 21.653"	117° 42' 19.933"
6	38° 42' 21.654"	117° 42' 19.519"
7	38° 42' 20.277"	117° 42' 19.505"
8	38° 42' 20.293"	117° 42' 16.797"
9	38° 42' 18.150"	117° 42' 16.776"
10	38° 42' 18.209"	117° 42' 07.008"
11	38° 42' 21.694"	117° 42' 07.042"
12	38° 42' 21.695"	117° 42' 06.628"
剩余界址点编号及坐标（北纬丨东经）见附页		

内部单元	用海方式	界址线		面积（公顷）
外输管道（五）	建设填海造地	1-2-3-4-5-6-7-8-9-10-11-12-1		0.5375
宗海		1-2-3-4-5-6-7-8-9-10-11-12-1		0.5375
坐标系	CGCS2000	投 影		高斯-克吕格（117°30′）
高程基准	1985 国家高程基准	深度基准		当地理论最低潮面
测量单位	海域海岛环境科技研究院（天津）有限公司			
测量人		绘图人		梁卉昕
绘制日期	2019 年 05 月	审核人		

Figure 16.1-8 Sea lot boundary map of Beijing Gas-Tianjin Nangang Emergency reserve project (Send-out pipeline No. 5)

北京燃气天津南港 LNG 应急储备项目（外输管线六）宗海界址图



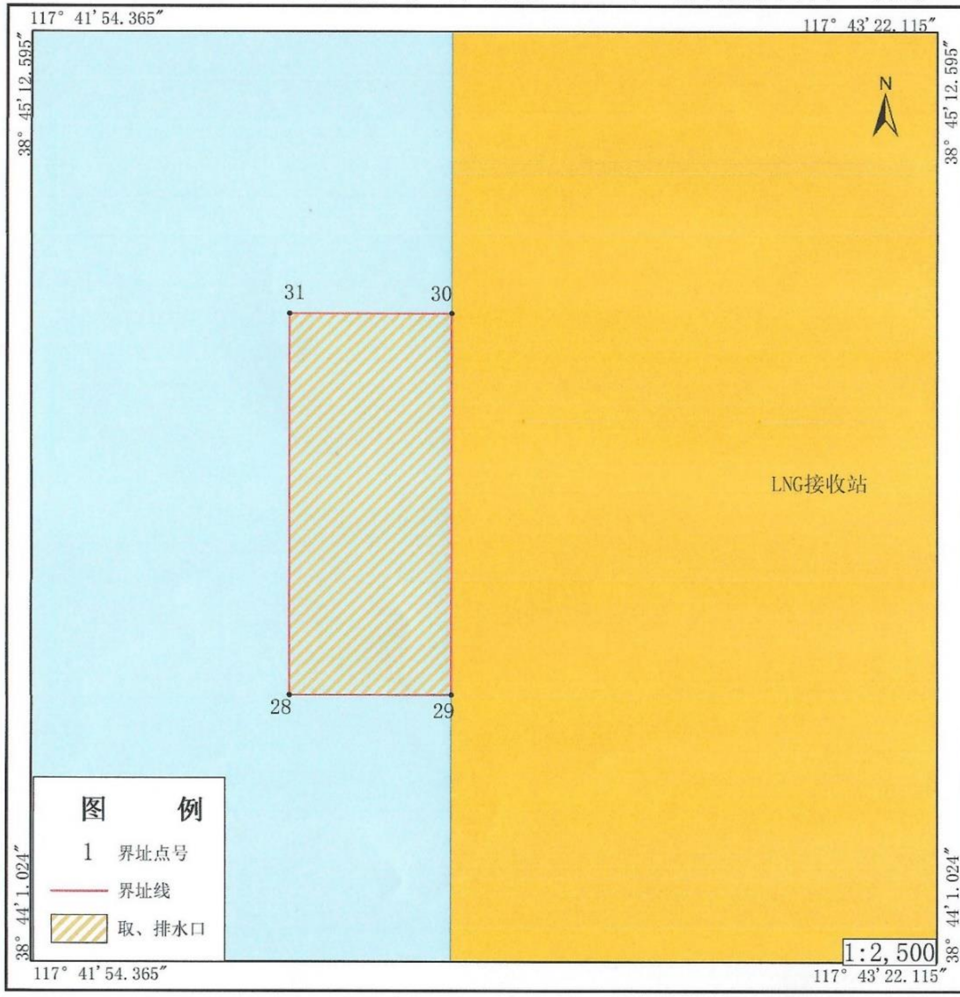
界址点编号及坐标（北纬丨东经）		
1	38° 42' 27.220"	117° 42' 58.954"
2	38° 42' 27.205"	117° 43' 02.265"
3	38° 42' 29.779"	117° 43' 02.283"
4	38° 42' 29.639"	117° 43' 02.255"
5	38° 42' 29.342"	117° 43' 02.038"
6	38° 42' 29.153"	117° 43' 01.452"
7	38° 42' 29.165"	117° 42' 58.968"

内部单元	用海方式	界址线	面积（公顷）
外输管线（六）	建设填海造地	1-2-3-4-5-6-7-1	0.4905
宗海		1-2-3-4-5-6-7-1	0.4905

坐标系	CGCS2000	投 影	高斯-克吕格（117°30'）
高程基准	1985 国家高程基准	深度基准	当地理论最低潮面
测量单位	海域海岛环境科技研究院（天津）有限公司		
测量人		绘图人	
绘制日期	2019 年 05 月	审核人	

Figure 16.1-9 Sea lot boundary map of Beijing Gas-Tianjin Nangang Emergency reserve project (Send-out pipeline No. 6)

北京燃气天津南港 LNG 应急储备项目（排水口）宗海界址图



界址点编号及坐标（北纬丨东经）		
28	38° 44' 15.059"	117° 42' 19.310"
29	38° 44' 15.039"	117° 42' 22.622"
30	38° 44' 21.096"	117° 42' 22.682"
31	38° 44' 21.116"	117° 42' 19.370"

内部单元	用海方式	界址线	面积（公顷）
排水口	取、排水口	28-29-30-31-28	1.4943
宗海		28-29-30-31-28	1.4943

坐标系	CGCS2000	投 影	高斯-克吕格（117°30'）
高程基准	1985 国家高程基准	深度基准	当地理论最低潮面
测量单位	海域海岛环境科技研究院（天津）有限公司		
测量人		绘图人	
绘制日期	2019 年 05 月	审核人	

Figure 16.1-10 Sea lot boundary map of Beijing Gas-Tianjin Nangang Emergency reserve project (Outfall)

16.2 Jetty and land area formation project

The occupation area for the land area site of the project is around 75.3580 hectares. At present, the land area site has been formed through the manner of land reclamation, and the reclamation materials are mainly the port basin dredging soil mainly composed by sludge and drift mud, with thickness of reclamation soil at around 10m.

Since 2009, Tianjin Nangang Industrial Area Development Co., Ltd started to conduct the land reclamation through sea at the eastern side of the coastline. Before reclamation of the land area at the north section of eastern jetty of eastern port basin, Tianjin Nangang Industrial Area where the project is located, the eastern breakwater and eastern port basin dyke project of the port area had already been completed, providing the precondition for the engineering construction of this project. Up till now, the primary land area formation project for the land area at north section of eastern jetty of eastern port basin has already been completed by Tianjin Nangang Industrial Area Development Co .,Ltd. For the land area of north section of eastern jetty of eastern port basin which has already been completed, the south-north length is 830m and east-west length is 1100m. For the land reclamation project of north section of eastern jetty of eastern port basin, the time of commencement was March, 2011 and the time of completion was December, 2012.

As consulted from Tianjin Planning and Natural Resources Bureau, the sea area reclaimed by Tianjin Nangang Industrial Area Development Co .,Ltd was public sea, without fishermen living on this sea area. And there has been no issues left over by history.

16.3 Handling of sea using formalities and changing of sea using area

According to the provisions of Law of the People's Republic of China on the Management of Sea Areas Use, entities and individuals can apply for using sea area from competent marine administrative authorities of people's government above the county level. Competent marine administrative authorities of people's government above the county level shall review the application of sea area utilization according to the marine functional division, and submit to the people's government with approval authority for approval. Sea use of national major construction projects shall be submitted to State Council for approval.

On May 23, 2019, the Appraisal Report of Sea Area Utilization passed the expert review organized by the Marine Consulting Center of Ministry of Natural Resources. The expert review committee put forward optimization suggestions to the utilization area of sea area. After optimization, the total area of sea utilization was changed to 129.6984 hectares, in which the sea utilization area of land reclamation was changed from 66.2170 hectares to 75.3580, the sea utilization area of water-permeable structures was 2.5968 hectares, sea utilization area of port basin was 47.9130 hectares, and the sea utilization area of water intake and outfall remained as 3.8306 hectares without changing.

On June 4, 2019, Beijing Gas Group submitted the application related to the changing of sea utilization area for this project to Tianjin Municipal Planning and Natural Resources Bureau, and Tianjin Municipal Planning and Natural Resources Bureau approved this application matter and submitted to Sea and Islands Division of Ministry of Natural Resources for examination.

According to the provisions of Law of the People's Republic of China on the Management of Sea Areas Use, China will implement paid use system of sea area. Entities and individuals intending to use sea area shall pay the sea area use fees according to the provisions of State Council. The sea area use fees shall be turned over to the Treasury according to provisions of the State Council.

The Sea Area Use Right Certificate will be received after the sea use application of this project is approved by competent national marine administrative authorities.

16.4 Handling of land use formalities

The occupation area of land area site for this project is around 75.3580 hectares, and the registration formalities of transformation from sea to land need to be handled. After the registration formalities of transformation from sea to land is completed, this land will be stored by Tianjin Municipal Land

Storage Center, and the land nature will be turned into state-owned construction land. If this project intends to get the use right of this piece of land, it's necessary to conduct land auction through municipal Planning and Natural Resources Planning Bureau, and corresponding land use right fees need to be paid. Afterwards, the Land User Planning Permit Certificate shall be handled in municipal Planning and Natural Resources Bureau, and then the Real Estate Registration Certificate needs to be handled in municipal Real Estate Registration Bureau. After these formalities are completed, Construction Work Permit shall be handled in municipal Construction Committee. Only after the Construction Work Permit has been handled can the LNG Receiving terminal of this project be commenced for construction.

17 Consolidated conclusions and recommendations

17.1 Comprehensive conclusion

To sum up, the project is in the economic and social development of Beijing-Tianjin-Hebei region, the demand for clean energy such as LNG continues to grow, the implementation of " Beijing-Tianjin-Hebei and surrounding areas 2017 air pollution prevention and control action plan ", " the North area winter clean heating program (2017-2021) " and " the North key area clean heating " coal to gas source protection program " to accelerate the promotion of parts of North China " coal to gas " project. It is in conformity with the Review Opinions of the General Office of the Ministry of Transport on Issuing Key Layout Plan for LNG Terminal in Bohai Rim Region (202) and the Environmental Report of the Ministry of Ecology on Adjustment of Environmental Impact Report for LNG Terminal Planning in Dagang Port Area of Tianjin Port (204),Planning for Main Marine Functional Area of Tianjin Municipality, Division of Marine Function of Tianjin (2011-2020) and Functional Area Division of Tianjin Coastal Waters . requirements of " Red Line of Tianjin Ecological Protection ", " Red Line of Tianjin Marine Ecology ", " Implementation Plan of Tianjin Marine Ecological Environment Protection ", " Plan of Tianjin Municipality for Ecological Environment Protection " and " Plan of Tianjin Binhai New Area for Environmental Protection ".

When the project is completed, it can promote the local economic and social development. Comply with the basic principles of standard discharge, total quantity control and clean production. The present situation of environmental quality near the proposed site is suitable for the project construction, and the results of environmental impact prediction show that the project construction has little influence on the surrounding environment, and the site selection is reasonable from the angle of environmental protection.

Therefore, the construction of this project is feasible from the point of view of environmental protection under the conditions of strengthening supervision and management in an all-round way, strictly implementing the " three simultaneous " system of environmental protection and conscientiously implementing all environmental protection measures.

17.2 Suggestion

To improve, improve, implement and maintain the safety control measures and facilities of the project risk source in the course of subsequent construction and operation, in strict accordance with national, industrial and local laws, regulations and relevant standards and norms ;

After the completion of this project, we must strengthen the management, take scientific and effective measures, formulate emergency plans for accident prevention, strengthen safety education, raise the safety awareness of operators, strictly implement operation rules and prevent the occurrence of environmental risk accidents.