Proposed Construction and Operation of a New Chinese Research Station, Victoria Land, Antarctica

DRAFT COMPREHENSIVE ENVIRONMENTAL EVALUATION

January 2014

Polar Research Institute of China

Tongji University

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CONTACT DETAILS

The compilation of the Draft Comprehensive Environmental Evaluation (Draft CEE) for the construction and operation of a new Chinese research station in Antarctica is organized by Chinese Arctic and Antarctic Administration (CAA), and drafted by Polar Research Institute of China (PRIC) and Tongji University. Both CAA and PRIC are affiliated to the State Oceanic Administration (SOA).

The present Draft CEE has been approved and endorsed by the State Oceanic Administration of People's Republic of China and made public on 10 January 2014. The document is currently available on CAA website (http://www.chinare.gov.cn/en/). Meanwhile, a note about the Draft CEE electronic version availability has been circulated to each Contracting Party via diplomatic channels. The Working Paper and Information Paper to Antarctic Treaty Consultative Meeting (ATCM) XXXVII (12 May 2014, Brasilia, Brazil) and the Committee for Environmental Protection (CEP) XVII will be submitted on time.

CAA welcomes any comments and recommendations on the Draft CEE.

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NON-TECHNICAL SUMMARY

1. Introduction

The compilation of the Draft Comprehensive Environmental Evaluation (draft CEE) has been organized by Chinese Arctic and Antarctic Administration (CAA) and drafted by Polar Research Institute of China (PRIC) and Tongji University for the proposed construction and operation of a new Chinese research station in Victoria Land Region, Antarctica. The Draft CEE has been prepared in accordance with Annex I of the Protocol on Environmental Protection to the Antarctic Treaty (1998). It also referred to the Guidelines for Environmental Impact Assessment in Antarctica (Resolution 4, XXVIII ATCM, 2005). The Draft CEE describes the following contents：

- Construction, operation and maintenance of the new Chinese research station
- Transportation process for cargos and personnel to the new Chinese research station
- Analysis of potential environmental impact
- Prevention and mitigation measures to minimize environmental impact
- Gaps in knowledge and uncertainties

Considering the research programs including international collaboration, convenience of logistics, and its impact on the local environment, the location of new Chinese Antarctic Research Station (74°55′S / 163°42′E) on the Inexpressible Island which is a rocky island located in the coastal area of Terra Nova Bay in Northern Victoria Land along the Ross Sea was chosen through an evaluation process of three candidate locations as the Oates Coast region (Location 1), the Terra Nova Bay of Victoria Land (Location 2) and the Cape Berks of Marie Byrd Land (Location 3) in the Antarctic region. Four alternative sites have been investigated and compared on the Inexpressible Island.

As an independent station that will operate all the year round, the new Chinese station will develop an Antarctic observatory network with the Zhongshan Station and other international stations in the Terra Nova Bay region. China believes that understanding climate change impacts on Antarctica is a matter of critical importance for the world and for the continent itself. The main purpose of the new Chinese station is to provide an international platform for regional multidisciplinary research focusing on the chain reactions caused by the changing climate.

The main scientific programs based on the new station include the studies on atmospheric and atmosphere-ice-ocean interaction, glacial and ice shelf-ocean interaction, environment and ecosystem monitoring, space physics and geological environment evaluation etc.

- To build an atmospheric observation platform and an ocean-ice-atmosphere observation system, in order to carry out a long-term monitoring of the atmospheric environment (both physical and chemical), sea ice change and marine environment to provide basic information for the study of climate change.

- The observation and research of ice shelf and physical oceanography in Ross Sea region not only give security for the scientific expedition in this area, but also improve our understanding the phenomena of the ice shelf and ocean in this area, and its role to regulate the local climate, sea ice distribution, water mass characteristics, and ecosystem. The observation and studies include sea level, glacier, ice-shelf and ice-shelf-ocean interaction.
- Scientists from the United States, New Zealand, and Italy scientists have done a lot studies on the ecosystem in the Ross Sea. However, the polynya and its role in the ecosystem have not been sufficiently studied. We hope to cooperate with scientists from other station understand more about the ecosystem and biodiversity in Ross Sea region.
- The location of the new station will be the Chinese first scientific base in the polar cap region where the magnetic field lines is open to the space. This station will be a very ideal platform for high latitude aurora and related phenomena. On the other hand, this station and Zhongshan, with 10 hours difference in Magnetic Local Time, is an ideal pair of stations to monitor the evolution of space phenomena in the polar region.
- To promote the multinational and multidisciplinary research collaborations in Northern Victoria. Currently, the United States, New Zealand, Italy and Germany run their research stations in the Ross Sea. Korea is constructing a new station, Jang Bogo, near the Germany station. We will share the observing and monitoring data with other stations. The scientists who are interested in the Antarctic researches are also welcome to utilize the research platform of the station.

2. Description of Proposed Activities

The proposed site for the Chinese new station is located on a relative flat ground in the south of the Inexpressible Island (74°55′S, 163°42′E). Inexpressible Island is a rocky island located in Terra Nova Bay with the latitude of 74°51′00″-74°56′00″S and the longitude of 163°35′00″-163°45′20″E.

The Terra Nova Bay region is bordered by Cape Washington to the northeast and Inexpressible Island to the southwest in the western Ross Sea of East Antarctica. The proposed site for the China’s new station is about 27 km far from the Mario Zucchelli Station, and the distances from it to Gondwana Station and Jang Bogo Station are about 35 and 36 km respectively.

The main activities conducted under the guidance of the CEE include: construction, operation, and dismantlement of the station, installation and use of temporary facilities during the construction, and transportation of supplies and personnel to the station. The construction is planned to start in December 2015 and continues for two Antarctic summer seasons. The station will begin to operate in early 2017.

The station includes the central buildings, research facilities, and maintenance and operation facilities with a building area of 5528 m^2. The station is planned to be used for no less than 25 years. It will accommodate up to 80 personnel in the summer and 30 personnel in the winter.

The design for the new station is based on a number of light-weight and modular buildings that can be combined together in a variety of ways. The modularity allows for changing user requirements, easier construction and maintenance through repetition, easier relocation, enhanced fire safety and acoustic performance through separation, and greater overall robustness.

The design incorporates energy efficiency measures by maximum use of natural lighting, the double outer walls, as well as five-time glazed windows, low energy products and phase change materials.

The stable aerodynamic structure of the central buildings will provide increased resistance against strong winds. Furthermore, the combination of the elevated and slanting structures helps to minimize the amount of snow pile-up around the buildings.

The use of hybrid Solar-Wind-Diesel power supply system will significantly minimize the consumption of fossil fuels and reduce CO_2 emission. A comprehensive high-level sewage treatment and solid waste disposal system will be installed and operated in order to prevent wastes and wastewater from affecting the clean Antarctic environment. All wastes will be stored under an appropriate management plan until safely treated or transported outside of the Antarctic region. Furthermore, the wastewater will be reused as much as possible by using the gray water reclamation and reuse system.

3. Alternatives to Proposed Activities

Several alternatives including no-action alternative, three alternative locations and four alternative sites on Inexpressible Island have been compared. The selection of the proposed site not only considered its compatibility in construction and operation, but also the research fields that China was planning to carry out. In order to minimize any impact of the station on the environment, while considering a variety of logistical, engineering, scientific, environmental and safety reasons, China has decided that the best practical option is to build and operate a new research station at a safe location on the Inexpressible Island.

Three alternative layout and shape designs of the main buildings have been compared while considering the construction ability, operation convenience, energy saving and safety, the station design principle combines centralization and decentralization. Modules with similar functions are centralized to form an energy-saving layout and provide better operation convenience. The layout of the station is designed to divide the noisy sections from the quiet ones, provide convenient communication, reduce the impact of snow drift，keep main modules away from hazardous materials, and in the meantime ensure a convenient traffic route.

The rotator vertical type wind turbine has been selected from the three alternatives considering the match of the voltage level, demand power, installation conditions determined, space saving, convenience for construction, low maintenance and minimization of noise.

Marine plus land transportation is better than air plus land transportation considering the cost, logistics convenience, and on-time performance under uneven weather conditions.

In order to keep the clean Antarctica baseline environment, considering the quantity of the solid waste during the year-round operation and the difficulty for storage and transportation in Antarctica regions, magnetization pyrolysis furnace has been selected after the comparison of the three waste disposal approaches which will be applied in the new station.

4. Initial Environmental Reference State of the Region

In the region where the new research station will be located, there are several typical Antarctic species like Antarctic skuas and Adélie penguins. However, there are no colonies or habitats of any species close to the proposed site within 1.5 km.

According to the data from the automatic weather station Manuela (1988-2002), the wind speed at proposed region is extremely high and variable. Strong westerly (main direction is 265.3 degrees) wind can reach a maximum instantaneous speed of 43.5 m/s, the maximum daily average wind speed is 34.2 m/s, and there are more than 117 days with strong wind above 15 m/s in average. The annual average temperature and wind speed of the region are -18.5℃ and 12.0m/s, respectively. The extreme low temperature is -42.3℃ (September. 1st, 1992), while the highest temperature is 6.9℃.

The elevation of the island is relative higher in the west than in the east. There is a north-southward mountain ridge on the west side, while the ground and hilly land in the east. The center of the site area selected at 74 ° 55 ' S and 163 ° 42 'E, and covers an area of 2.2 square kilometers. The regional difference of elevation is within 15 meters. The height difference between ground and west ridge altitude is 110 meters.

There are three lakes near the proposed site, the southern part of the island. Lake 1 is about 546 m in perimeter, covering an area of about 21235 m^2. Lake 2 is about 1127m in perimeter, covering an area of about 49540 m^2. Lake 3 is about 408 m in perimeter, covering an area of about 11566 m^2.

As to the investigation of 29th Chinese Antarctic Expedition, there is no moss and only a few lichens on some large rocks on the island. In the north of the Inexpressible Island, small quantities of rust-colored lichens are found on the shady side of more than 10 big stones. There are also dead and carbonized large lichens. Besides those, no deep red-brown lichen is found.

The discovered lichen is located more than 2 km to the proposed site in the north.

In the proposed site, animals found are mainly Adélie penguins, Antarctic skuas and Weddell seals. There are about 20000 penguins along the northern coast of the island, and chicks make up about 30% of the total population. According to GPS data and onsite estimation, the penguin community covers an area of 0.5 square kilometer. In the northernmost part of penguin colony, there is a small salt lake. There are eight seal bodies, some has been air-dried and some are bare bones. On southernmost tip of the island, the thawed snow and ice form a small lake, where about forty adult penguins and no chicks were found. The center of the penguin colony is located to the north of the proposed site, and the distance between them is more than 2.5 km. The discovered seal bodies are also located to the north of the proposed site, and it is more than 2.8 km between them.

5. Identification and Prediction of Environmental Impact, Assessment and Mitigation Measures of the Proposed Activities

A comprehensive environmental impact identification, prediction and assessment of the station's full life cycle period including the construction, operation and decommission has been done based on the data and experiences acquired by the survey and provided by references.

In addition, the environmental impact on air, snow, ice, ocean, ecosystem, wilderness and aesthetic values in the period of the station construction and operation was estimated according to major factors including air pollutants, potential fuel and oil leakage, solid waste disposal, wastewater treatment and discharge, noise, man-made light, alien species introduction and ecosystem disturbance.

The main environmental impact of proposed activities includes:

- Atmospheric pollutants from fuel consumption
- Risks of fuel and oil spills from fuel transfer and refueling process as well as the leakage of fuel pipelines and tanks
- Discharge of hazardous and non-hazardous wastes such as construction waste, domestic waste, waste oil, chemical and food waste
- Wastewater from the construction and operation of the station
- Noise from loading and unloading activities, equipment operations and other activities
- Disturbance to the local ecosystem of both marine and land bio-species (e.g., penguins , skuas and lichens)

Prevention and mitigation measures have been identified in the impact matrices to avoid or minimize these predicted impacts.

Hybrid solar-wind-diesel power supply system will be used as a primary energy source to reduce the emissions of air pollutants. The use of fossil fuels will be minimized by increasing renewable energy, maximizing the indoor usage of natural sunlight, and recycling the waste heat.

To prevent fuel spills, fuel tanks will be double-skinned and oil impermeable bund wall will be built around the fuel tank. For prevention and clean-up of spills, appropriate equipment will be prepared in the station in accordance with associated regulations such as the guidelines of COMNAP/SCALOP (2003), etc. Intelligent Monitoring System based on internet technology (including automatic control operations, security monitoring, safety warning, remote data transmission and so on) will be applied to the fuel storage area.

Wastes will be managed according to the Waste Management Manual. All wastes will be separated and securely stored until safely treated or transported outside of Antarctic region for disposal or recycling.

Wastewater will be treated using advanced treatment system. The treated water will be discharged up to the stringent level of wastewater standards e.g., BOD_5 less than 4 mg/ℓ and COD_{Mn} less than 6 mg/ℓ according to Chinese Environmental Quality Standards for Surface Water (GB3838-2002) (Grade Ⅲ, normally for source water).

Noise will be kept at the level without disturbing the Antarctic skua or penguin colonies by appropriately uses of construction equipment.

Given that there is no area playing important role as habitats or colonies of a certain species close to the proposed site within 1.5 km, the station will not influence the surrounding ecosystem. An Antarctic Specially Protected Area will be suggested to protect the penguin colony and detail management plan will be prepared by China in the future. During the construction and operation period, visitors without clear scientific research or monitoring purposes will be prohibited to getting close to the penguin colony.

6. Environmental Management and Environmental Impact Monitoring Plan

Before the construction, PRIC will formulate the Environmental Management Plan. The Environmental Management Plan will cover the management on the protection measures for penguins and skuas, refueling and fuels transportation, waste collection and disposal, sewage treatment and gray water recycling, equipment, field operation and the tackling of emergencies etc. It will guarantee the safety and orderly progress of various activities, and consequently prevent the occurrence of environmental accidents and minimize environmental impact.

PRIC will establish a station environmental monitoring plan to observe the actual impacts in Antarctica. The monitoring activities can be divided into two categories. One is to monitor the potential environmental impact, so as to discover as early as possible the disadvantageous impact and take actions immediately to reduce or eliminate such impact. Another is to monitor and record the relevant station operation information to verify the CEE and determine whether the impact conform to those estimated.

7. Gaps in Knowledge and Uncertainties

The gaps in knowledge and uncertainties identified in the draft CEE for the construction and operation of the new station are as follows:

- Distribution of sea ice around the proposed site and climate conditions during construction period
- Long-term climate change near the construction site
- Uncertainties in the knowledge and information of natural environment near the proposed site
- Status of a few Antarctic Skua nests distributed close to the proposed site
- Items related to the future expansion of the station
- Changes in activities of the station according to the change in future perspectives of research.

8. Conclusion

In construction and operation of the new station, great importance has been attached to environmental protection and energy saving. As much as possible renewable energy and the updated environmental technologies will be applied in order to minimize the impact on the environment caused by construction and operation. Furthermore, as a research hub supporting not only the activities of Chinese scientists, but also partnerships with leading foreign experts on climate change in the Antarctic region, the new station is expected to enable and inspire international collaboration and multidisciplinary researches.

China concludes that the global scientific importance and value to be gained by the construction and operation of the new research station in Victoria Land, Antarctica and the continued operation of the research facility outweigh the more than minor and transitory impact the station will have on the Antarctic environment and fully justifies this activity proceeding.

1. Introduction

1.1 Purpose of a new station in Victoria Land

As an independent station that will operate all the year round, the new Chinese station will develop an Antarctic observatory network with the Zhongshan Station and other international stations in the Terra Nova Bay region. China believes that understanding climate change impacts on Antarctica is a matter of critical importance for the world and for the continent itself. The main purpose of the new Chinese station is to provide an international platform for regional multidisciplinary research focusing on the chain reactions caused by the changing climate.

Although isolated from other continents, Antarctica is connected to the rest of world through oceanic and atmospheric circulations. Antarctica and the surrounding Southern Ocean are key drivers of Earth's oceanic and atmospheric systems.

A critical important feature is that about 90% of Earth's ice (around 25.2 million gigatonnes) is found in Antarctic, and 70% of all available fresh water is locked up in the Antarctic ice sheet - if melted, it would raise sea level by nearly 60 meters. Equally important, the Southern Ocean extends over about 38 million km^2 and encompasses about 20% of the world's ocean waters. It connects the three main ocean basins (Atlantic, Pacific and Indian) and creates a global circulation system that is largely driven by the eastward flowing Antarctic Circumpolar Current - the world's largest current. The current generates an overturning circulation that transports vast amounts of heat and also takes up a significant amount of carbon dioxide from the atmosphere. Atmospheric pressure, humidity, air temperatures and wind patterns for our entire planet are interconnected and greatly influenced by processes in the Southern Ocean.

Cooling and sinking processes in the Southern Ocean and circulation of sea waters throughout the global deep ocean exert a powerful control on the Earth's climate. The Southern Ocean also plays a very important role in the global carbon cycle and removing carbon dioxide from the atmosphere through chemical and biological processes. The Southern Ocean supports the abundant marine ecosystem. All of these important functions have a critical relationship with sea ice. Changes in the integrated polar ocean-ice system will have far-reaching impacts.

In order to further understand the Antarctic environmental characteristics and variations under the influence of global climate change, China is implementing a special project to clarify the changes of the polar environment, especially the polar ocean environment. China is going to strengthen the investigations and researches of changes in Southern Ocean (characteristics, ice shelf-ocean interaction and atmosphere-ice-ocean interaction) and response to climate and marine ecosystem. Until now, most of Chinese Southern Ocean investigation activities are mainly limited in: (1) Prydz Bay（Zhongshan Station as a base）, where the warming is less obvious and the physical, chemical and biological oceanography, ice shelf-ocean interaction, sea ice variation are studied, (2) Waters near Antarctic Peninsula (Great Wall Station as a base), a region of quick warming, where ocean environment and marine ecosystem are investigated, and (3) Part of waters during the cruise to Great Wall Station or Zhongshan Station (Fig 1-1).

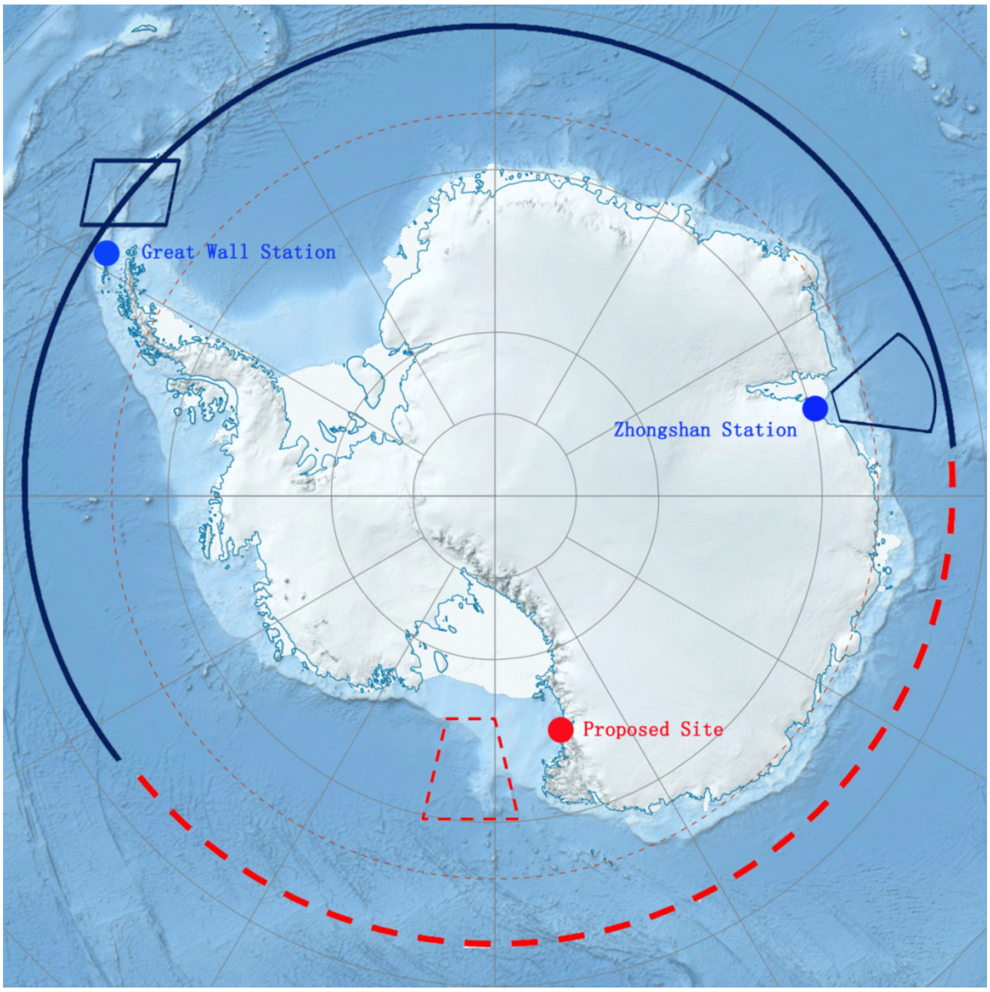

Figure 1-1 Investigation areas of the Chinese Antarctic Research Expedition (CHINARE) in Southern Ocean

The Ross Sea is one of the most productive regions in the Antarctic (a phytoplankton bloom was observed in the Ross Sea in spring, see Fig 1-2). While its food web is relatively stable, its oceanography, biogeochemistry, and sea ice coverage have been changing dramatically, and the situation is likely to continue in the future. Sea ice coverage and persistence have been increasing, in contrast to the Amundsen-Bellingshausen sector, which has resulted in reduced open water duration for its biota. Models predict that as the ozone hole recovers, ice cover will begin to diminish. Currents on the continental shelf will be likely to change in the coming century, with a projected intensification of flow leading to altered deep ocean ventilation. Such changes in ice and circulation will lead to altered plankton distributions and composition, but it is difficult to predict the nature of these changes at present. Unlike other Southern Ocean regions, where continental shelves are very narrow and Antarctic krill dominates the herbivorous fauna, the broad shelf of the Ross Sea is dominated by crystal krill and silverfish, which are the major prey items for species of higher trophic levels. At present, the Ross Sea is considered to be one of the most species-rich areas of the Southern Ocean and a biodiversity "hotspot" due to its heterogeneous habitats. Despite being among the best-studied regions in the entire Southern Ocean, the impact of climate change on the oceanography and ecology of the Ross Sea remain fraught with uncertainty.

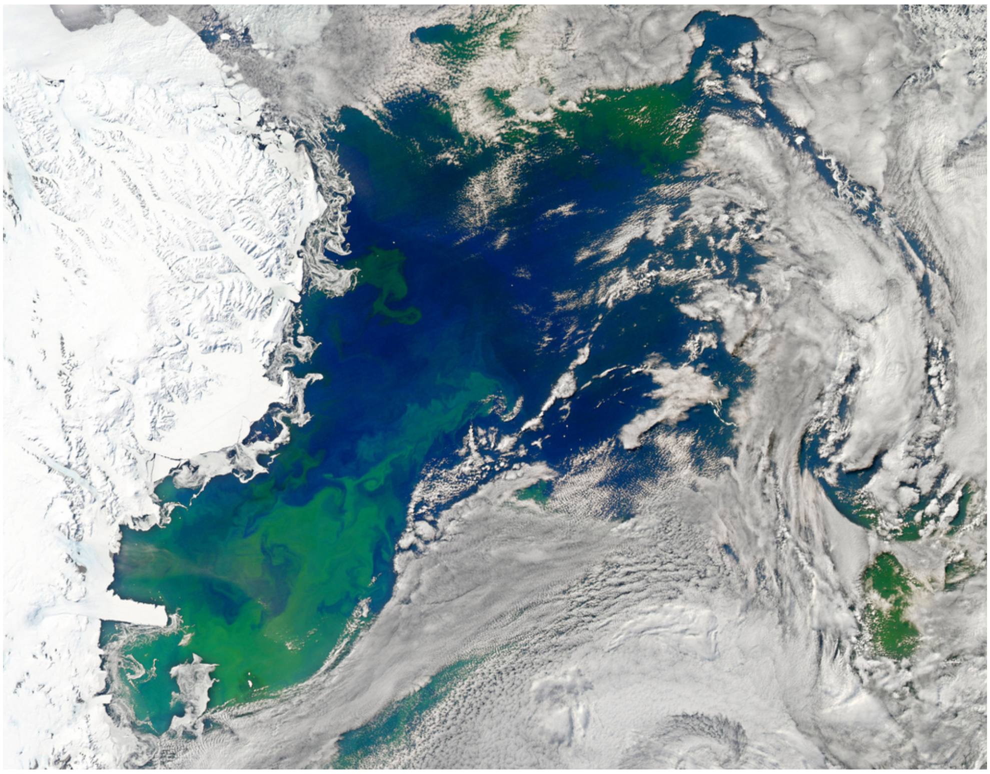

Figure 1-2 A phytoplankton bloom was viewed in the Ross Sea on January 22, 2011

(By the Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA’s Aqua satellite and cited from: http://www.flickr.com/photos/gsfc/5398237910/sizes/l/in/photostream/)

The Ross Sea Ice Shelf is considered to be the largest ice shelf in Antarctica (about 182,000 square miles). A large polynya occurred in front of the shelf formed by ocean current and wind. The ice shelf and polynya are important for the water current, air-ice-ocean interaction and ecosystem.

The western Antarctic Peninsula region has been warming two to three times faster than the global average and has become one of the fastest warming regions on Earth. Over this period, 3 of the 12 ice shelves in the peninsula region have retreated significantly and 4 have collapsed, amounting to a loss of about 18% of the floating ice. However, in East Antarctica, which has been shielded from the effects of global warming by the ozone hole, the warming is slower than the global average (see Fig 1-3). The regional differences in responses to climate warming and variability highlight the complexity of the processes currently affecting Earth's environment.

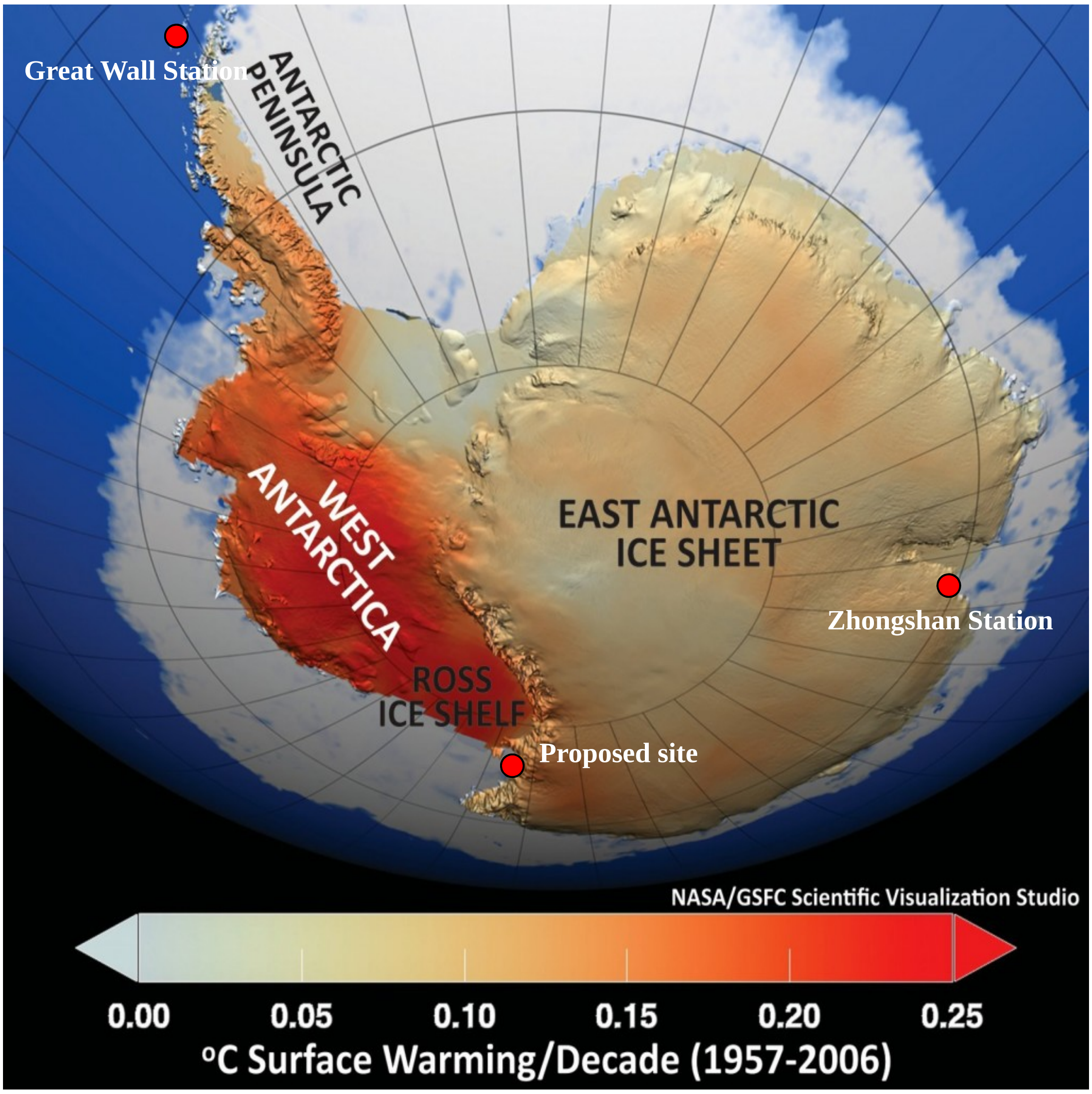

Figure 1-3 Surface Warming of West Antarctica (Cited from: http://www.sciblogs.co.nz)

The Ross Sea is an ideal place for oceanography and air-ice-ocean interaction researches, and the station is a platform for long-term environmental monitoring, which is important for understanding characteristics of the variation. To build a new station in the region of the Ross Sea, China will have the capacity to monitor and research the typical waters in the Southern Ocean, the sub-Antarctic waters with fast warming, the east Antarctic waters with relatively low warming and Antarctic waters with severe ice shelf- ocean and air-ice-ocean interaction, which can help us understand the characteristics and variations of the Southern Ocean.

The proposal of construction of a new station and the related scientific plans are the major contents of China's Polar Plan for the 12th Five-Year Plan. By implementation of these plans, China hopes to deepen the study on the Southern Ocean, develop its role in climate changes, and make contribution to better environmental conservation, promotion of sustainable development and further enhancement of the scientific knowledge of the public.

1.2 History of Chinese Antarctic activities

Chinese Antarctic activities were initiated in the 1980s. During that period, China sent scientists to Australia and some other countries to participate in their Antarctic programs and expedition activities. They learned a great deal of knowledge about Antarctica and gained experience in scientific studies and logistic support.

In November 1984, China sent its first Antarctic expedition to West Antarctica and the expeditioners landed on the King George Island in December of the same year. A ceremony for the foundation of the Great Wall Station (62°12′59″S, 58°57′52″W Fig.1-4) was held. In February 1985, the Great Wall Station was successfully built up and some expeditioners overwinter there in the same year. In November 1988, China dispatched an expedition to East Antarctica and built up the second Chinese Antarctic Base, the Zhongshan Station in the Miller Peninsula in February 1989 (69°22′24″S, 76°22′40″E Fig.1-4). In January 2009, China dispatched an expedition to inland Antarctica and built up its third Chinese Antarctica Base, the Kunlun Station (80°25′01″S, 77°06′58″E Fig.1-4). Up to the present, China has successfully organized 30 Antarctic scientific expeditions and sent more than 3500 expeditioners in total to the Antarctic for scientific studies and logistic support, gradually forming a supporting system of "one ship to three stations", that is, R/V Xuelong (Fig. 1-5) provides logistic support to the Great Wall Station (Fig. 1-6), Zhongshan Station (Fig. 1-7) and Kunlun Station (Fig. 1-8). All the stations have become not only good bases for the scientists to carry out scientific studies in Antarctica but also a window for China’s opening to the outside world to cooperate with other countries in the Antarctic scientific studies.

Looking into the near future, China is trying to build an aviation network with relevant partners to provide necessary logistics for researches and emergency. Recently, Chinese government just approved the purchase of one Basler BT-67 aircraft with modified scientific instruments. PRIC is working closely with Basler, Lake Central Air Service, University of Texas and Kenn Borek Air to implement the project. Hopefully, the aircraft will be put into use by the end of 2015. Possible cooperation with DROMLAN and other national operators is under discussion. The aircraft will transport important materials and equipment for carrying out Chinese Antarctic scientific research and give more advantages when dealing with emergency.

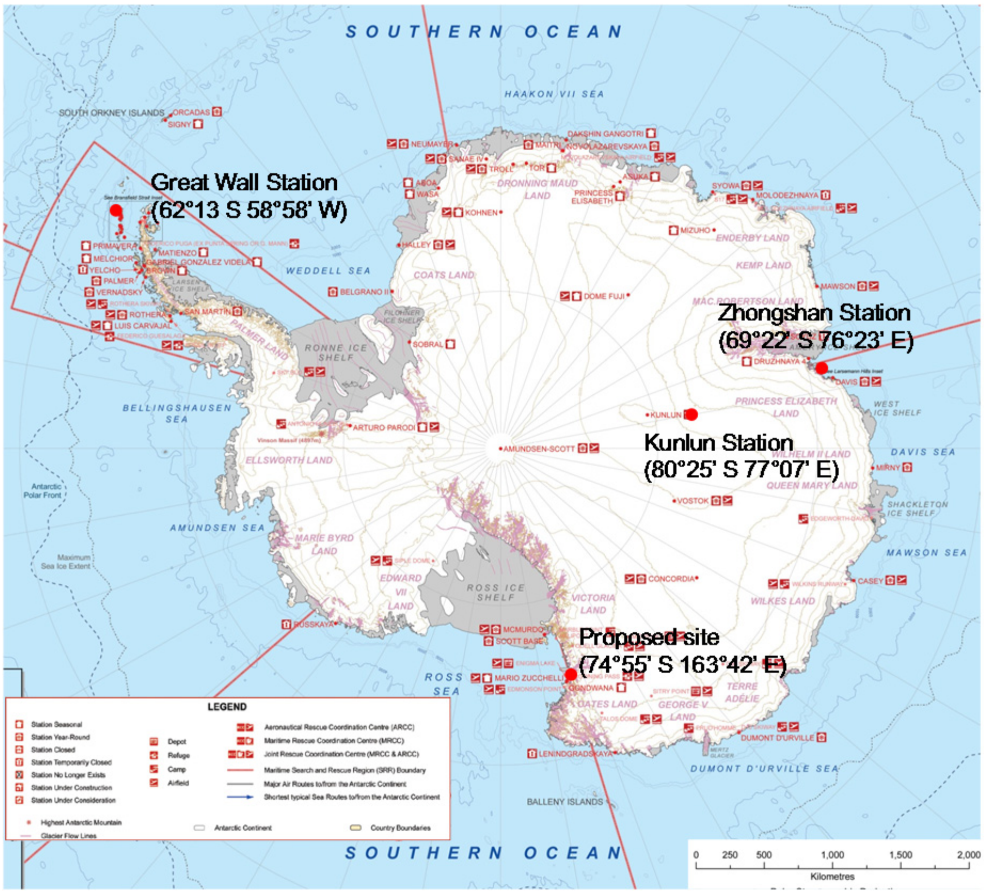

Figure 1-4 Distribution of the Chinese Antarctica Research Stations

(Base Map: COMNAP 2009)

Figure 1-5 R/V Xuelong in the Southern Ocean

Figure 1-6 Chinese Great Wall Station located in West Antarctic

Figure 1-7 Chinese Zhongshan Station located in East Antarctic

Figure 1-8 Chinese Kunlun Station located in the inland of Antarctica

Over the last 30 years, the Chinese Antarctic scientists have carried out multiple disciplinary observations and surveys in glaciology, oceanography, atmosphere science, biology, geology and mapping, etc. They have collected a great amount of precious samples, data and information from multi-years of arduous field surveys under harsh conditions. In terms of geological studies, a deepened understanding of the crust evolution in East Antarctica has been scored through the studies on the pan-African tectonic structure. At the same time, with arduous efforts in the past years, the CHINARE has collected more than 11,400 pieces of meteorite samples and has laid a foundation for further studies on the movement of celestial bodies. The ecological studies took Antarctic krill as an important indicator and combined it with environmental and climatic changes. The glaciology studies have initially accomplished the detection on the basic observation profiles in the area from the Zhongshan Station to Kunlun Station in China's 9thand 10thFive-Year Plan Periods, which have laid a foundation for China's studies on inland ice sheets and the construction of a new station in the inland, Antarctica. Base on this, the study on the interaction between Amery ice shelf and ocean has been carried out and promoted a more broad combination between glaciology and the international frontier sciences. In the solar-terrestrial studies, a cooperative project between China and Japan for medium and long-term observation was implemented and a group of important phenomena such as afternoon aurora was discovered and proved. The project further promoted the construction of the Arctic observation station which is mutually conjugated with the Zhongshan Station by taking the observation in the Zhongshan Station as basis, thus promote the joint observation of the solar-terrestrial space from the South to North Poles. In the studies on recent modern environmental evolution in the Antarctic, the geochemical index elements integrated study was proposed to study the evolution of important biological populations on the scale of thousand years. In addition, much progress has been made in climate studies, landform mapping, earthquake observation and physical oceanography survey of the Southern Ocean. These scientific studies have enriched the knowledge of the ice and snow world of the Antarctic and made contribution to the conservation of global ecological environment and the common prosperity of the human society.

During IPY (2007-2008), China carried out a Chinese IPY program, including a key international program named "PANDA" with the full name of "The Prydz Bay, Amery Ice Shelf and Dome A Observatories – A Chinese Key International Program for IPY" as shown in Fig. 1-9. During IPY, China built Chinese Antarctic Kunlun Station in the highest point of the Antarctic Dome A region, carried out the Dome A deep ice core drilling in science and engineering, and the astronomical observatory in Antarctica, carried out comprehensive inland ice sheet survey for four times, built inland icecap observation system, made a series of research results, especially the results of research on the origin and early evolution of the Antarctic ice sheet which was published in scientific journal "NATURE", carried out Zhongshan Station - Kunlun Station cross-section integrated observation of atmospheric environment and geophysics for four times. Continuously, carried out integrated ocean observation on Amery Ice Shelf - Prydz Bay - South Indian Ocean section for four times, carried out in the CUSP Aurora north and south poles conjunctive observational study.

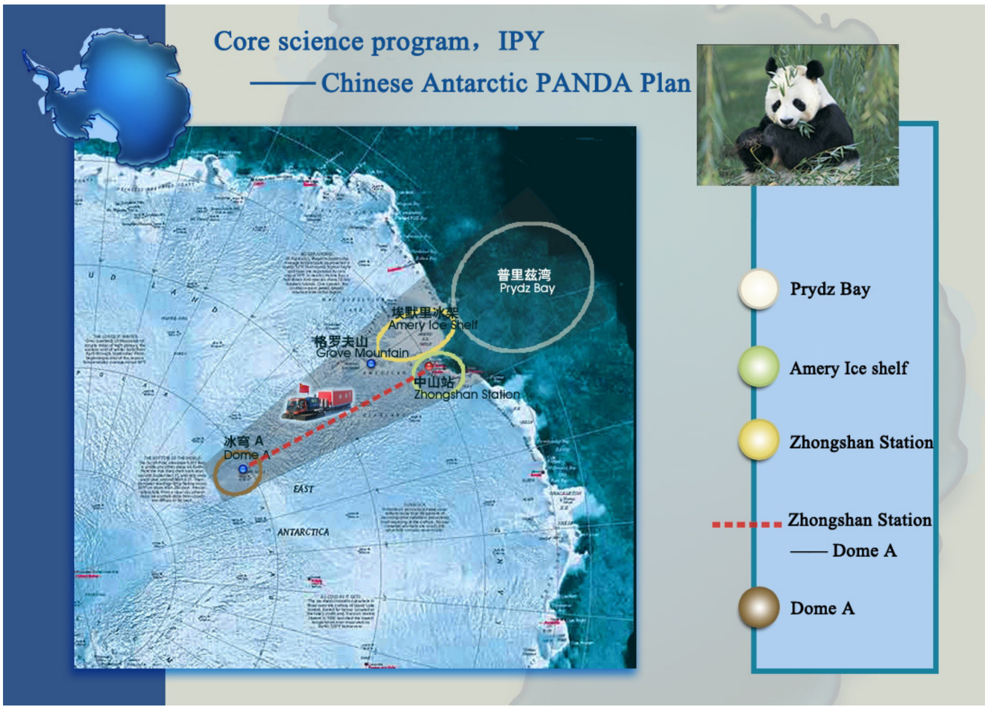

Figure 1-9 China's PANDA project during IPY

1.3 Scientific programs for the new station

Antarctica, surrounded by the Southern Ocean, is vital for understanding the global climate change. Its vast ice-covered regions are like a global thermostat that regulates the Earth's climate system. However, its different areas are behaving differently. For example, the ice sheet in East Antarctica appears close to balance, but that in West Antarctica is thinning rapidly. In order to understand how Antarctica impacts and responses to the global climate change, we need to consider it as a whole and to put it into the whole Earth system. In Antarctica, China has built Great Wall, Zhongshan and Kunlun stations on the Southern tip of Antarctica peninsula, in East Antarctica and at Dome A inland Antarctica, respectively. Systematic observations about climate change have been carried out based on these stations. Additional observations based on the new station, where is located in the West Antarctica, will much improve our ability to study Antarctica as a whole. In addition, besides in Polar Regions, China is also making efforts for understanding the climate change in subtropical and tropical regions. For example, a multi-national ongoing program, NPOCE (the Northwestern Pacific Ocean Circulation and Climate Experiment), leading by China is designed to observe, simulate, and understand the dynamics of the Northwestern Pacific ocean circulation and its role in low-frequency modulations of regional and global climate. Based on the new station and relied on the Xuelong, we will carry out comprehensive surveys from Rose Sea to Southern Pacific Ocean. Combining these surveys with the NPOCE program will provide us an opportunity to put Antarctica into the whole Earth system to consider its role in global climate change. In order to realize this purpose, the scientific programs planned for the new station include：

1) Atmospheric and Atmosphere-Ice-Ocean interaction studies

Monitoring the characteristics, variations, sources and influences of the climate-sensitive chemicals is an important content for the studies on the Antarctic environmental variation and feedback reaction to the global change. The polar oceans and atmosphere have a great impact on the global atmospheric circulation and climate change. Ross Sea is a region where cyclone generates and extinguishes frequently, and is also one of the regions with maximal sea ice change and main sources of southern ocean bottom water. The observation study on the atmosphere and atmosphere-ice-ocean in this region will help us to better understand the interaction between ocean, ice and atmosphere, and provide essential data and reference for the study of climate change.

We plan to build an atmospheric observation platform and an ocean-ice-atmosphere observation system, in order to carry out a long-term monitoring of the atmospheric environment (both physical and chemical), sea ice change and marine environment to provide basic information for the study of climate change, which includes:

● Measuring the long-term marine environmental properties, include sea temperature, salinity , current speed, current direction, air pressure and other elements,

● Monitoring the long-term variation of the sea ice distribution using shore-based radar and s atellite remote sensing station,

● Measuring sea ice thickness and drifting by ice buoy automatically, consistent sea ice-air vertical temperature change, and consistent ice-atmosphere turbulent flux, radiation flux and sea ice albedo above the ice surface,

● Building a gradient wind profile observation system and measuring the air temperature, humidity, wind speed and wind direction of upper atmosphere using balloons,

● Building an atmospheric observation platform to measure the main greenhouse gas (CO_2, N_2O, CH_4 and O_3, etc.) and aerosol (Heavy metal such as Hg, POPs and microorganisms).

U.S. McMurdo Station has carried out a systematic marine, sea ice and atmospheric study. Our observational study could be used as a useful supplement. Furthermore, the sea ice albedo long-term observation will be our unique operation.

2) Glacial and Ice shelf-Ocean interaction

Ross Ice Shelf is the largest ice shelf in Antarctic, and Ross Sea is one of the most important source regions of Antarctic Bottom Water. The composition and structure of water mass in this area is complex and could influence Antarctic Circumpolar Current. The tidal range in Ross Sea is not so large compared with other area, but some studies show that tides of the Ross Sea and Ross Ice Shelf cavity could accelerate ice shelf melting. We do not have any systematic observations in Ross Sea till now. This is out of proportion to our object of comprehensive survey and estimate of Antarctic environment.

Along with the historically unprecedented collapse of numerous small Antarctic ice shelves in recent decades and the discovery that the Southern Ocean is warming to depth, raises major concern about the stability of the Ross Ice Shelf, another focus of the Antarctic Climate Drivers group. The Ross Ice Shelf, the largest on Earth, separates the West Antarctic Ice Sheet, which is largely grounded below sea level, from the open ocean. The loss of this floating natural barrier would put West Antarctica’s grounded ice in grave danger of melting and/or detaching, either of which would raise global sea level by up to six meters.

The observation and research of ice shelf and physical oceanography in Ross Sea region not only give security for the scientific expedition in this area, but also improve our understanding the phenomena of the ice shelf and ocean in this area, and its role to regulate the local climate, sea ice distribution, water mass characteristics, and ecosystem. The observation and studies include sea level, glacier, and ice-shelf and ice-shelf-ocean interaction.

Some regular observation of the glacier, ice-shelf and ocean in Ross sea region has also been carried out by the stations of other countries as America, Italy, German, Korea etc. However the study in our new station will be the first fixed oceanographic station in Ross Sea, which is established and maintained by China totally independently.

3) Environment and ecosystem monitoring

The Ross Sea ecosystem is almost the last intact marine ecosystem left on Earth. Unlike many other areas of the world's oceans, the Ross Sea's top predators are still abundant. Here they drive the system, shaping the food web in a way that's totally unique as shown in Fig 1-10. While comprising just two percent of the Southern Ocean, the Ross Sea is the most productive stretch of Antarctic waters. It has the richest diversity of Southern Ocean fishes, an incredible array of benthic invertebrates and massive populations of mammals and seabirds. More than a third of all Adélie penguins, as well as almost a third of the world's Antarctic petrels and Emperor penguins, makes their home here. Also found here are Antarctic Minke whales, Weddell and Leopard seals, and Orcas, including a population specially adapted to feed on Antarctic toothfish, the top fish predator of the Ross Sea. Supported by the new station, China plans to set a long-term marine environmental and ecosystem monitoring system in the polynya of Terra Nova Bay to understand the role of polynya to the marine ecosystem in this area, and an observation transect within the Ross Sea with both icebreaker and mooring system. The Observation studies include:

- Environmental variation monitoring (sea ice, T, S, Nutrients, Chlorophyll, et al).
- Ecosystem monitoring (plankton structure, penguins, et al.).
- Carbon flux (CO_2, particle flux by the sediment traps).
- Biodiversity and Environmental investigation.

Scientists from the United States, New Zealand and Italy have done a lot studies on the ecosystem in the Ross Sea. However, the polynya and its role in the ecosystem have not been sufficiently studied. We hope to cooperate with scientists from other stations understand more about the ecosystem and biodiversity in Ross Sea region.

4) Space Physics studies

The polar regions have been called Earth's window to outer space，which are two only platforms on the ground to study aurora and other phenomena related to interaction of solar wind (ionized plasma blown from the Sun) with the Earth's magnetosphere. In this context, the polar upper atmosphere is a screen on which the results of such interaction can be viewed and through which other evidence of space physics processes can be passed.

The location of the new station will be the Chinese first scientific base in the polar cap region where the magnetic field lines is open to the space. This station will be a very ideal platform for high latitude aurora and related phenomena. On the other hand, this station and Zhongshan, with 10 hours difference in Magnetic Local Time, is an ideal pair of stations to monitor the evolution of space phenomena in the polar region. Two research fields are planned to carry out:

● Middle and upper atmosphere - mesosphere and thermosphere

Research will focus on atmospheric temperature changes and dynamics of temperature and neutral winds from troposphere to a few hundred kilometers at altitude, particularly in atmospheric waves and climate change dynamics.

● Near-Earth solar wind, magnetosphere, and ionosphere.

Research will focus on Solar wind-Magnetosphere-Ionosphere Coupling, and its implication for space weather. Solar wind energy and momentum are transported into the coupled magnetosphere and ionosphere, causing dynamic phenomena in polar geospace, such as aurora, ionospheric disturbances and scintillation，plasma waves and convection.

The U.S. McMurdo Station monitors aurora, magnetic field variation, ionospheric absorption and convection, mesospheric kinetic temperature and so on. The New Zealand’s Scott Base located about 1.8 miles (three kilometers) from the U.S. McMurdo Station, is engaged in the research activities of magnetosphere. These stations are about 320 km from the Inexpressible Island, just a good distance in cooperation to conduct triangle aurora observation, to extend field of view of aurora observation, and to monitor space plasma wave propagation, etc. Italian Zucchelli Station (74.70° S 164.11° E) has a digisonde, an imaging riometer and permanent observatories for Geomagnetism, and we might have some cooperation in observation of ionosperic and magnetic field.

5) The geological environment evaluation studies

The location of the new station belongs to the south part of Deep Freeze Range ridge's southward extension. The altitude of Deep Freeze Range inclines northwest to southeast and the highest altitude is 3070m. The location of the new station situated at the junction between East Antarctic block and West Antarctic block, possesses an advantageous position to investigate the geological evolution histories of these two different geologic bodies. The general aim of the study is to carry on investigation of different geological evolution histories between East Antarctic block and West Antarctic block.

Regionally, the new station lies in the middle part of Victoria Land located at the southeast part of Transantarctic Mountains. The strata of this region consist of Proterzoic and Early Paleozoic basement rocks and Late Paleozoic and younger cover rocks. There is an unconformable contact between these two layers. The main strata contain Late Paleozoic (pt3) metamorphic rocks, Late Paleozoic (γ2) granodiorite, Early Paleozoic (γ3) granite, Early-Middle Jurassic (J1-2) continental extrusive basalt and Cenozoic (N-Q) alkali basalt. The distribution of the basement's tectonic line is northwest-southeast trend, while the distribution of the cover's is close to south-north trend.

The location of the new station is situated within Late Proterzoic metamorphic area. There are a set of extrusive alkali basalts in both C. Washington on the east side of the new station and Terra Nova Bay's bottom. Considering that there are many volcanoes still in the activity near the east side of the new station, we should comprehensively analyze the volcanic activities and the correspondingly countermeasures for building the new station.

The new Chinese station is also expected to promote the multinational and multidisciplinary research collaborations in Northern Victoria. Currently, the United States, New Zealand, Italy and Germany run their research stations in the Ross Sea. Korea is constructing a new station, Jang Bogo, near the Germany station. We will share the observing and monitoring data with other stations. The scientists who are interested in the Antarctic researches are also welcome to utilize the research platform of the station.

1.4 Preparation and submission of the Draft CEE

The Draft CEE of the Chinese new station in Antarctic Vitoria Land area is prepared by CAA based in Beijing, and PRIC located in Shanghai, with support and input from China’s institutions of environmental impact assessment, the institutions for station design, technical support units and scientists. The Draft CEE has been approved by China’s Ministry of Foreign Affairs and SOA.

The present Draft CEE has been approved and endorsed by the Ministry of Foreign Affairs and State Oceanic Administration of People’s Republic of China and will make public on 12 January 2014. The document is currently available on CAA website (http://www.chinare.gov.cn/en/). A paper copy of the Draft CEE will be circulated to each Contracting Party via diplomatic channels at the beginning of February, and submitted as a Working Paper and Information Paper to Antarctic Treaty Consultative Meeting (ATCM) XXXVII (12 May 2014, Brasilia, Brazil) and the Committee for Environmental Protection (CEP) XVII.

1.5 Laws, standards and guidelines

During the preparation of the Draft CEE, full reference has been given to many international public laws as the Antarctic Treaty System, the Convention on Biological Diversity, the Kyoto Protocol on Climate Change, the Protocol of the International Convention for the Prevention of Marine Pollution from Ships (MARPOL 73/78) and the Convention on the Dumping of Wastes at Sea as well as China's relevant laws and regulations. The guidelines and documents for environmental impact assessment developed by the COMNAP and SCAR have been followed in the course.

1.5.1 International laws, standards and guidelines

The Antarctic Treaty System, which includes Antarctic Treaty itself and the related measures, resolutions and decisions adopted by ATCM, and the Convention for the Conservation of Antarctic Seals (CCAS 1972), the Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR 1980) and the Environmental Protocol .

China acceded to the Antarctic Treaty in 1983 and obtained consultative party status in 1985. China ratified the Environmental Protocol in 1994. The Environmental Protocol set out environmental principles, procedures and obligations for the comprehensive protection of the Antarctic environment and its dependent and associated ecosystems. Compilation and submission of this CEE are an important act of China to implement her obligations under the Protocol.

The international conventions such as the Convention on Biological Diversity (1993), the Kyoto Protocol on Climate Change (2005), the Protocol of the International Convention for the Prevention of Marine Pollution from Ships (MARPOL 73/78) and the Convention on the Dumping of Wastes at Sea (1975), to which China has become a contracting party, have established the requirements for environmental protection and sustainable development in different aspects and have become important bases for the development of the CEE for the construction and operation of the Chinese new scientific research station.

The COMNAP and the SCAR are two international organizations involved in the Antarctic affairs. They have developed relevant guidelines and documents regarding the activities in Antarctica. The CEE has made reference mainly to the Guidelines for Oil Spill Contingency Planning (COMNAP, 1992), the Environmental Monitoring Manual in Antarctica (COMNAP, 2000), The Technical Standards for Environmental Monitoring in Antarctica (COMNAP, 2000), the Practical Guidelines for the Development and Design of Environmental Monitoring Programs (COMNAP, 2005b) and the Guidelines for EIA in Antarctica (COMNAP/ATCM, 2005a) , Fuel Manual in Antarctica(COMNAP/ATCM, 2008) , Non-native Species in Antarctica (ATCM/CEP, 2011) etc.

1.5.2. Chinese laws, standards and guidelines

The construction and operation of new station will enforce strictly relevant domestic environmental laws, standards as well as technical guidelines for Environmental Impact Assessment, as listed below:

1. Legal Instruments

PRC Law on Environmental Protection, 26 December 1989

PRC Law on Solid Waste Prevention and Control, 30 October 1995

PRC Law on Water Pollution Prevention and Control, 15 May 1996

PRC Law on Environmental Noise Prevention and Control, 29 October 1996

PRC Law on Energy Saving, 1 November 1997

PRC Law on Marine Environmental Protection, 25 December 1999

Regulations Concerning the Management of Hazardous Wastes Transfer Bills, 31 May 1999

Implementation Rules of PRC Law on Water Pollution Prevention and Control, 20 March 2000

PRC Law on Atmospheric Pollution Prevention and Control, 29 April 2000

Policies on Urban Sewage Treatment and Pollution Prevention and Control Technologies, 13 July，2000

PRC Law on Environmental Impact Assessment, 28 October 2002

PRC Law on Renewable Energy, 28 February 2005

National Scheme for Emergent Environmental Incidents, 24 January 2006

Regulations Concerning Environmental Monitoring Management, 25 July 2007

2. Environmental Standards

PRC Standards on Surface Water Environmental Quality, GB3838-2002)；

Water Quality Standards for Using Regenerated Water for Urban Miscellaneous Uses, (GB/T18920-2002)

3. Environmental Assessment Guidelines

PRC Technical Guidelines for Environmental Impact Assessment—General Principles HJ/T2.1-2011).

PRC Technical Guidelines for Environmental Impact Assessment—Atmospheric Environments (HJ/T2.2-2008).

PRC Technical Guidelines for Environmental Impact Assessment—Aquatic Environment (HJ/T2.3-1993).

PRC Technical Guidelines for Environmental Impact Assessment—Acoustic Environment (HJ/T2.4-2009).

PRC Technical Guidelines for Environmental Impact Assessment—Ecological Impact (HJ19-2011).

1.6 Project management system

Under the direct leadership of SOA, and with the support from the Ministry of Foreign Affairs, the State Development and Reform Commission, the Ministry of Science and Technology and National Natural Science Foundation, CAA takes responsibility for coordinating the design and construction of the new Chinese station.

The designing institution of the station has broadly analyzed the architectural history in Antarctica, compared and studied various modes of buildings, conducted on-site investigations, learned lessons and experiences of building in Antarctica and absorbed comments and recommendations from specialists in architecture, scientific research, logistics and management. The systematic design of the station gives priorities to the environmental protection, safety, energy saving. The economization as the important basis for assessing and guiding all the conceptual decision-making requires adopting technologies with sustainability and high energy efficiency and minimization of environmental impact. The construction of the station is expected to be finished in 2017 and then it will go into trail operation. Polar Research Institute of China (PRIC) is responsible for the management and maintenance of the station and CAA responsible for co-ordination and implementation of the follow-up scientific research, logistic support, environmental management and overseeing the project.

1.7 Acknowledgements

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2. Description of Proposed Activity

2.1 Scope

The draft CEE is developed in accordance with Annex I of the Environmental Protocol and the references had been made to the Guidelines for EIA in Antarctica (Resolution 4, ATCM XXVIII, 2005).

2.2 Location

The Terra Nova Bay region is bordered by Cape Washington to the northeast and Inexpressible Island to the southwest in the western Ross Sea of East Antarctica. Italy's Mario Zucchelli Station is located in the Northern Foothills in the west. The station mainly operates as a summer station, where qualified research on oceanography, geology, ecology etc. is conducted. Cape Möbius lies approximately 7 km northeast of the Mario Zucchelli Station, and the Germany's Gondwana Station is situated at the southern end of the cape. The station is a base for research in geology and geophysics only during the alternate summer. The Korean Jang Bogo Station is located on the flat ground of a small bay1.2 km to the northeast of the Gondwana Station. The distances from the proposed site to the Mario Zucchelli Station is about 27 km, to the Gondwana Station is 35 km and to the Jang Bogo Station is 36 km as shown in Fig 2-1.

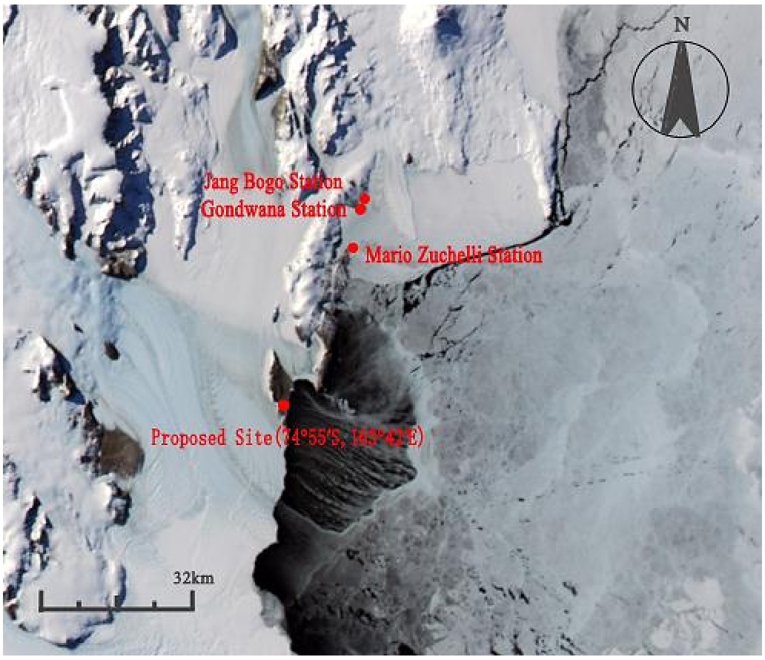


Figure 2-1 Location of the proposed site

(Source of the base map: NOAA, 1999)

The proposed site for the new Chinese station is located on the flat ground of Inexpressible Island (74°55′S, 163°42′E). Inexpressible Island is a rocky island located in Terra Nova Bay at 74° 54'S, 163° 43'E as shown in Fig 2-2.

Figure 2-2 Overview of the Inexpressible Island

Mt. Larsen (1562m), Mt.Gerlache (980m) and Mt.Crummer (895m) stands NW-SE direction in the southwest rear of the proposed site, over which the 16 km wide Reeves Glacier is developed in parallel, which stretches from northwest to southeast and flows to the sea. The Larsen glacier lies 30 km away in the southwest direction from proposed site and are parallel to the Reeves Glacier, which stretches from northwest to southeast and flows to the sea. The David glacier lies 45km away from proposed site in the south, which stretches from west to east and flows to the sea as shown in Fig 2-3.

The colony of South Polar Skua and Adélie Penguin located in the north coast of the Inexpressible Island will not be directly disturbed due to the construction and operation of the station, but indirect impact are expected considering relative proximity of the colony, the shortest distance between the colony and the site being approximately 1.5 km.

Several Weddell Seals were observed on the north end of the Inexpressible Island but no colony was found, and hence, they will not be directly disturbed by the construction and operation of the station.

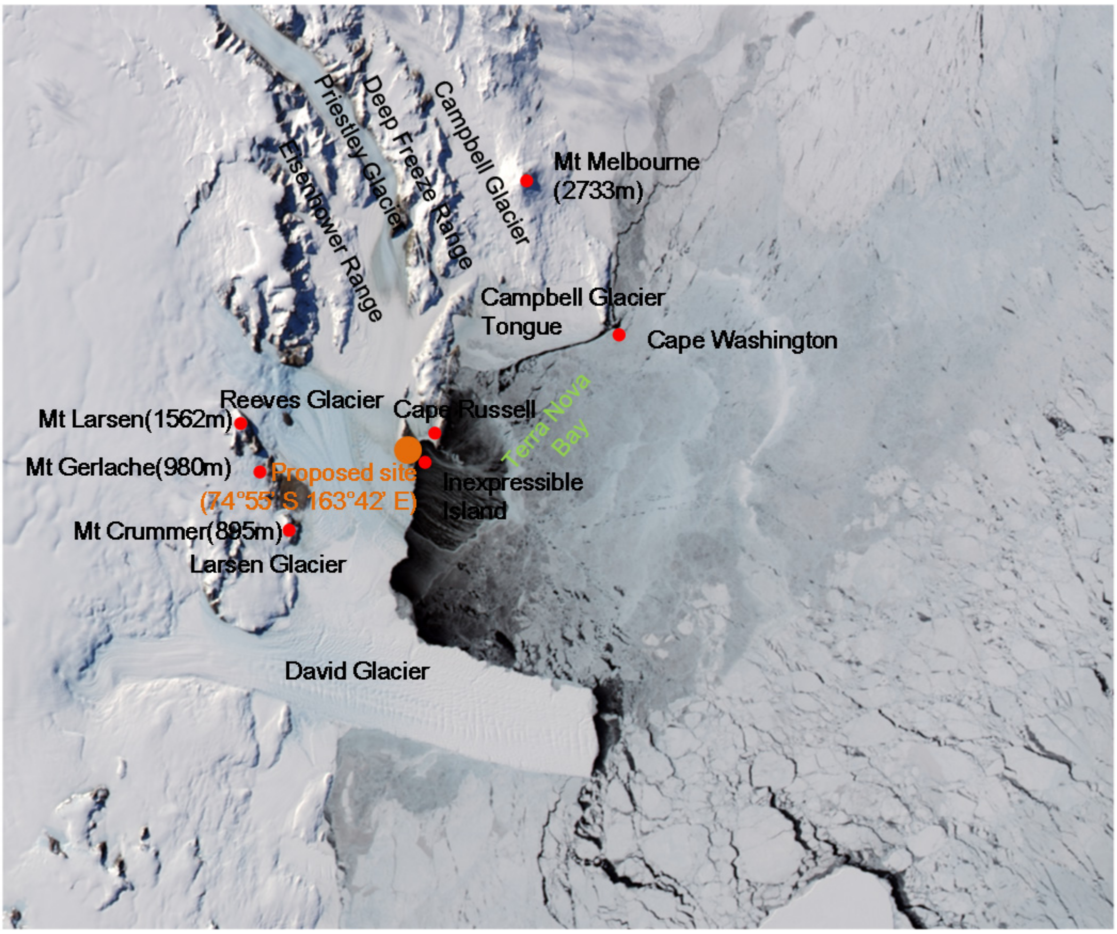


Figure 2-3 Surroundings of the proposed site

(Base image: adapted from Aqua-Modis，NASA，2007.10.16)

2.3 Follow-up site selection

The selected site of the station must have outstanding significance for research and involve scientific issues closely related to human survival environment and other important scientific resources. The site must be accessible and able for logistic supports and human survival.

On consideration of the potential environmental impact and convenience of station construction and operation, several comparable criteria including biological sensitivity, fresh water availability, landing possibility, logistics convenience, site elevation, land flatness and snow accumulation risk were established.

Through the comprehensive consideration of the above-mentioned factors, the Inexpressible Island in Terra Nova Bay region is considered as the most suitable location as the site of the new station.

2.4 Principal characteristics of proposed activities

The activities covered by this CEE are:

- construction, operation and maintenance of the new station
- the transportation process for cargoes and personnel to the new station
- analysis on the potential environmental impact
- prevention and mitigation of the environmental impact

2.4.1 General specification of the station

The construction of the Chinese New Station is planned to be initiated in the austral summer of 2015/16 and completed in the two austral summer of 2015/16 and 2016/17. The operational life of the new station is designed to be a minimum lifetime of 25 years.

The station has the following characteristics:

- The station will be staffed with engineers, mechanics, electricians, doctors, and other managing staff for their year-round operation. It will also accommodate researchers in various fields such as atmospheric science, geophysics, oceanography, biology and ecology, etc.
- The maximum expected number of occupancy is 30 during winter while being up to 80 during summer if more research staff and visitors are anticipated. The station's routine facilities and emergency shelter are designed for more people.
- Expected design lifetime: 25 years.
- The total building area of the station will be about 5528 m^2. Solar energy facilities and wind turbines are not included.
- The station will be equipped with instruments and facilities to meet scientific needs and transport facilities suitable for field operation.
- The construction, operation and dismantlement of the station are conducted in compliance with the regulations concerning the reduction of the environmental impact to the minimum in the Environmental Protocol.
- The system design of the station follows the principles of environmental protection, safety, minimization of material use and technologies of sustainable and efficient renewable energy.
- The health and safety risks should be reduced as much as possible. The design, plan and supply of the facilities of the station will ensure the least health and safety hazards.
- The construction of the station will combine the prefabricated building modules with assembly building modules made in China to reduce field construction workload.
- The building will be designed for easy maintenance, repair and control. The equipment maintenance should keep a minimum.
- The station is designed to allow room for extension and upgrading capabilities. It will

be easy to integrate updated technologies.

- The renewable energy including wind power and solar power will be the primary energy source for the operation of the station. To assure the supplement of energy and meet the emergency needs for a year-round station in a long term expectation, back-up generators for emergency use will be installed.
- The station will use microgrid system and energy management system to ensure wind power, solar energy and fossil fuels to be supplemented each other.
- The environmental impact will be minimized during its lifetime operation.
- Temperate facilities will be used as the emergency shelter so as to avoid the shipping back cost and reducing the work on site.

2.4.2 Materials and personnel required

2.4.2.1 Major materials and mode of preparation

The major materials needed for the construction of the new station include building materials, windmills, solar panels, power generators and heating facilities, engineering machineries and equipment, vehicles, fuels, oils, various kinds of spare parts for maintenance and repair, communication facilities, medical devices, fire extinction equipment, foods, labor protection articles, daily use necessities, safety and emergency facilities and part of materials for scientific purpose, etc.

Except building materials and Antarctic Diesel, most of the materials and fuels needed for the construction and transportation are featured by less amount and greater varieties. The supply must consider the principles of procurement mainly from the domestic market, cost-effectiveness, time-saving, flexibility and convenience and quality guarantee. In general, the greater part of the materials and fuels needed for the construction of the new station and the vehicle convoy for land transportation will be purchased from the domestic market and part of the machineries and equipment and their assemblies might be purchased in the international markets.

2.4.2.2 Total amount of materials required

The new station requires about 7672 tons of materials for the construction and about 500 tons for its yearly operation. The major materials for the construction will be shipped to the proposed region in 2015/16 and 2016/17 as shown in Tab 2-1 and Tab 2-2.

Table 2-1 Materials required for the new station in the austral summer of 2015/16

No	Items	Weight (in tons)
1	Materials for station construction	3500
2	Temporary facilities	126
3	Fuel Containers	683
4	Fuels	Antarctic Diesel 70 (45 for the station and 15for machines and vehicles in one austral summer), other 10 for emergency
5	Machinery and vehicles and Auxiliary and spare parts for those repair	160 (Wheel crane*2, Wheel loader*2,digger,bulldozer, flatbed trailer)
6	Materials for maintenance and repair of construction facilities	10
7	Auxiliary parts for environmental protection facilities	2
8	Auxiliary parts for repairing and maintaining power generators and power facilities	2
9	Auxiliary parts for repairing and maintaining heat insulation facilities	1
10	Auxiliary parts for satellite communications	0.2
11	Articles for medical uses	0.3
12	Fire extinction materials	1
13	Foods and beverage	60
14	Garments and articles for labor protection and prevention	0.5
15	Articles for daily life	3
16	Parts for repairing and maintaining other facilities and equipment	4
17	Safety and emergency equipment	2
18	Materials for scientific purpose	2
19	Temporary cabins	40
	Subtotal	4667

Table 2-2 Materials required for the new station in the austral summer of 2016/17

No	Items	Weight (in tons)
1	Materials for station construction	2500
2	Fuel Containers	683
3	Windmills and solar panels and accessories	90
4	fuels	Antarctic Diesel 70 (45 for the station and 15for machines and vehicles in one austral summer), other 10 for emergency
5	Auxiliary and spare parts for repair of machinery and vehicles	16
6	Materials for maintenance and repair of construction facilities	10
7	Auxiliary parts for environmental protection facilities	2
8	Auxiliary parts for repairing and maintaining power generators and power facilities	2
9	Auxiliary parts for repairing and maintaining heat insulation facilities	1
10	Auxiliary parts for satellite communications	0.2
11	Articles for medical uses	0.3
12	Fire extinction materials	1
13	Foods and beverage	60
14	Garments and articles for labor protection and prevention	0.5
15	Articles for daily life	3
16	Parts for repairing and maintaining other facilities and equipment	4
17	Safety and emergency equipment	2
18	Materials for scientific purpose	20
19	Temporary cabins	40
	Subtotal	3005

3. Personnel required

It is planned to send 70 engineers and construction workers each year in the two austral summers to the site for the station construction. In addition, 5 scientists will be sent for scientific survey and 10 logistic persons for support. They will go by R/V Xuelong to the proposed construction site.

2.4.3 The mode of transport

The R/V Xuelong will ship the personnel and materials for the construction of the new Chinese station. It will leave Shanghai Port and sail along the conventional route pass by west Australia to the Chinese stations in Antarctica. There are two possible transportation routes as follows:

Firstly, Xuelong will arrive in the waters off the Zhongshan Station, cargoes for the Zhongshan Station and Kunlun Station will be unloaded at the dock of the Zhongshan Station, secondly, it will leave Zhongshan Station and sail along the East Antarctica to the new Chinese station on Inexpressible Island and unload the personnel and materials, thirdly, it will leave the new station on Inexpressible Island and sail to the Great Wall Station. Two alternative routes are shown in Fig 2-4 and Fig.2-5.

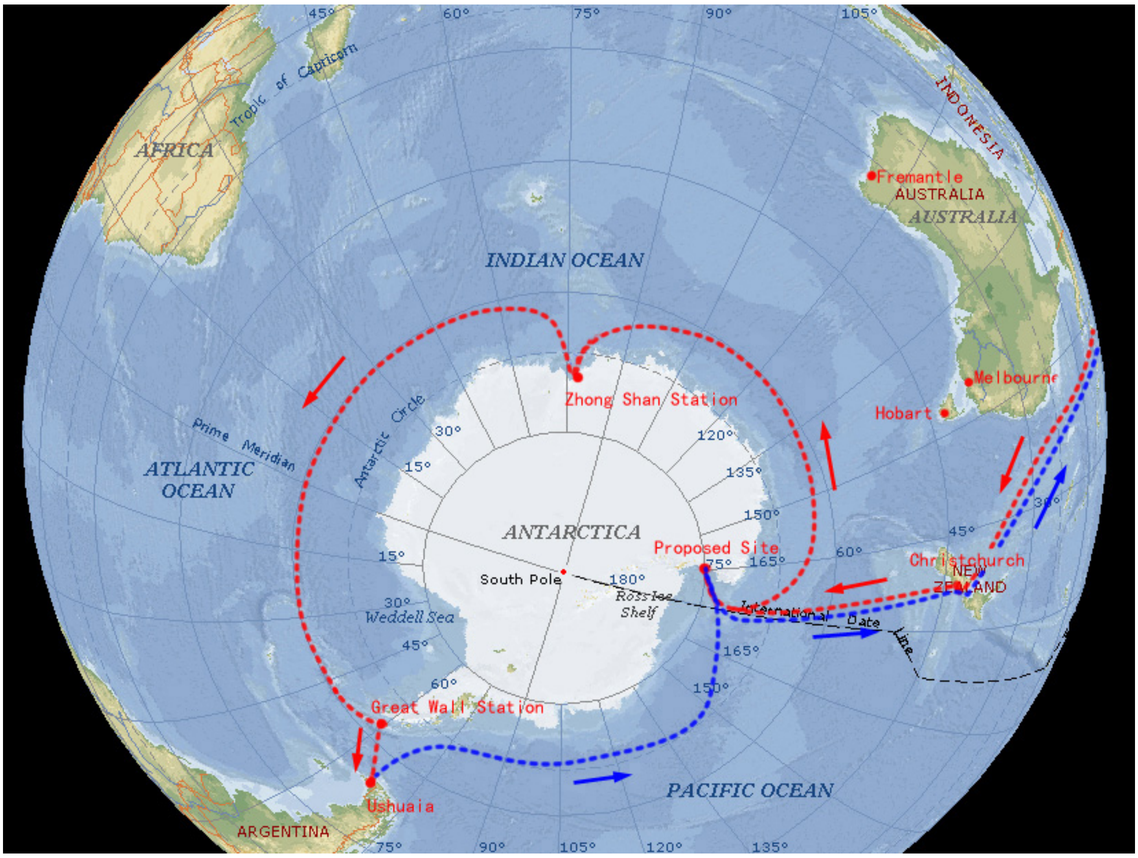


Figure 2-4 Navigation route 1 of R/V Xuelong to and from the Antarctica

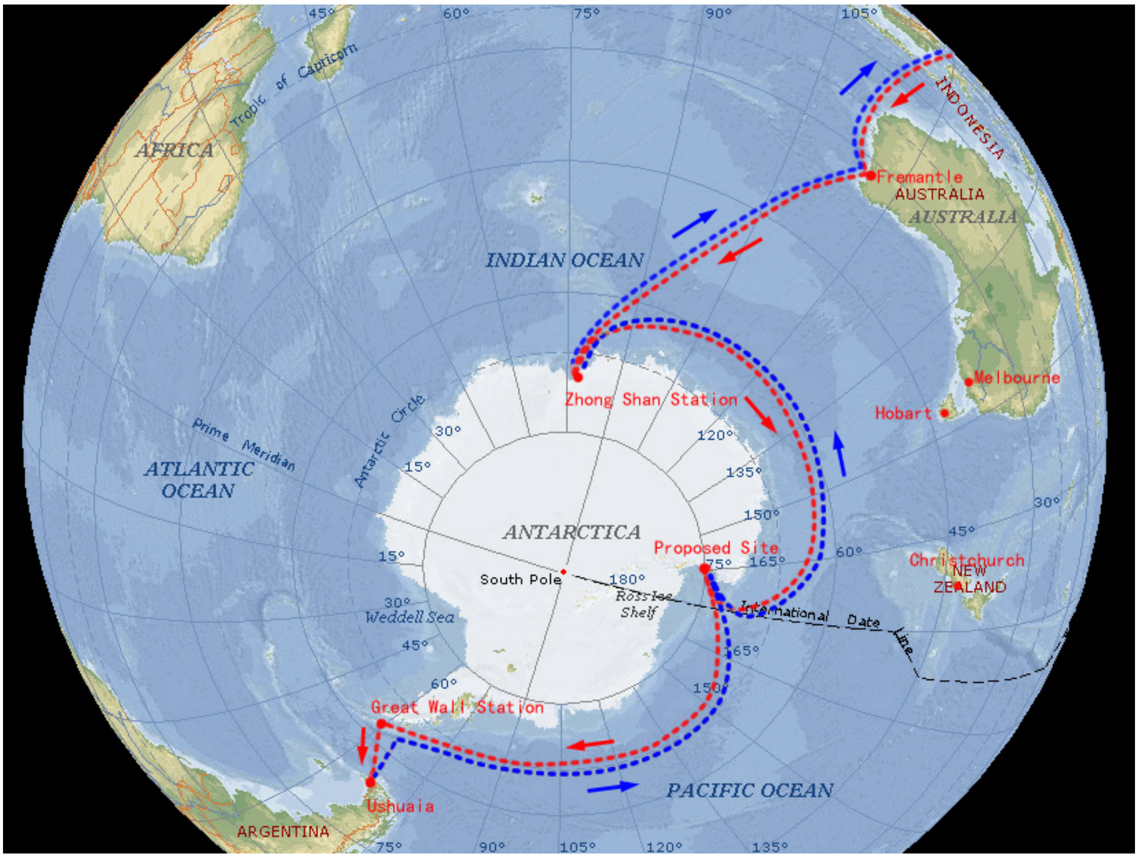


Figure 2-5 Navigation route 2 of R/V Xuelong to and from the Antarctica

For the transportation of cargos and workers associated with the construction of the station, a chartered ice-strengthened cargo ship might be used as necessary back-up. After R/V Xuelong anchor near the proposed site, up to 1.0 to 3.0 nautical miles away (according to the sea ice coverage), barge ships and helicopters will carry the workers and cargos from the ships to the land. Tracked vehicles will be needed for the additional 300m ground transportation from the unloading point to the proposed site, three land transport routes from the unloading position were considered as shown in Fig 2-6 from the perspective of each access.

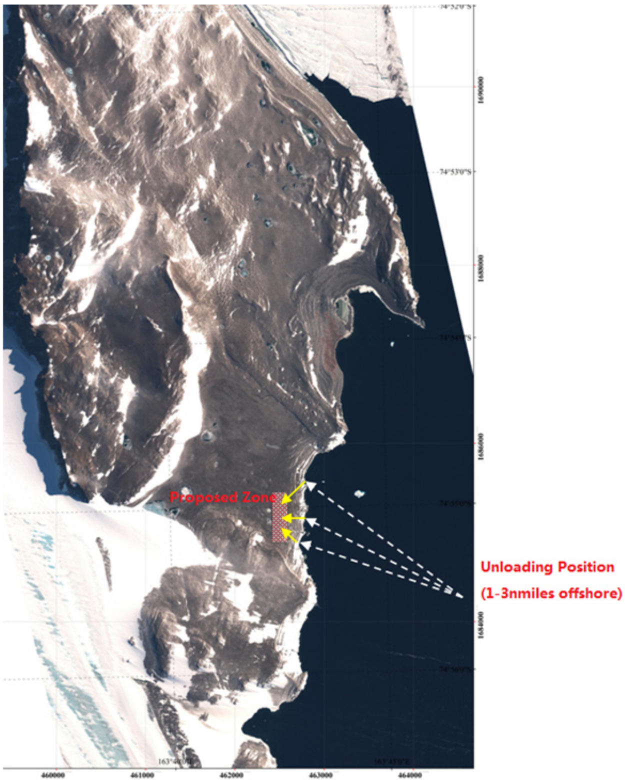


Figure 2-6 Unloading position and alternative routes

2.4.4 Medical security system

It is an important premise to guarantee the life safety and work efficiency of the expeditioners in the construction of the new station under the harsh environments. Therefore, a system for medical care, disease prevention and control and field rescue will be set up, and in the future a remote medical system will also be possible to set up so as to develop a Chinese medical security system in Antarctica. This is of great importance for the smooth implementation of the exploration and survey in Antarctica. The medical post will be created in the expedition team which will be manned with medical staff with experiences on specific diseases. Necessary training is provided for the medical staff and the expeditioners. The expedition will be equipped with various types of steel oxygen bottles, oxygen producers, emergency medicines for critical diseases and other conventional medicines and medical instruments.

In case of any injuries or emergency, a contingent plan for evacuation will be placed before construction.

2.5. Station construction and operation plan

The new station will be built to support the field survey and study on Victoria Land, Antarctic. The station will meet both the needs for scientific purpose and the requirements of environmental protection. Therefore the station will use as much as possible sustainable and higher energy- efficiency technologies and renewable energy to minimize the production of wastes. The design of the station has considered its capacity for extension and upgradeability and easy application of new technologies so as to support a year-round station with the least material consumption and environmental impact in the future.

2.5.1 Principles for design and construction

1. Principle of giving priority to environmental protection

In order to protect the Antarctic environment, which receives the least impact from human activities, the principles of giving top priority to environmental protection will be adhered to the whole process of the new station construction in Antarctica. Every step, either the selection of materials, equipment, and engineering process, operation of the station or the disposal of wastes must be in compliance with the regulations stated in the Environmental Protocol to minimize unfavorable environmental impact.

2. Principle of safety and feasibility

The harsh environmental conditions of Antarctica require special safety measures. Particular considerations have been taken into some extreme conditions including low temperature, transport difficulties and other unexpected issues in ensuring personnel safety.

3. Principle of energy-saving and waste-reduction

Energy saving and waste reduction is key principle for the design of the new station. The fuel stored and re-provisioned in the station will be with higher costs for limited amounts, so reduction in the consumption of fuel means the reduction of environmental impact and cost for the station.

Following the Environmental Protocol and the Energy Conservation Law of the People's Republic of China, the design of the station has taken the principle into full consideration to save energy and try to achieve the best balance among the harsh climate, logistic capabilities, construction capacity and technical capacity, and among the practicability, economy, feasibility and creativeness. Various energy-saving measures have been adopted for developing renewable energy, the way of heating, recycle of waste heat, structure maintenance, and reduction of ventilation energy and the control of water consumption so as to minimize environmental impact as much as possible.

4. Principle of economy and feasibility

The construction of a station in Antarctica cannot be completed in a short period, normally it would take several years to complete the whole construction due to the extreme harsh environmental conditions. A simple construction may be completed in a short period, but a construction without integrated design may lead to the overlapping and lower utilization rate, as an independent construction which may not be favorable for its maximum use under such harsh environmental conditions. Therefore, there should be an integrated design, and the construction and operation of each building should be accomplished step by step.

The philosophy of construction by steps may adapt to the harsh conditions in Antarctica and to ensure the earlier operation of a part of the finished construction. Once the whole construction project is accomplished, various parts can be integrated into an organic complex with highly operational efficiency.

Comprehensive consideration is also given to the short term and long term efficiency. Some constructional items require a larger amount of investment, such as solar energy facilities, wind turbines and heating by solar energy, but the advantages they bring will effectively reduce the cost for maintenance and operation, and earn better long-term efficiency and benefits to environmental protection.

2.5.2 Station layout

In the design, according to the different functions of building, rational combination of the centralized and decentralized distribution mode will be adopted. All the buildings with similar functions and non-hazardous effect will be integrated. While the buildings which have the risk of hazardous materials will be separated away and connected to other buildings by corridors to save energy. Long open corridor will be used to connect the core buildings to the scientific observation building in the far west to assure the safety of the researchers during winter season.

The image of the proposed new station as shown in Fig 2-7 has one centralized buildings and several decentralized buildings. There are three functional zones including the mechanical working area (Zone A), personnel living area (Zone B), energy and water supply center (Zone C) as shown in Fig 2-8.

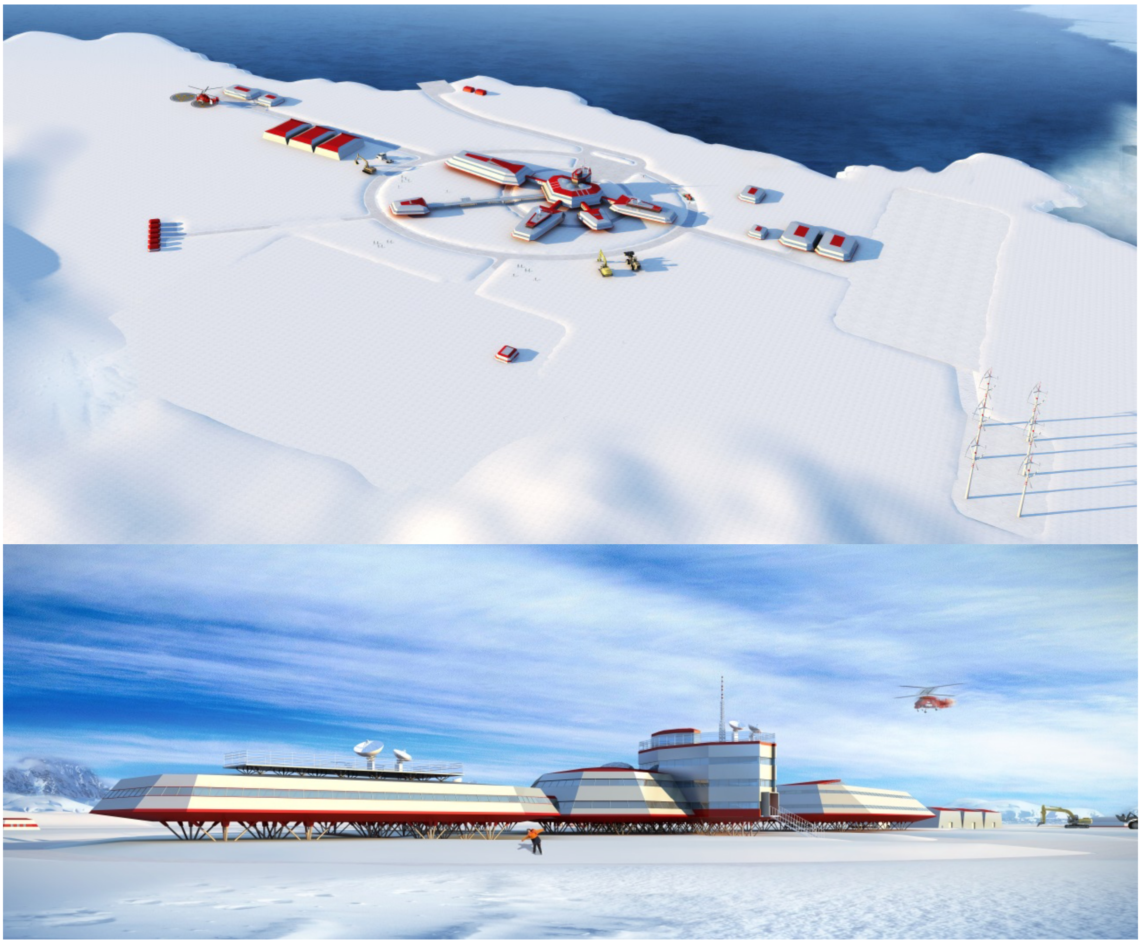


Figure 2-7 Design image of the proposed station

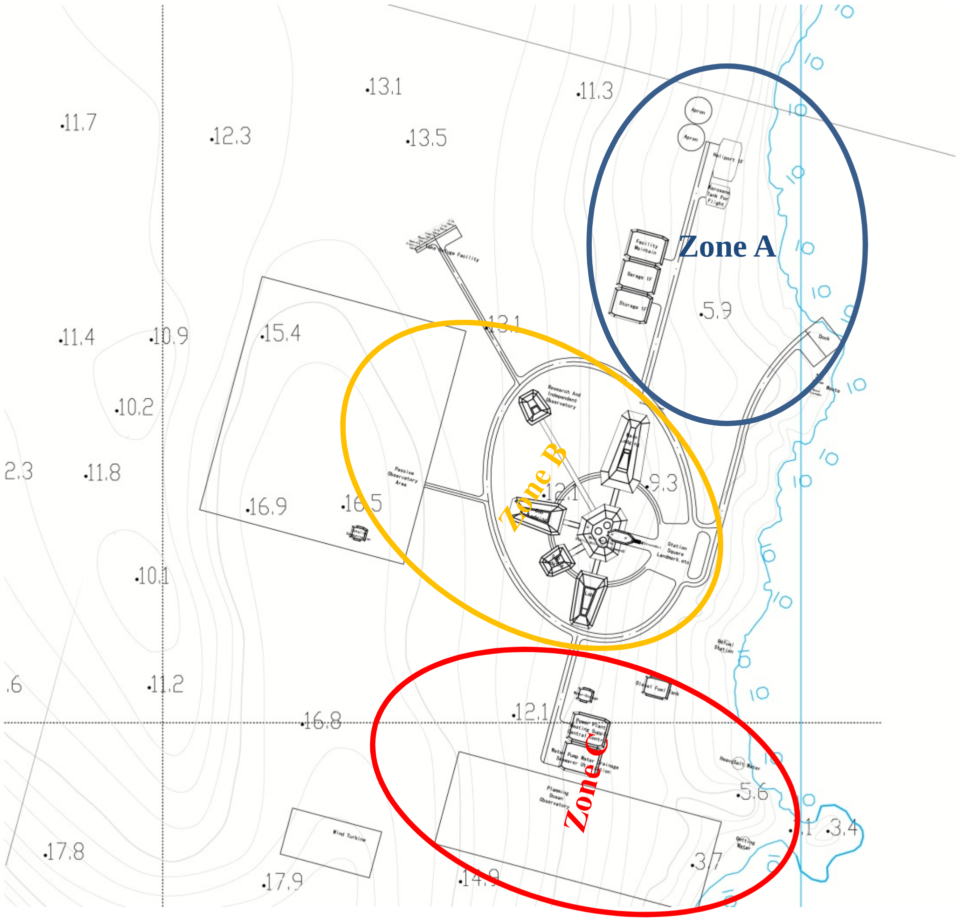


Figure 2-8 Layout of the proposed station

Layout of the station as shown in Fig 2-8 divides the noisy section from the quiet section, for communication, reduces the impact of snow drift，keeps main modules away from hazardous materials, and ensures a convenient transportation route as shown in Fig 2-9.

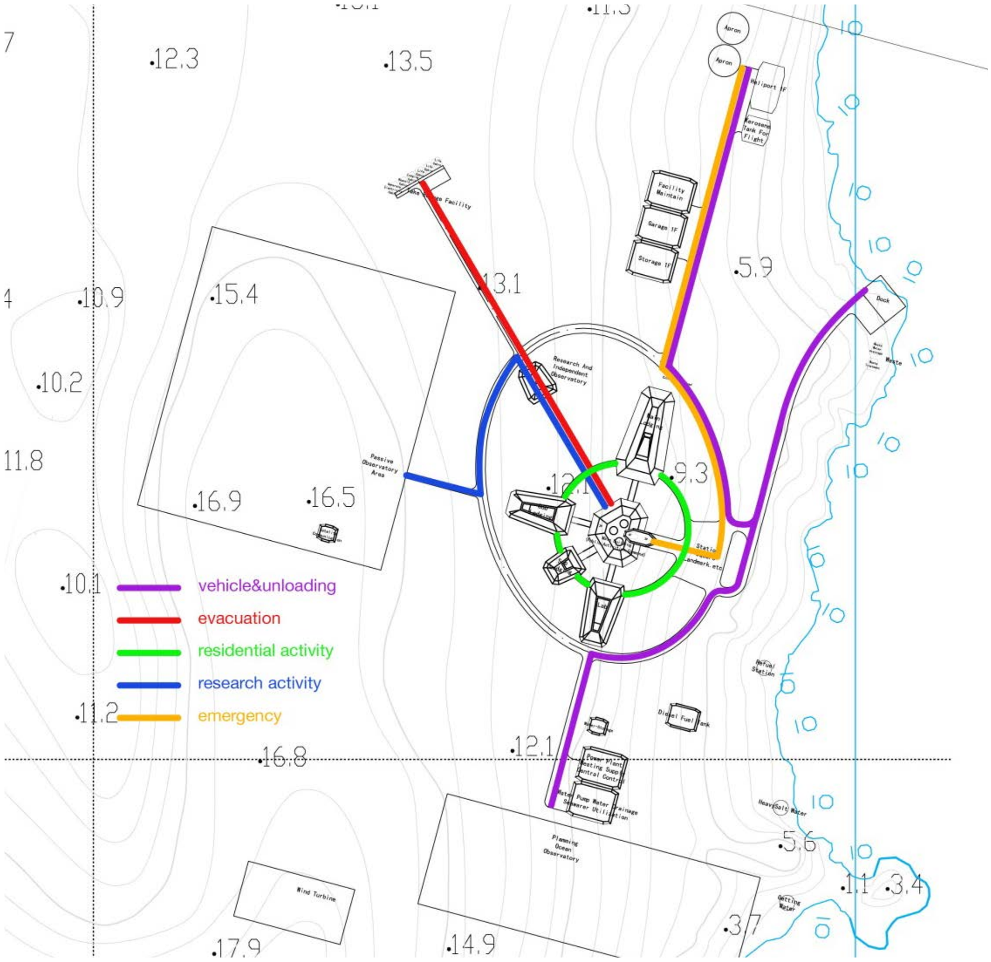


Figure 2-9 Transportation route of the proposed station

The contour of the station can effectively reduce wind drag and snow accumulation. The main accommodation modules and storage will locate in the north wing while the scientific activities will locate in the south. Considering the low temperature, strong wind and snow accumulation, the central buildings will be overhead while the logistic related buildings will directly on the floor.

The new station’s massive structural feature is prefabricated steel strengthen. The bottom of the building is elevated, and these station buildings are distributed by volume and connected by corridors. Though each station building is of uniform size, their elementary internal layout structures all possess the features as follows:

All station buildings inside are set out ring corridors along outer wall, and this setting could form a new air interlayer between central zone(prime area of working or living) and outer wall, that is beneficial to the heat preservation of the main activity and living area, In addition, unity arrangement of pipelines and electromechanical devices can be undertaken for the convenience for maintenance and overhaul, The coordination of continuous banding pattern windows on corridors and outer walls enables to achieve better horizon and illumination, besides, there are more storage space under the lower edge of banding pattern windows.

Because the out ring corridors undertake main functions of transportation and evacuation, so the substations inside could have a larger and more integrated multi-function space. In the stations, this part of space could be used as the site of multi-function space, scientific research center and amusement, while in the station buildings of dwelling unit, this part of space could be used as the large space for amusement of team members.

Station buildings constructed by multilateral blocks distributed arrange on the snowfield, which is strewed random and rich of change, integrated with the pure scenery of Antarctic. The greyness and Chinese red on the surface abstractly express the Chinese intention. The oblique surface and posture processing, which possess the sense of technology and floating, and continuous crosswise windows make this scheme look futuristic as an airship parking at Antarctic.

The dominant color of station’s appearance is white, which is harmonized with Antarctic scenery. We partially paint with Chinese red, which is national color, to be recognized clearly in a snow condition as well as highlight the characteristics of China.

The color inside is in stark contrast to the polar climate outside. We construct warm atmosphere by large area of burlywood and milk white, interspersed calm kermesinus expresses the characteristic of China and creates a warm and sweet atmosphere for living and working. We do our best to minimize the team members’ psychological effect caused by long-term polar life by rational combination of color and light.

2.5.3 Scale and functional zoning

2.5.3.1 Scale

In the limited building space of the research station, the function of the building should take safety, healthy, efficiency and interaction into consideration. The total building area of the station will be 5528 m^2 comprised of 3068 m^2 main central buildings, 2460 m^2 complex storage, emergency power generation and refuge, scientific facilities etc. in Tab 2-3). Solar energy facilities and windmills area are not included. All the buildings will be constructed by phases.

Table 2-3 Size and details of the construction

Items	Planned time	Size (m^2)	Mode of construction
Main lodging	2015/16	950	assembled in situ
Sub lodging 1	2016/17	380	assembled in situ
Sub lodging 2	2016/17	160	assembled in situ
Lab	2015/16	380	assembled in situ
Main building (central zone including living and entertainment, operation command and communication center etc.)	2015/16 2016/17	1198	assembled in situ
Helicopter library	2015/16	300	assembled in situ
Garage	2015/16	900	assembled in situ
Storage	2015/16	160	assembled in situ
Logistics module (generators, gas fuel dual-energy boilers)	2015/16	270	assembled in situ
Logistics module (water supply and wastewater treatment facilities and etc.)	2015/16	300	assembled in situ
Logistics module (maintaining hangar)	2015/16	500	assembled in situ
Solid waste treatment	2015/16	30	Container structure
Sub-total		5528	

2.5.3.2 Description of functional Zone A

Zone A including the garage, helipad, dock, oil storage area and maintenance module will locate in the northeast of the central buildings, so the noise and potential hazardous materials can be separated away from the main buildings. The dock and warehouse will locate in this area and convenient for unloading and storage.

The building area of the garage is 900 m^2, the cranes, light snow vehicles, heavy snow vehicles, bulldozer, excavator, snowmobiling, ATVs, loaders and other vehicles will be parked inside.

Helicopter hangar is about 300 m^2, 2 helicopters will be equipped.

The warehouse will hold the machinery parts, living facilities, foods, vegetables, clothes and so on. The maintenance workshop is about 500 m^2, mainly for equipment maintenance, spare parts machining. The workshop can also act as firefighting station where all the firefighting vehicles and materials will be stored.

2.5.3.3 Description of functional Zone B

The main function of the Zone B is accommodation, living and entertainment, operational command and scientific activities. Daily activities of staff mainly happen in the central buildings, which makes the heart of the station.

Tiled lightweight metal materials will be used and the overall overhead supporting structure will be applied. The total height is about 11.8 m. The main functions of the core buildings as shown in Fig 2-10 include the scientific observation, accommodation, living and entertainment, medical and emergency rescue and so on. Fluorocarbon coated metal insulation board will be used for roof materials.

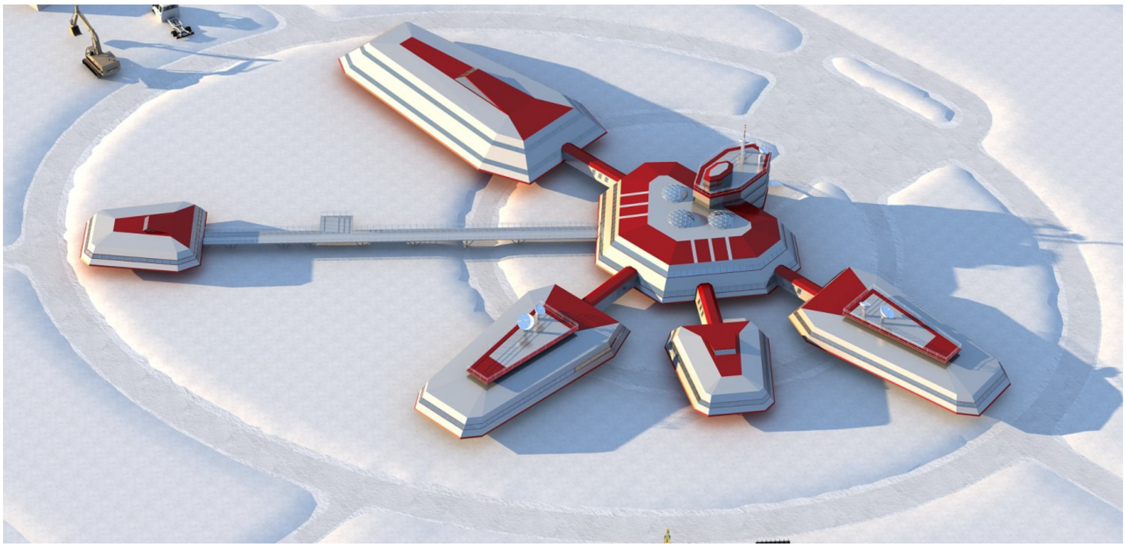


Figure 2-10 Layout of the core buildings

1. Main lodging

The long accommodation module has two floors, the building area of the first floor is 650 m^2 and the area of the second floor is 300 m^2. On the first floor, there are 24 rooms including 4 suites and 20 double bed rooms, and 16 double beds rooms on the second floor. All rooms have daylight windows surrounded. Both floors have shared washing rooms and toilets. The medical room is at the first floor.

2. Sub lodging 1

The middle size module for accommodation has one floor with building area of 380 m^2. There are 18 double bed rooms equipped with shared toilets and washing rooms.

3. Sub lodging 2

The short module has one floor with building area of 160 m^2. There are 8 double bed rooms equipped with shared toilets and washing rooms.

4. Lab

The middle size module for scientific activities has one floor with building area of 380 m^2. There are observation rooms, laboratories, warehouses and facility storage rooms.

5. **Main building**

The building area of the central zone is 1198 m^2 with many functions, comprised of locker room, dining room, kitchen, public toilets and showers, medical room on the first floor, function rooms, medical rooms, public office areas on the second floor, master room and communication room on the third floor, and the command and control room on the fourth floor.

6. **Scientific observation center**

Scientific observation center is a research and working platform for scientists from different fields. The offices inside will be equipped with telecom, internet, and other necessary furniture. To the west of the scientific observation center is the scientific background observation area, in order to ensure the original environmental background information, vehicles and personnel are forbidden to enter into this area without permission of the administrator.

7. **Emergency protection center**

Emergency protection area will set up mobile container cabins (20 ft standard containers). During fires, hurricanes and other emergency situations, if the buildings and facilities have been destroyed, the emergency protection center can supply the basic needs for the personnel.

8. **Building interior layout**

All the living space will be modular and lighting with warm colors that can effectively alleviate the long polar life psychological and physiologically.

Figure 2-11 Interior space layout

9. **Inner ring corridors**

The major transportation corridors within the buildings will use peripheral annular arrangement, and the advantages of this configuration are as follows:

- Maximization of the effective building area without the transportation corridors inside the rooms
- Inner ring corridors can increase the insulation effect to save more energy, because the corridor can separate the inner living rooms with the outside
- Maximization of the corner effective space, the irregular lower part of the corridors can be used as storage space, the upper part of the corridors can be used for pipelines

- Enhance natural daylighting and expand communication space

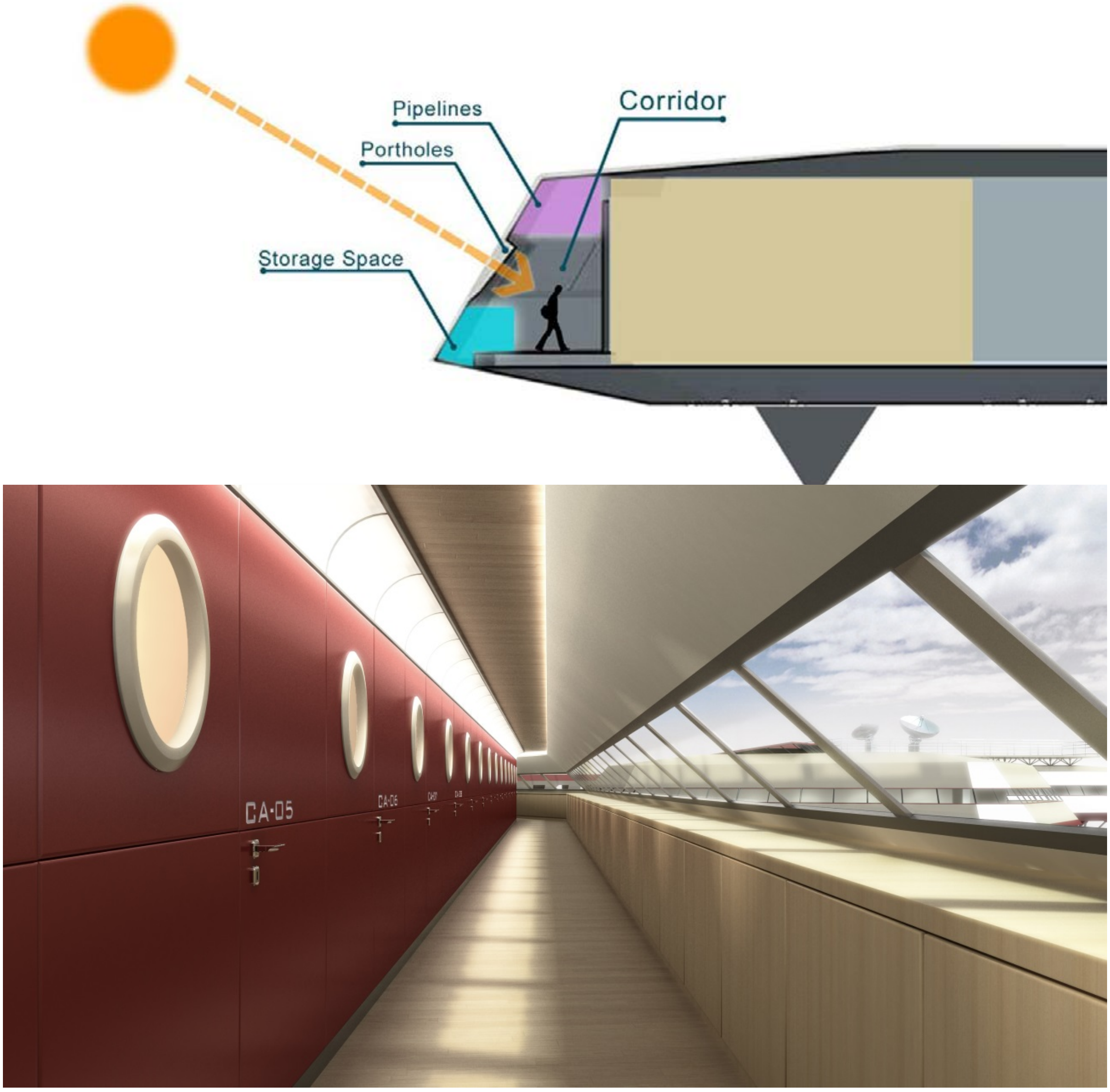


Figure 2-12 Inner ring corridors

2.5.3.3 Description of functional Zone C

Zone C is the power center and water supply center for the whole station, together with the oil storage and fresh water storage area. The windmills will locate on the southwest of the central buildings, and the logistic module including the generator, water supply system and wastewater treatment system locates in the south of the central buildings. The details of the fuel storage system, water supply system, wastewater treatment and gray water recycling system, hybrid Solar-Wind-Diesel power system and the heating and ventilation system will be introduced in the following sections (2.5.4 to 2.5.8) in this chapter.

2.5.4 Fuel storage system

Fuel storage system in the new station will be divided into two separated systems as Antarctica Diesel storage system and aviation kerosene storage system, for preventing mixture with each other. Each system will has its own oil storage tanks, turnover oil tank, pipelines, pumps, underground anti-static devices, environmental leak proof sump, fuel trucks and Intelligent Monitoring System based on internet of things（including automatic control operations, security monitoring, safety warning and remote data transmission and so on）as shown in Fig 2-13.

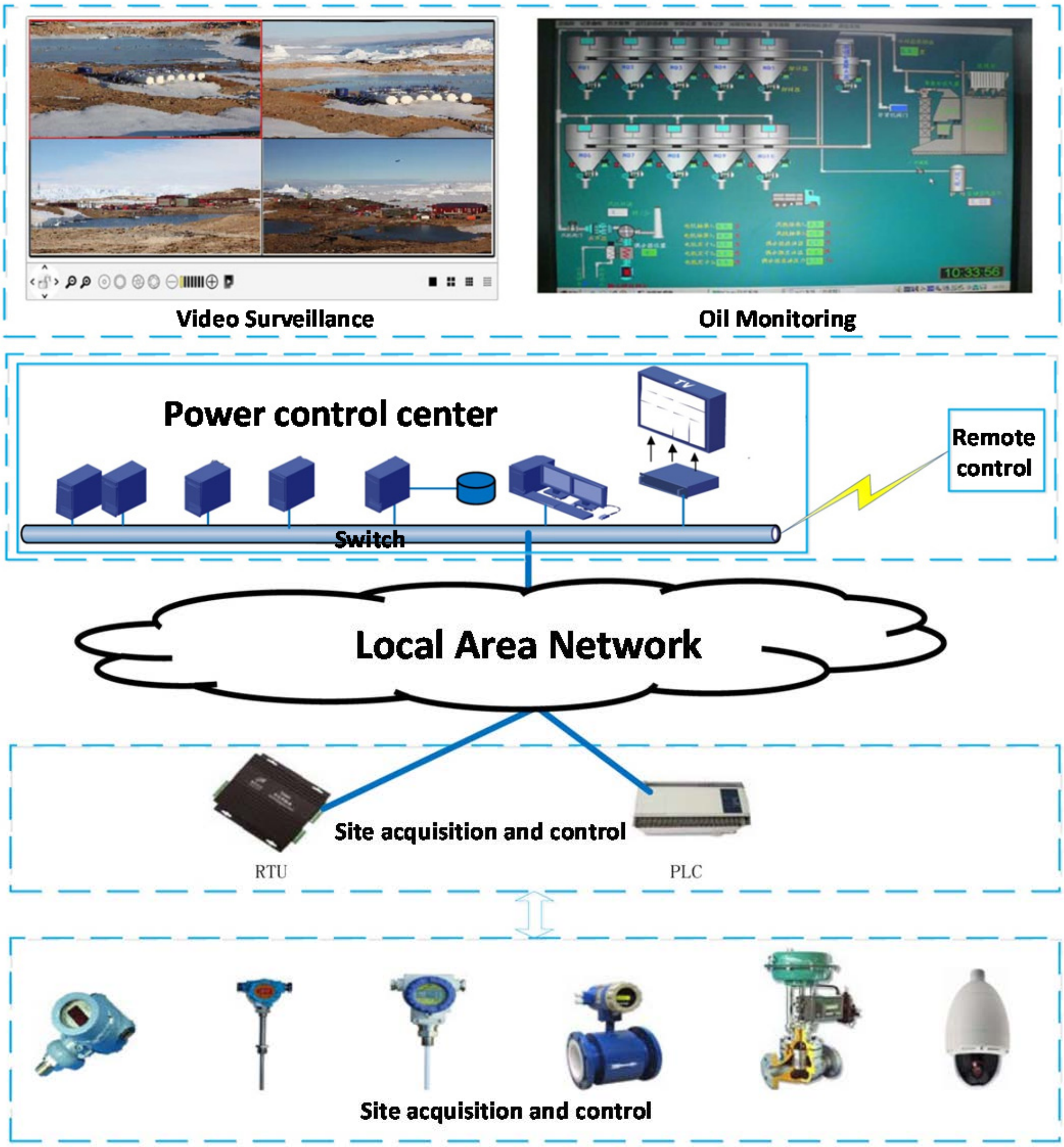


Figure 2-13 Intelligent Monitoring System based on internet of things

During the initial construction stage of the station in 2015/16 and 2016/17, 45 tons of Antarctica Diesel will be needed for power generation and heating, another 15 tons for the vehicles and engineering machineries in each austral summer. To meet the needs of continuous power generation and emergencies, 70 tons oil should be stored.

Considering full year operation of the station in future, the capacity of Antarctica Diesel storage tanks in the station will be about 660 cubic meters. Therefore, there will be 12 oil tanks, and each volume will be 55 cubic meters plus oil pumping room and necessary pipelines.

Considering full year operation of the station in future, the capacity of aviation kerosene storage tanks in the station will be about 400 cubic meters. Therefore, there will be 8 oil tanks, and each volume will be 50 cubic meters plus one fuel truck and necessary pipelines.

2.5.5 Water supply system

2.5.5.1 Water sources

Water sources for Antarctica research stations normally include the snow, ice, lakes or seawater. In the proposed area, there are two lakes with good quality of fresh water source, but they are deep frozen even in summer. The proposed area is an ice free area during summer with limited snow or ice which means not sufficient freshwater during summer. The only possible water source nearby will be the seawater. In addition, the grey water recycling system will be applied during the operation of the station to meet the non-drinking water requirements.

The planned intake is situated on the western seashore of Terra Nova Bay, opposite to and at sufficient distance from the dock facility and the discharge point (Fig 2-14). The water pipes will be installed above ground with heating wires and insulation to prevent freezing and strong wind.

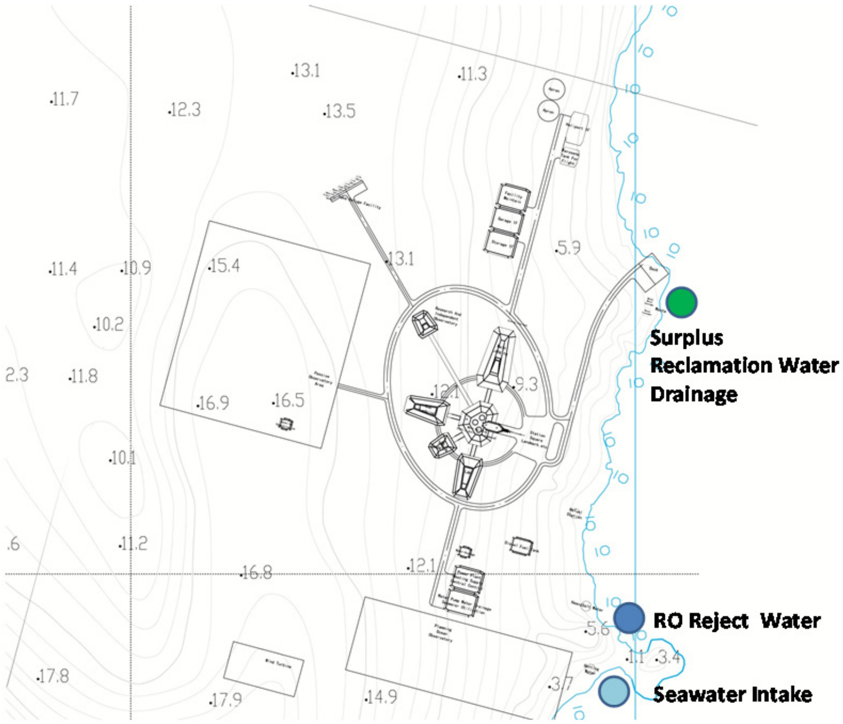


Figure 2-14 Intake and drainage locations

2.5.5.2 Seawater reverse osmosis system

A complete drinking water system comprised of multi-media filters pretreatment, cartridge filtration, and a single pass, single stage Seawater Reverse Osmosis (SWRO), followed by a remineralization system will be used in the new station, considering the low temperature of the seawater, additional heat exchanger will be necessary before the feed pump. The diagram of the SWRO is shown in Fig 2-15.

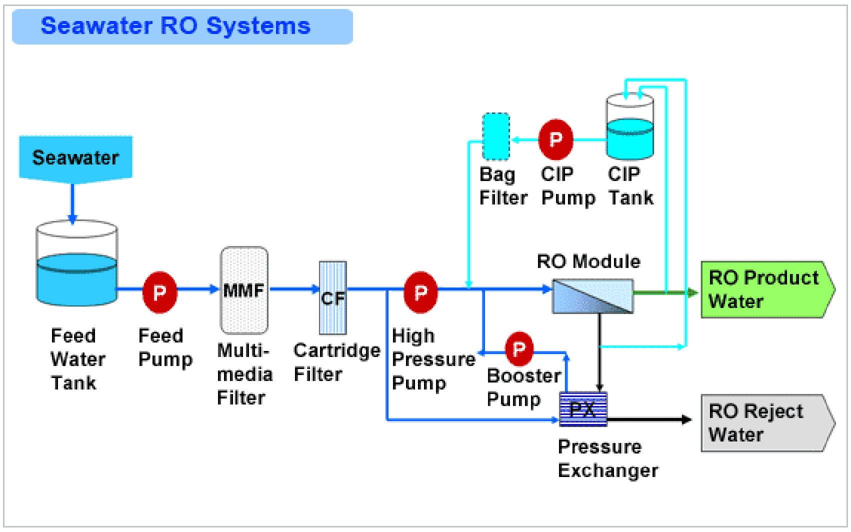


Figure 2-15 Diagram of the SWRO system

All components, with the exception of the optional feed water pump and membrane unit, are installed in a customized 20' ISO shipping container, pre-piped and wired as shown in Fig 2-16.

Figure 2-16 Integrated SWRO installed in a customized 20' ISO shipping container

The planned reverse-osmosis desalination system is easy to operate and energy efficient. An outside seawater storage tank will be installed with double-skinned for durability. Desalinated water will be stored in the tanks located in the power plant, which will be distributed in the station after treatment. Pipelines will be heat-wired to prevent freezing.

Using waste heat from the CHP plant, the snow and ice melting facility can provide up to 20 tons of water per day during winter. The snow melting may be operated in parallel with ice melting when snow supply at the site remains sufficient. An emergency electric-based snow melting facility including a 20-ton water tank will also be constructed as a part of the emergency power plant. Seawater will be first delivered to a seawater tank from the intake pump and temporarily stored there, and then pumped into the seawater desalination device in the power plant.

2.5.5.3 Fresh water and ice storage system

Considering the low temperature, difficult operation conditions of SWRO and less water consumption (only 30 people in winter) during winter (from March to October), a fresh water and ice storage system will be explored. During summer, SWRO will run intermittently according to the water consumption quantity and the productive efficiency of the system. The surplus fresh water will be stored in the storage system. Before the winter coming, SWRO system will run for several full days to produce sufficient fresh water for whole winter and stored in the open air tanks. During winter, the freshwater will be frozen naturally without any energy consumption. The blocked ice can be stored and used safely for the whole winter without any operation of SWRO. The stored ice will be thawed according to the water consumption ratio of the station during winter, the prefabricated modules of the ice can be easily moved to the fresh water supply system after melting as shown in Fig 2-17.

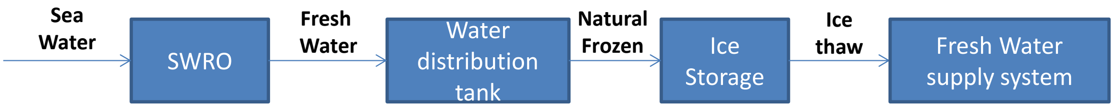


Figure 2-17 Diagram of the ice storage system

2.5.5.4 Water consumption

The data of water consumption of several Antarctica research stations was collected but limited. German Neumayer Station is located on Ekström Ice Shelf, where the water consumption per person per day is 117 liters (Enss, 2004). In the American Amundsen-Scott Station, the water consumption per person per day is estimated at 95 liters (Number of personnel living there in summer is 230 -235；NSF, 2004). The water supply required was calculated to be 150 liters per person per day in the Korean Jang Bogo station, which includes water needed for cooking, washing and personal hygiene.

When the proposed station is in operation, the station will need 7200 liters per day for 80 summering expeditioners' daily use (average 90 L/head/d) including drinking, cooking, brushing, washing, bathing and sanitary water. Among which, 4320 liters are from seawater desalination, for daily drinking, cooking and brushing, the rest 2880 liters of daily use water will be the recycling water up to the standard after treatment as shown in Tab 2-4.

Table2-4 Estimation of water consumption in summer

No.	Use	Number of people	Water used (L/d)	source
1	Drinking and Cooking	80	1656	Sea water desalination
2	Utensils cleaning, Brushing and washing, and Bathing	80	2664	Sea water desalination
3	Simple cleaning of clothes and articles	80	1440	Reuse of grey water
4	Sanitation cleaning and toilet flushing	80	1440	Reuse of grey water
	Subtotal		7200	

Once the proposed station is in operation in winter, the station will need 2700 liters water per day for 30 winter expeditioners' daily use (average 90 L/head/d) including drinking, cooking, brushing, washing, bathing and sanitary water. Among which, 1620 liters are from seawater desalination, for daily drinking, cooking and brushing, the rest 1080 liters of daily use water will be the recycled water up to the standard after treatment as shown in Tab 2-5.

Table2-5 Estimation of water consumption in winter

No.	Use	Number of people	Water used (L/d)	source
1	Drinking and Cooking	30	620	Sea water desalination
2	Utensils cleaning, Brushing and washing, and Bathing	30	1000	Sea water desalination
3	Simple cleaning of clothes and articles	30	540	Reuse of grey water
4	Sanitation cleaning and toilet flushing	30	540	Reuse of grey water
	Subtotal		2700	

2.5.6 Waste water treatment and grey water recycling system

To minimize environmental impact, the principles guiding the design of the waste water treatment and grey water recycling system are the first, secondly, to make rational layout so as to minimize land use, and thirdly, to operate safely and reliably and make the system easy to manage and operate with higher auto-control functions.

Korean Jang Bogo has used Internal Circulation in a Sequence Batch Reactor (IC-BSR) to maximize the reuse of water and to discharge relatively clean water through a high-level treatment. (BOD <5mg/l, COD< 20mg/l, TN < 20mg/l and TP< 0.2mg/l)

The new wastewater treatment system at Scott Base has selected the submerged aerated media process and the proposed effluent quality. (BOD < 20mg/l, SS< 20mg/l and faecal coliforms < 100cfu/100ml)

2.5.6.1 Water saving products and source separation system

Well-designed products can be helpful to the environment and high efficiency faucets, clothes washers and toilets etc. will be applied. Upon the consideration of small amount of water consumption, environmental protection, easy management and simplification of treatment facilities, a negative pressure free-of-flushing system will be used in the toilet to reduce the capacity of black water.

2.5.6.2 Sewage treatment and grey water recycling process

The proposed station will set up an integrated container-type of sewage treatment and grey water recycling system. The system mainly consists of sewage tank, regulation tank, membrane biological reactor tank, granular activated carbon (GAC) tank, desalination water tank, Ultra-Filtration/reverse osmosis tank, out-tank pump valve and filters. It is a sealed unit made of stainless steel plate. Without special attendee, it will operate continuously or intermittently stops at night. One person might be appointed to make routine inspection and maintenance. Residual black water coming from super-filtering unit will flow into a combined rector. According to the dimensions of the container, the sewage treatment and recycling system will be installed in several standard containers (3700 x 2700 x 2400 mm as an integrated unit).

The black water (including night soil and urine) together with the organic solid waste and sludge of the MBR system will be treated by anaerobic fermentation tank. The dried sludge after dehydration unit will be treated by the magnetization pyrolysis furnace, the biogas produced during the anaerobic reaction will be supplement energy source for the boilers.

The lower contaminated waste water through Membrane Biological Reactor will be further treated by GAC, Ultra filtration or Reverse Osmosis. The treated water will be in compliance with the standards of Category Ⅲ of Surface Water in China (GB 3838-2002). It will be recycled for simple cleaning of clothes in the station and toilet flushing and the excess treated water will be discharged back to the sea.

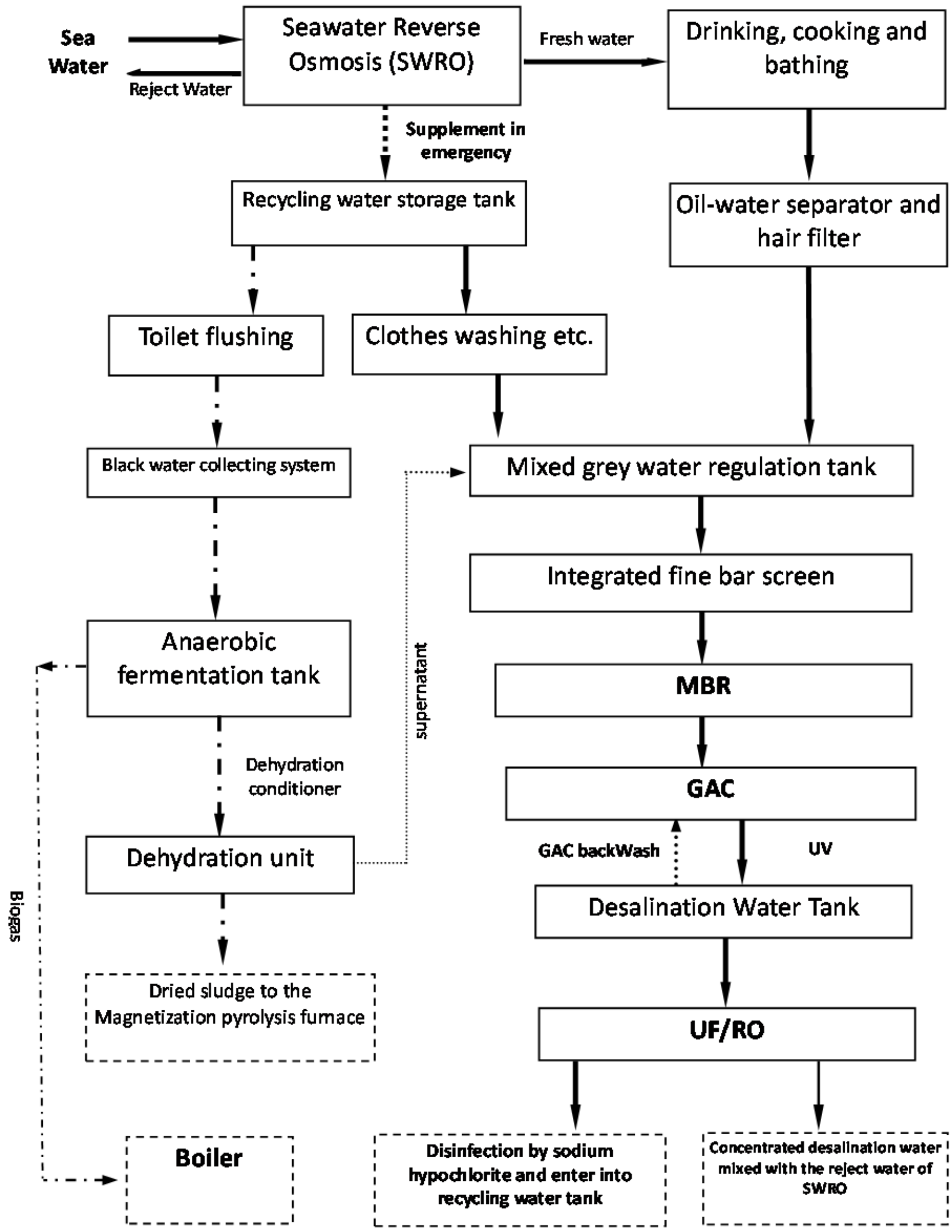


Figure 2-18 Diagram of grey water recycling and black water treatment system

2.5.6.3 Designed water quality of influent and effluent

The sewage of the station is mainly from the living rooms and kitchen. No black water will enter into the grey water collecting system. The water quality of the influent is shown in Tab 2-6.

Table2-6 Designed influent water quality

Indicator	pH	COD_{Mn} (mg/L)	BOD_5 (mg/L)	SS (mg/L)	NH_3-N (mg/L)	Fecal colon bacillus (ind /L)
Designed input water quality	6～9	350～450	180~250	200～300	35～45	100000

The water quality of the swage treated for recycling use or discharge will be in compliance with the standards of Category Ⅲ of Chinese Water Quality Standards for Surface Water (GB3838-2002). The control indicators for water quality are shown in Tab 2-7.

Table2-7 Quality of recycling and discharged water

Indicator	pH	COD_{Mn} (mg/L)	BOD_5 (mg/L)	SS (mg/L)	Turbid -ity (NTU)	NH_3-N (mg/L)	Fecal colon bacillus (ind/L)
Recycling water	6～9	≤6	≤4	≤5	≤1	≤1	≤200
Discharged water	6～9	≤6	≤4	≤5	≤1	≤1	≤200

2.5.7 Hybrid Solar- Wind-Diesel power supply system

2.5.7.1 Power load estimation

The total installed capacity of the station is 620kW, with estimated computational load of 240kW in summer and 175kW in the winter as shown in Tab 2-8.

Table2-8 Estimated power load in summer and in winter

Items	Size (m^2)	installed load kW	calculated load in summer kW	calculated load in winter kW	calculated load in emergency kW
Main lodging	950	120	35	30	10
Sub lodging 1	380	40	15	10	5
Sub lodging 2	160	25	10	10	5
Lab	380	40	15	10	5
Main lodging	1198	150	50	40	15
Helicopter library	300	35	20	10	2
Garage	900	30	15	5	0
Storage	160	50	25	15	10
Logistics module (generators, gas fuel dual-energy boilers)	270	40	20	20	15
Logistics module (water supply and wastewater treatment facilities and etc.)	300	30	20	15	10
Logistics module (maintaining hangar)	500	40	10	5	0
Solid waste treatment	30	20	5	5	0
Sub-total	5528	620	240	175	77

2.5.7.2 Microgrid power system

As electric distribution technology moves into new century, many trends are becoming apparent, which will change the requirements of energy delivery. These changes are being driven from both the demand side where higher energy availability and efficiency are desired and the supply side where the integration of distributed generation and peak-shaving technologies must be accommodated. Distribution systems possessing distributed generation and controllable loads with the ability to operate in both grid-connected and standalone modes are an important class of the so-called Microgrid power system as shown in Fig 2-19.

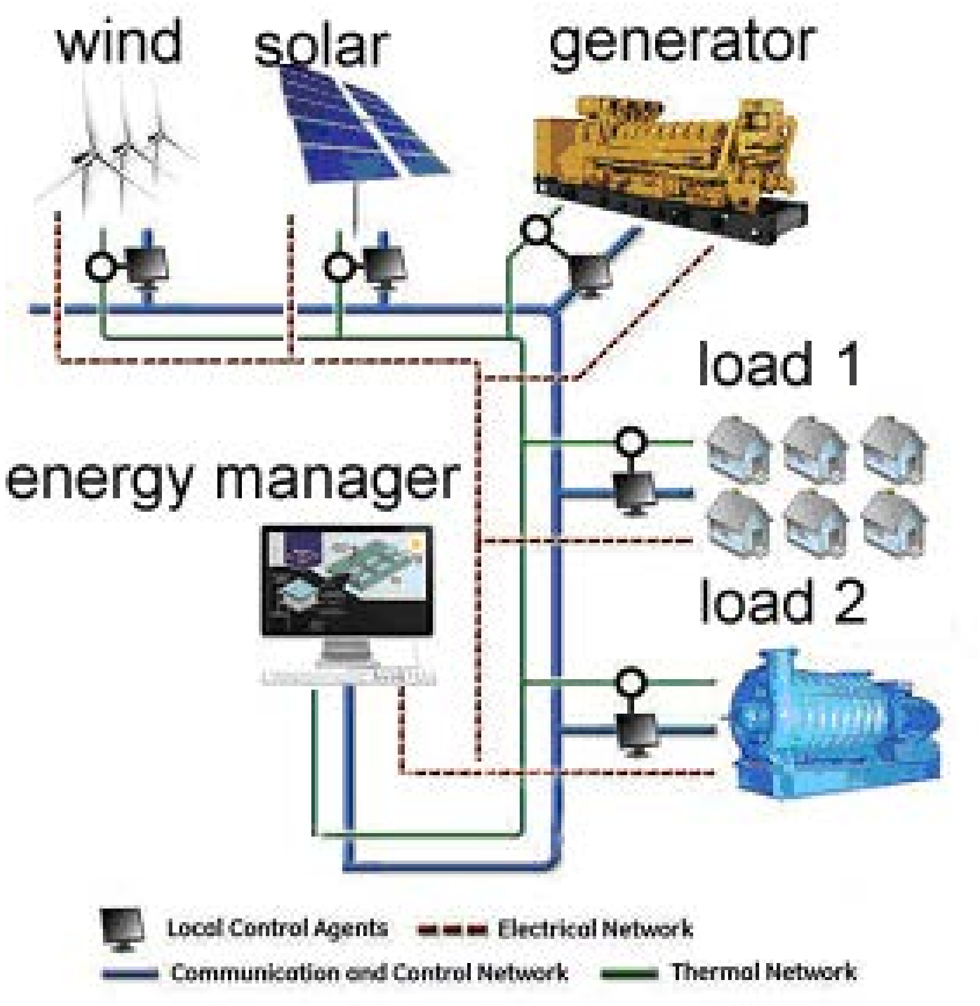


Figure 2-19 Scheme of microgrid system

There will be probably three alternative power supply systems in the new station and a unified energy monitoring system will be set up for effective power management, load distribution and system monitoring. The microgrid power system will serve for the whole station.

A distributed power supply and load-place controller will be applied for microgrid power system, to achieve power balance control, system operation optimization, fault detection and protection and power quality control. The principle of the microgrid system design is to prioritize the use of renewable energy including wind and solar, and to minimize the output power of the electrical generator.

The solar and wind power generation is given priority to the Antarctic new stations energy system, and the diesel generator is complementary to guarantee the load application of the stations in case of the peak load and unstable situation of the renewable energy system. Solar power installed capacity of 50 kW and wind power installed capacity of 300 kW, to make a hybrid Solar-Wind-Diesel power supply system. In summer, solar power and wind power is given the priority, while wind power is given the priority in winter. Monitoring system will be set up to the operation of the system.

Solar photovoltaic power generation is to use the solar cell array changing solar energy into DC energy. Wind power generation is converting wind energy to dc energy. Through the DC/AC inverter, the DC out of solar or wind power will be changed into AC, as power supply to Antarctic survey. The surplus energy will be stored in the battery. Fig 2-20 shows the solar and wind power generation system diagram. Reduce the capacity of the battery in this system as far as possible. Because battery could increase cost and system complexity, when designing solar and wind power, generation capacity should be balanced with the load power consumption as much as possible. In addition, system can also be combined with diesel generator to get a hybrid power supply system, which can improve the system efficiency and reliability.

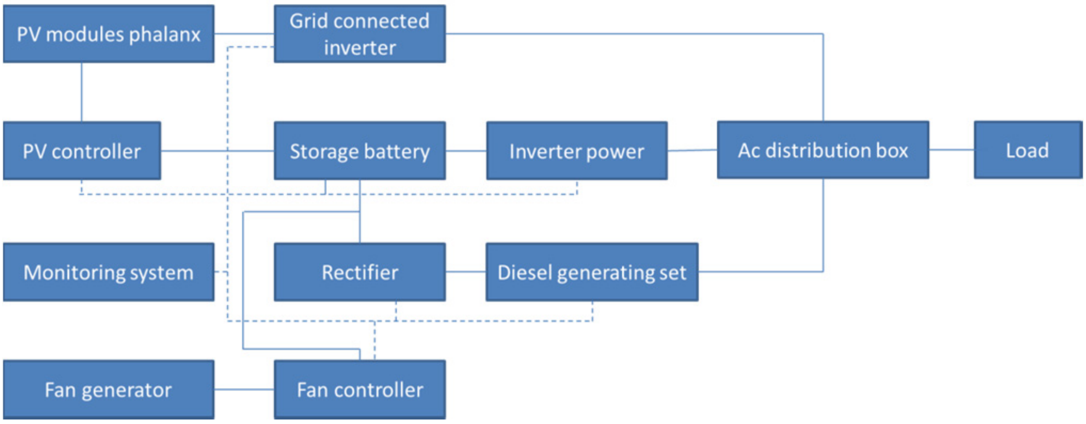


Figure 2-20 Diagram of solar and wind power generation system

2.5.7.3 Solar photovoltaic power generation system

Solar photovoltaic system installed capacity of about 50 kW with PV module selection of single crystal silicon PV module, according to the 70 °angle of inclination toward the north installation, mounting height should be more than the height of snow, to avoid accumulation of snow as well as taking wind capacity into consideration. Considering the shadow effect, it needs alternative arrangement. Installation position should take slope, the use of the elevation difference into consideration in order to reduce shadow effect and covered area. System can be configured one 50 kW grid inverter, with output voltage 380 V, 50 Hz. Annual generation capacity is about 50500 kWh. System can be configured one 50 kW grid inverter, with output voltage 380 V, 50 Hz. Annual generation capacity is about 50500 kWh. Solar panels will be installed with the latest technology. The BIPV (Building-integrated photovoltaic) will be suggested in priority considering the strong wind in the proposed area.

2.5.7.4 Wind power generation system

The installed capacity of wind power generation system will be up to 300 kW. Wind turbine selection is according to the matching of the voltage level, demand power, installation conditions determined, space saving, convenient for construction, low maintenance and minimization of noise. For single wind turbine, if it is larger and higher, it will be more difficult for transportation and installation.

15 rotor vertically type wind turbines (UGE-9M) will be installed, the maximum output power is 20 kW for each (rated wind speed is 15 m/s), and the total capacity will be 300 kW. The total height of the turbine is 9.6 meter, the width is 6.4 meter, the swept area is about 61.44 m^2, and the weight is about 4 tons. The cut in wind speed of the turbine is 3.5 m/s and the cut out wind speed is 30 m/s, while the survival wind speed is up to 50 m/s.

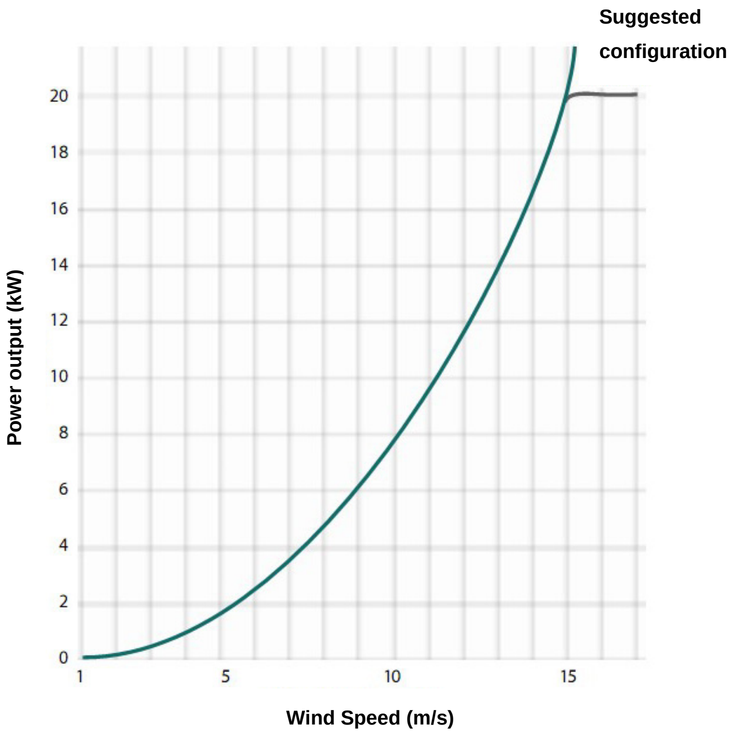


Figure 2-21 Diagram of output power curve of UGE-9M

2.5.7.5 Diesel power supply system

It is recommended that there will be 5 diesel generators (150kW each) in the station. During the first phase, 3 diesel generators will be set up, one in operation, one at standby and one under maintenance. The 380V 50Hz AC output of the generator can serve the entire station when the renewable energy is not sufficient. During the second phase, the load of the entire station will be around 240kW, and then 2 more generators will be equipped, the peak load can be 300kW, two in operation, two at standby and one under maintenance.

The number of the running generators is dependent on the consumption load and the efficiency of renewable energy system. The centralized control and shift system will automatically adjust the generators to improve the efficiency and reliability.

2.5.7.6 Emergency power supply system

Safety is the most important factor for each research stations in Antarctica. The emergency power supply system is necessary to ensure the survival during the accidents of the normal power supply system. The capacity of the emergency power supply system depends on the location of the station and the availability of rescue. In any case, it will be difficult during winter. So the capacity of the emergency power supply system should cover all the necessary supply for living and communication of the over-winter personnel. The estimated emergency load will be around 60-80kW.

The hybrid Solar-Wind-Diesel power supply system is more reliable than the single power supply system, when one of the power system is damaged, the microgrid system can shift to another available energy system automatically. The renewable power system is around 300 m away from the station, so the probability of suffering damage together is limited. In case of the unstable of the wind power during winter, in order to protect the power distribution facilities in the power center, the diesel emergency power supply system will be prepared. In case of emergency, when the hybrid Solar-Wind-Diesel power supply system is abnormal, the emergency generator can supply electricity. Since the station load then will be up to 70kW, it is recommended that there will be 2 sets of 150kW generators to ensure the emergency power demand.

2.5.7.7 Power distribution system

A power distribution cabinet will be equipped in the power generation room. In addition, an emergency power distribution cabinet that switches to the emergency power source will be also equipped.

The output cable will be laid in a radiation way to various buildings along the bridges in the intercalated layer of the buildings. An overall power distribution box or power distribution cabinet will be equipped in each functional zone from which power is distributed to each electric equipment or systems. The lines inside the room that uses combustion-preventive or fire-preventive cables for safety will be arranged in the cable tray. The out-door cables can tolerate as low temperature as -90˚C for working and -50˚C for installation.

2.5.7.8 Lighting system

The lighting system consists of general room lighting, out-door lighting and emergency lighting by functions. The in-door lighting source will consist of fluorescent lamps and LED lamps and the outdoor lighting source will consist of LED lamps (working temperature lower than -90˚C), more tolerant of low temperature. The emergency lamps equipped with individual batteries will be installed in the power distribution rooms, the key engine rooms, the stairs and the corridors. Emergency indicator lamps will be arranged in the evacuation route and the exits for safe evacuation.

2.5.7.9 Grounding and safety system

In consideration of the reliability of power supply, the power distribution system in the proposed station will adopt the mode of non-grounding of the neutral point. The safety measures will include the connection between the overall iso-electric potential and local iso-electric potential for balancing the potential and decreasing the contact voltage so as to bring the voltage below the safe value and prevent electric shock accidents. An insulation monitoring unit with warning function will be connected to the outlet of the general power distribution board, which will remind the manager of examination and repair by sending out warning signals. No neutral line or single-phase load will be allowed for the power distribution system and a 400/230V transformer and a RCD will be used for protection. Static electricity prevention measures (by static electricity prevention ground coiled material) will be used on the special electronic facilities. Special soft grounding cables buried under ice will be used as the grounding unit.

Grounding resistance: The grounding of the electric appliances will be made together with the grounding in the overall iso-electric potential combination in the station.

2.5.7.10 Automatic fire alarm system and fire-fighting linkage control system

The central alarming controller for fire alarm that monitors the entire station area will be installed in the room with people on duty. Regional warning controllers are distributed inside the building base on needs. Fire alarming lines, linkage control lines, fire protection telephone lines and broadcasting lines are laid in steel tubes inside the wall. The circuits out of door are armored and laid along the supporters of the facilities.

The system leaves a remote terminal in advance by which the communication system may transmit important data and information.

2.5.7.11 Monitoring and control system for facilities installed

The monitoring and control center for facilities installed is set up in the building of power generators.

The monitoring and control system will monitor and control the boiler system, ventilation system, water supply and drainage system, in-door and out-door lighting system and power distribution system in the station for energy-saving operation and intelligent management.

The monitoring and control cables will be deployed openly in the wire trough on the wall inside the generator room and the out-door trunk cable are armored and will be deployed along the supporters of the facilities.

The system leaves a remote communication terminal in advance by which the communication system can transmit important data and information.

2.5.7.12 Communication and information system

In consideration of its remote location and harsh environmental conditions of the station, it is imperative to build up a reliable telecommunication system.

The maintenance of no interruption of the telecommunication system at any case will be a major issue to be considered in the design of the communication system. Therefore, the system design considers not only the preparation of the duplicate equipment for that between different and in the same communication systems, but also the distribution of the location of the communication equipment. The construction of the communication and information system will include radio telecommunication system, local computer network, telephone auto-exchanger system inside the station, radio communication system inside the station, remote tracking and management system for the transport vehicle convoy, aircraft radio communication system and the software application system.

2.5.8 Heating and ventilation system

As the outdoor temperature will be very low, it is planned to use the concentrated ventilation system with heat recovery units.

2.5.8.1 In-door design parameters

For energy-saving and comfort feeling, room temperature will be controlled between 15 to 20˚C. The specific heating parameters for various rooms are indicated in Tab 2-9.

Table 2-9 Design parameters for heating and ventilation

Functional zones	Room temperature (˚C)	Ventilation (m^3/h per capita)
Accommodation	18~20	50
Store house	5~10	50
Scientific, office and communication rooms	15~18	50
Kitchen	15~18	3times /hour
Living rooms and entertainment	15~18	50
Facilities	10	4times /hour
Toilets and washing rooms	16~20	1.5times /hour
Sewage treatment	5~10	4times /hour

2.5.8.2 Out-door design parameters

According to the previous long-term observatory data produced by Manuela station, the annual average temperature of the regions is -18.5℃ respectively. The recorded extreme low temperature is -42.3℃ (September. 1st, 1992), the recorded highest temperature is 6.9℃.

2.5.8.3 Heating load estimation

The maximum heating load for the proposed site will be up to 184.9 kW which includs the 50kW (Intermittent load) for hot water supply and 134.9 kW for building heating.

2.5.8.4 Thermal management system

Generator cooling water is used for hot water heating， steam is used for sewage treatment facility and flue gas pipe insulation, phase change thermal storage system is used for water supply, and air heat pump technology is used to enhance the fresh air temperature and lower the emission air temperature.

In order to minimize the heat loss and energy consumption, try to keep the external transfer pipelines above freezing point, and reduce the temperature difference between inside and outside of the pipelines, reduce the length of outside pipelines and try to install pipelines within the building and the corridor.

The thermal control system will be used to distribute heat throughout the system as shown in Fig 2-22.

Step 1, the circulated water from customer-side will exchange the heat with generator cooling water.

Step 2, the heated circulation water will pass through the evaporator of heat pump system and be cooled, the cold drinking water will be heated in the condenser of heat pump system.

Step 3, part of circulated water will exchange the heat with sewage treatment system, the temperature of the drainage of the treated sewage will decrease and the temperature of the circulated water will increase.

Step 4, the circulated water will pass through the thermal storage system and exchange the heat with each other and increase its temperature. The thermal storage system will use middle temperature phase change materials to store the heat generated by residue electric energy.

Step 5, heated circulated water will be pumped to the buildings and try to keep the temperature inside the room, then the circulated water cooled down by the heat pump and flowed back to the generator cooling water heat exchanger, and then the next cycle started. The heat drawn from circulated water is used to heat the cold fresh air by heat pump system.

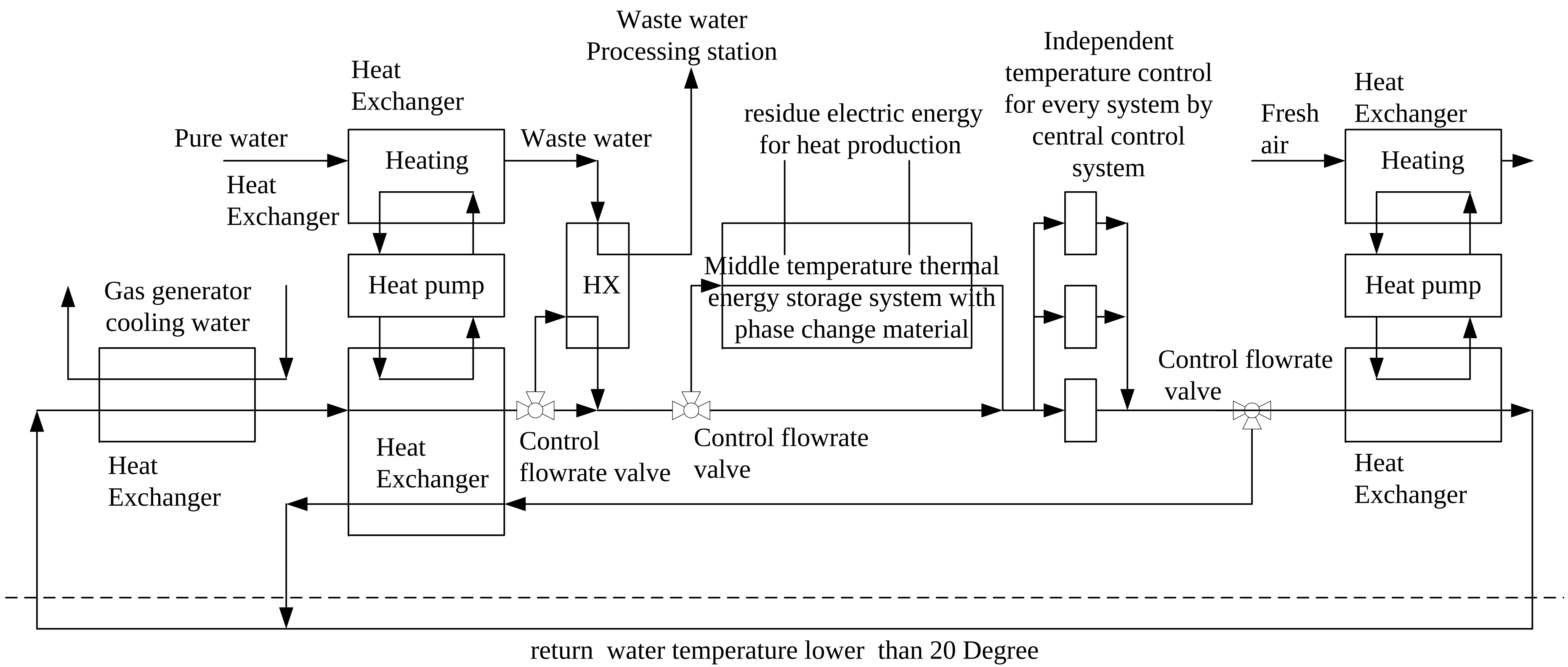


Figure 2-22 Diagram of thermal control system

2.5.8.5 Thermal source

Thermal sources of the new station include windmills, solar thermal exchanger, generator residue heat and boiler. Windmill and solar photovoltaic power generation will be the primary thermal source for the new station. The sufficient wind power will be able to change to thermal source and be stored. There are 3 sets of 150kW generators in the station. At the same time, the cooling water of the generator can provide 30kW of heat, which can also be used to circulate water of the heating system and the domestic hot water. Altogether, when the generator is working normally, residue heat that can be recovered is about 60kW. The station can use waste heat to satisfy its heating demand without the boiler, when domestic water demand is at its peak and the boiler will be started as supplementary.

2.5.8.6 Thermal storage system

Medium temperature phase change thermal storage devices will be suggested to store the heat from the high-grade redundant power generation, the theoretical maximum storage temperature is up to 400℃ as shown in Fig 2-23. Comparing to the water storage system, the volume of the phase change thermal storage devices is reduced significantly and the leakage problem is also prohibited. The module phase change thermal storage devices will be equipped with electric heating pipe and heat exchanger to make the water hot.

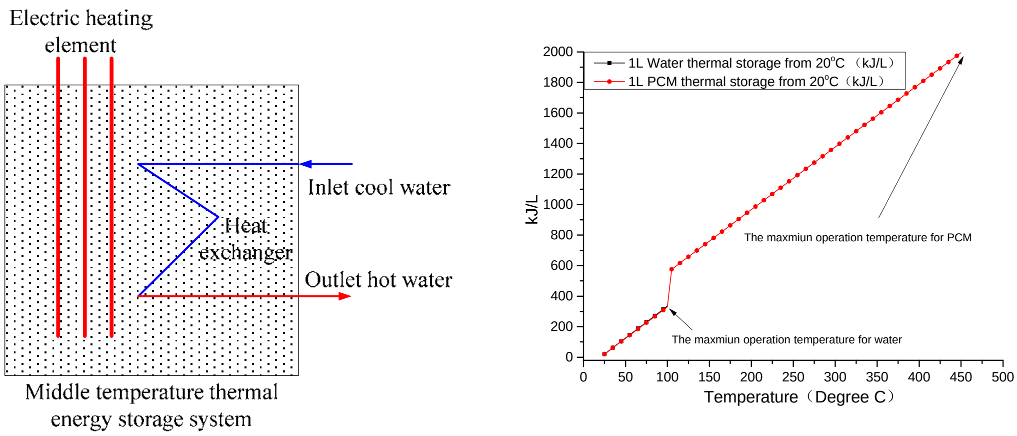


Figure 2-23 Schematic diagram of middle temperature thermal energy storage system with PCM

2.5.8.7 Heating system for buildings

1. Centralized buildings

The centralized buildings including the accommodation, office, living rooms, scientific observation, and communication etc., the circulated heating water system will be used. Both of automatic centralized control system and manual control system will be applied to adjust the temperature inside different functional areas. Phase change thermal storage floor will be used for all the buildings as shown in Fig 2-24.

2. Decentralized buildings

The garage, store house and other decentralized buildings are far from the heat sources, the electronic radiator will be applied to reduce the heat loss of long distance transmission. Most of the electricity will come from the renewable windmills and photo voltage cell plates, and the phase change thermal storage floor will preserve the heat better.

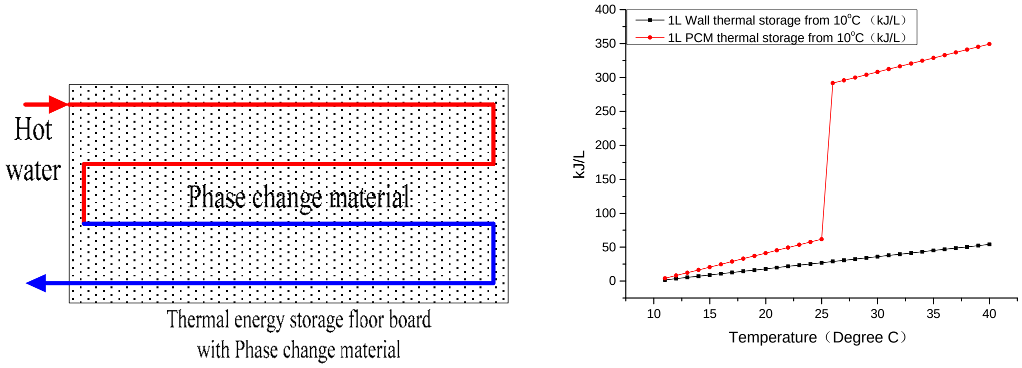


Figure 2-24 Schematic diagram of thermal energy storage system with PCM

2.5.8.8 Ventilation and fresh air heating system

The ventilation system includes fresh-air handling unit and heat recovery unit. Fresh air from outdoor will transfer heat with the discharged air (around 20℃) in the heat recovery system, and then be further heated and humidified to around 40℃ before it is sent indoor, while the cooled air will be discharged.

Considering the low temperature in the proposed site, the energy consumption of the heating for the fresh air before entering into the rooms is high. Vacuum tube solar air heating system as shown in Fig 2-25 is proposed to preheat the fresh air during summer, it is an effective supplement to the wind power and the efficiency is higher than the photovoltaic systems.

The centralized buildings will have two separated fresh air ventilation system, one is for accommodation area and the other is for scientific activities.

There will be process ventilation system in the logistics module and complex storage, to satisfy ventilation and safety demand of the power house, boiler house, pump house and the switch house.

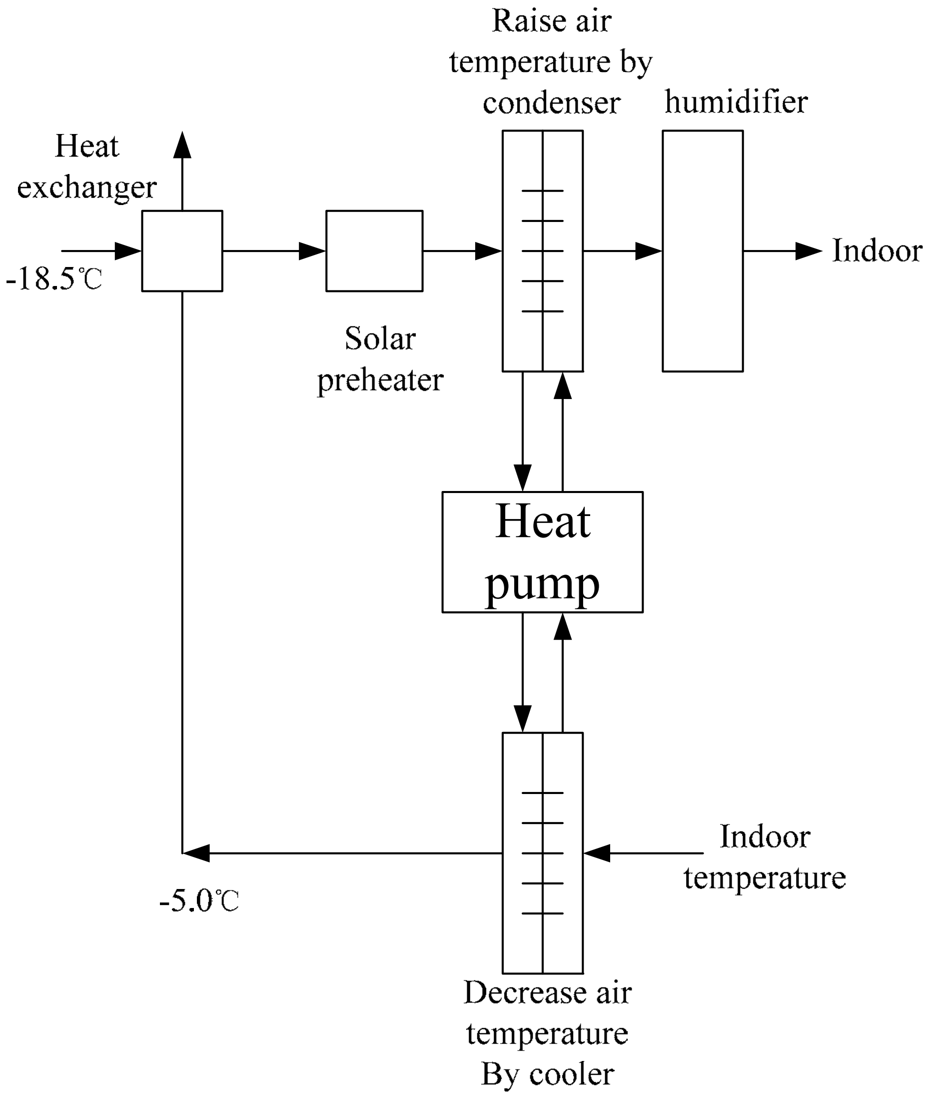


Figure 2-25 Schematic diagram of fresh air preheating system

2.5.8.9 Drinking water heating system

During winter, most of the fresh water will be stored in the form of ice blocks. The drinking water tank will be equipped with heat exchanger to keep the temperature of the drinking water 15℃, ice blocks will be supplied according to the water depth inside the tank, when the temperature is below15℃, the heat exchanger will start automatically to heat the drinking water.

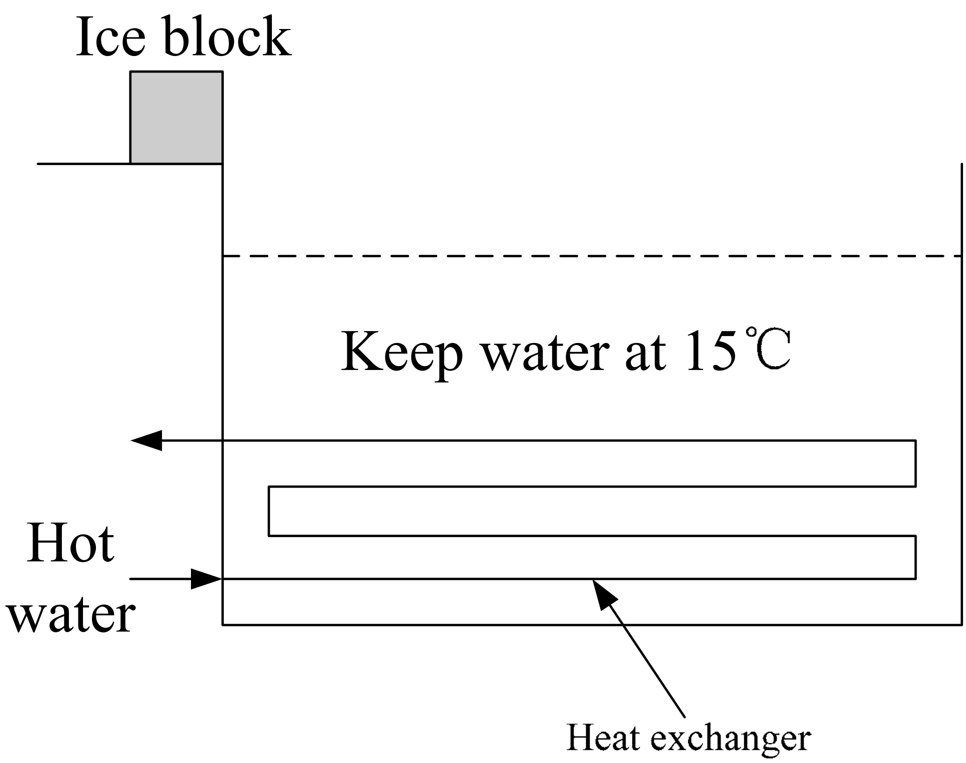


Figure 2-26 Schematic diagram of ice block melting system

2.5.9 Structure and foundation

2.5.9.1 Structural design and construction

Direct landing steel bent structure will be used for the garage and helicopter library, while steel frame structure will be applied in the upper part of other buildings. The lower overhead layer will be a steel platform composed of diagonal support members to support the upper part.

Reinforced concrete panels will be used for all floors and the part of roofs (for manual operation). For irregular planes or pipeline centralized site, situ reinforced concrete with pressure plate will be used. Roofs without manual operation works and all the outside walls insulated sandwich steel plate will be used.

The structure of the windmill is steel. It is recommended that the tower may be considered to increase the steel support diagonals without affecting the operation of the windmill.

2.5.9.2 Foundation design and construction

1. Geological condition of the site

The flat areas are covered by moraine gravel and glacial moraine, the depth is unknown. The hilly areas are estimated to be bedrock, mainly the weathered granitic rocks. More detail will be introduced in section 4.

2. Foundations for buildings

The reference of engineering geological exploration is limited in the proposed site, and the detailed investigation will be carried out during the 30th CHINARE in January 2014. Combined with previous experience in the Antarctic projects, considering the minimization of on-site construction works and environmental impact, the possible countermeasures were summarized as follows:

(1) If the site is flat, the bearing capacity of the lower part of the foundation is reliable and natural foundation can be used. The foundation can be prefabricated independent foundation. (Experience from Great Wall Station).

(2) If the site is hilly and the bedrock surface is exposed or shallow, situ reinforced concrete pier foundation with rock anchorage can be used directly on the bedrock (Experience from Zhongshan Station).

(3) If strongly decayed rock (gravel) sets on visual depth and lower part is middle decayed or volcanic rock which has strong bearing capacity. Under this circumstance, using pre-stress bolts to anchor into rock layer in a specific depth to resist the pull-out strength. The foundation can be built on the rock directly after clean upper gravel.

(4) If all depth of the site is gravel. Under this circumstance, using partial grouting method to reinforce the subgrade, using bolts anchor into grouting layer to resist the pull-out strength.

(5) If shallow layer is gravel and lower layer is clay. Under this circumstance, to build the foundation on the clay directly after clean upper gravel, using bolts anchor into clay in a specific depth to resist the pull-out strength. If the site and foundation underneath is complicated and variable, miniature steel pipe pile foundation can be used.

3. Proposed foundation for windmills

Anchor bolt steel foundation is selected in design to overcome the disadvantages of the traditional foundation. It uses prefabricated steel foundation instead of reinforced concrete, which can save its self-weight dramatically and be installed easily. As shown in Fig 2-27, the foundation is constituted by a steel box instead of the concrete foundation. Pre-stress anchor bolt is used in this type of foundation to decrease the bottom area of the foundation. As the result the execution volume is significantly decreased in anchor bolt foundation comparing to that of traditional foundation.

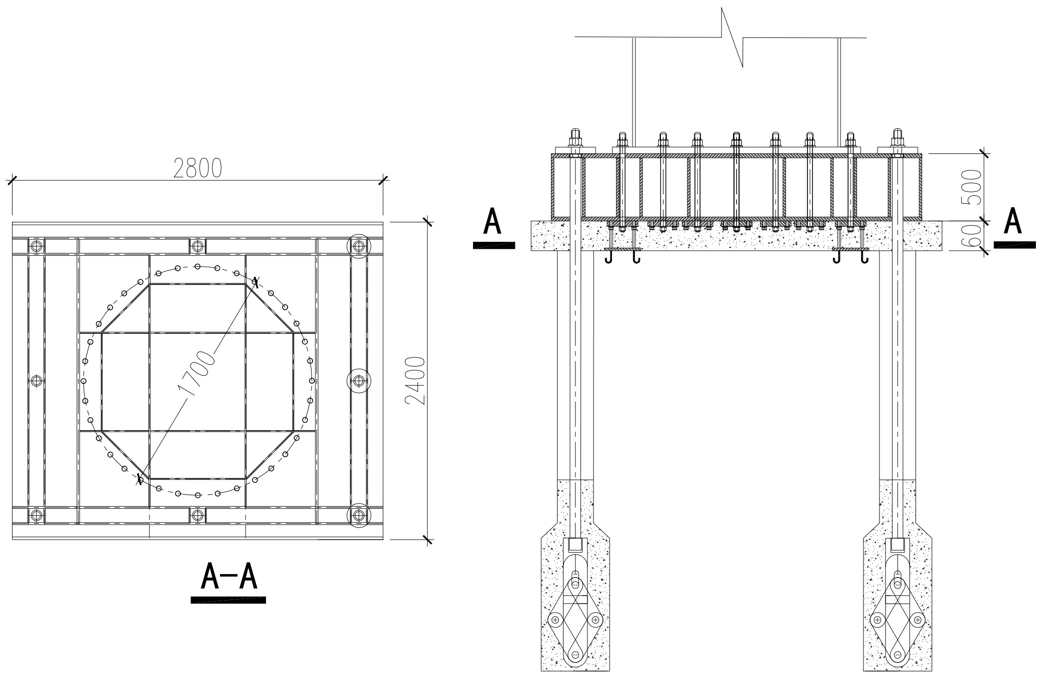


Figure 2-27 Rock anchor bolt foundation sketch

To apply the anchor bolts, special expending drill is used to make the expending foot at the end of the hole. This aiguille needs to drill a 0.7m depth's expending hole on the bottom of the normal hole. Percussion drilling machine will be compatible with this kind of aiguille, which is easily executed and transported to the site.

After drilling the expending hole, the rhombus expanding anchor bolts should be put into the expending hole to let it develop automatically. Then use grouting to connect the rhombus expending feet and rock hole. Finally, pre-stress on the top of the anchor bolts after the concrete meet the strength.

2.5.10 Emergency facilities

For guaranteeing human life and living safety, the proposed station has taken into consideration the construction of emergency facilities, which consist of emergency power generation cabin, emergency accommodation cabin, emergency living cabin, life vests, tents and other emergency facilities. Their specification and quantity are described in Tab 2-10.

Table 2-10 Description of emergency construction

No.	Item	Description	Remarks
1	Emergency power generation cabin	1 container	80kW, 2 sets
2	Emergency accommodation cabin	4 containers	30 people, each for 8 people
3	Emergency living cabin	1 container	Cooking and communication
4	Emergency storage	2 container s	30 people, foods etc.
5	Emergency freeze storage	2 container s	30 people, foods etc.
6	Life vests	30 sets	30 people
7	Tents	15 sets	2 people in each
8	Other emergency facilities	1 container	30 people, Snow sticks, bags, ropes, walky-talkies

2.5.11 Special machineries

The machineries and vehicles in the proposed station will be mainly used for the construction project, construction maintenance and repair, loading and unloading operation, clearance of road surface and accumulated snow, haunting and lifting operations and materials transport, etc. The transport vehicles are used inside the station or for short-distance transport in the field.

1) Environmental requirements for special machineries and transport vehicles

Firstly, the storage batteries, starters, hydraulic, oil lines and electricity systems for special machineries and vehicles should tolerate low temperature and meet the operating requirements in the proposed area. On these facilities, electricity or boiler pre-warming systems will be installed to guarantee the normal starting. Secondly, as the annual average wind velocity is 12m/s in the proposed region, the particular selected machineries should have excellent properties of sealing and heat insulation, and be easy to remove effectively accumulated snow from them. Thirdly, the low oxygen concentration in proposed region will cause lower combustion and dynamic of the machineries. Therefore, these challenges have been taken into consideration in the selection of the vehicles. At the same time, measures should be adopted to control the hydraulic oil overflowing and anti-freeze liquid under lower atmospheric pressure.

2) Selection and composition of special machineries and vehicles for the construction project

In consideration of the mission of the station and the composition of machineries and vehicles in the foreign Antarctic stations, the Proposed station will be equipped with one light snow vehicle, one caterpillar carrier and five snow motor vans, among which the light snow vehicle will be used for the clearance of road surface and accumulated snow as well as the handling of small articles inside the station, the caterpillar will be used for construction engineering, piling of materials and snow removal and melting and the snow motor vans will be used for the transport of small articles between buildings.

Table 2-11 Construction vehicles and special machineries

Items	Number	Weight (ton/per)
25-ton Crane	1	18.8
50-ton Crane	1	24.4
Excavator	2	47.2
Loader	3	12.6
compactor	1	1.2
concrete-mixer	2	3.6
Light snow vehicle	1	5.7
caterpillar	1	22.6
all-terrain vehicle	2	1.6
Self-acting truck	1	12.3
Tracked trailer	1	23

2.5.12 Floating dock design and operation

During the construction and operation period of the proposed new station, a large number of materials, equipment, supplies and other goods need to be shipped from China and unloaded to designated areas. Considering the limited water depth, small motorized barges will be used to transport the goods from R/V Xuelong to the dock, after which the goods will be lifted on the dock to the land.

According to the local environment conditions, the inclining floating dock is the most suitable choice during the temporary construction period. The structure can minimize the impact on sea environment as well as the resistance to environmental load such as pack ice and wave force. Compared to other structure types, the floating pier and floating dock can minimize the impact on the natural landscape and biological disturbance. The location of the mobile dock is dependent on the water depth around the coast lines as shown in Fig 2-28 and Fig 2-29.

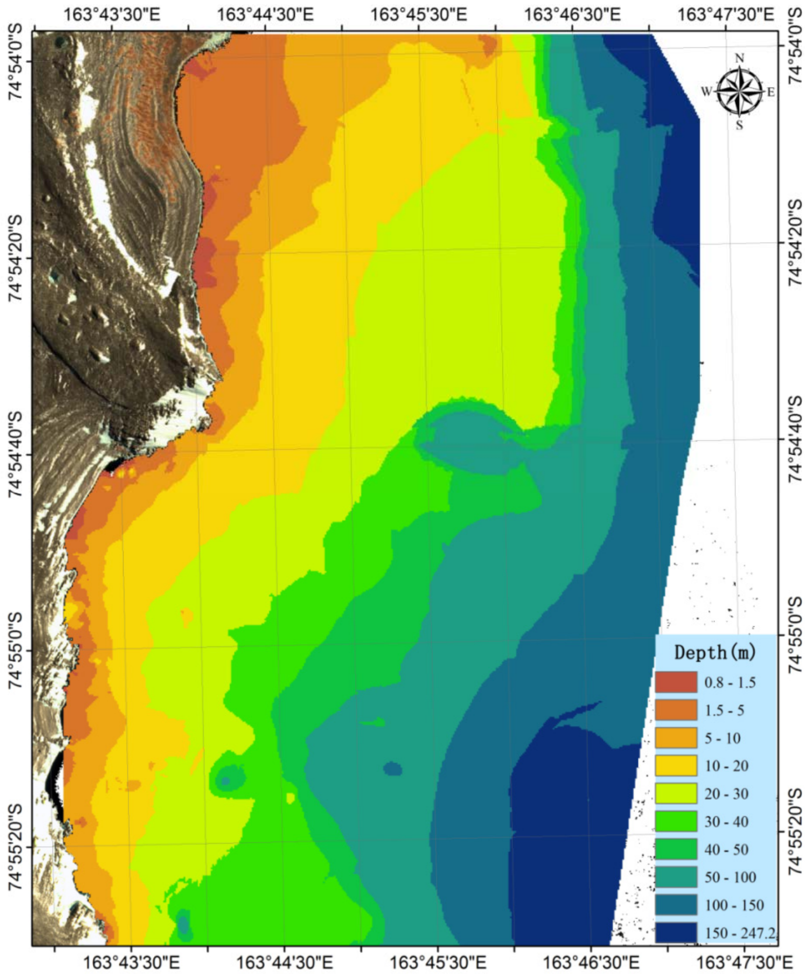


Figure 2-28 Water depth near the proposed site

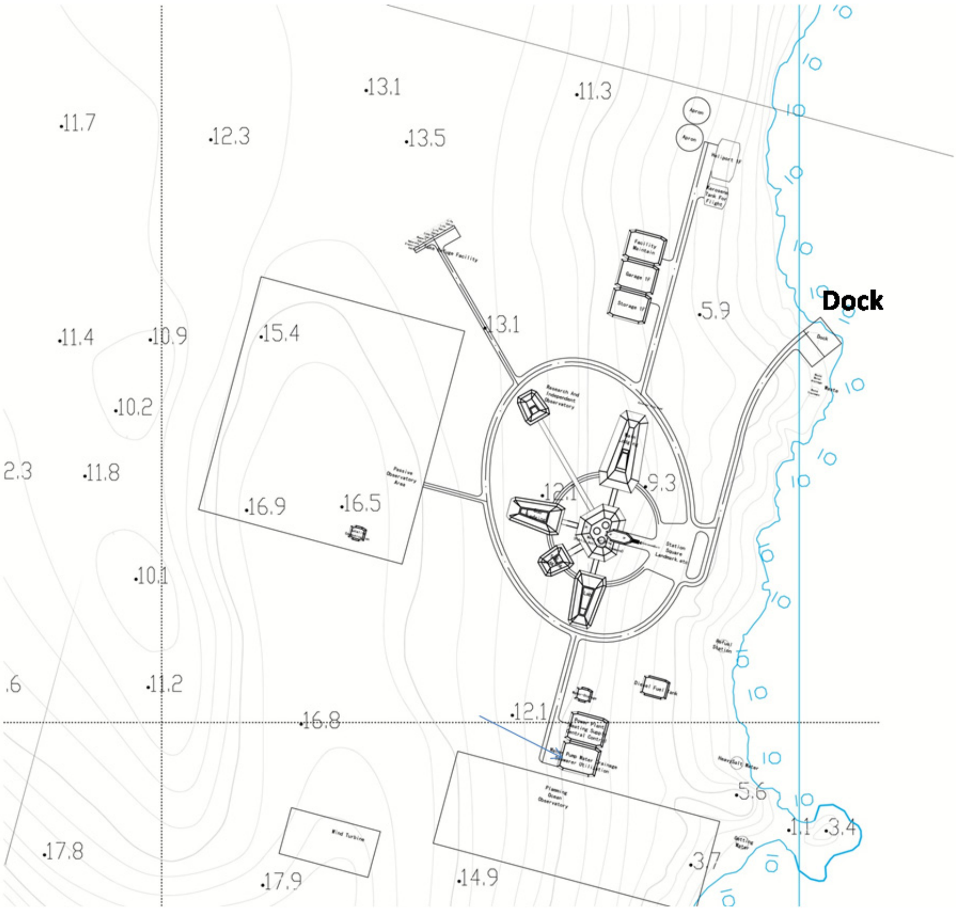
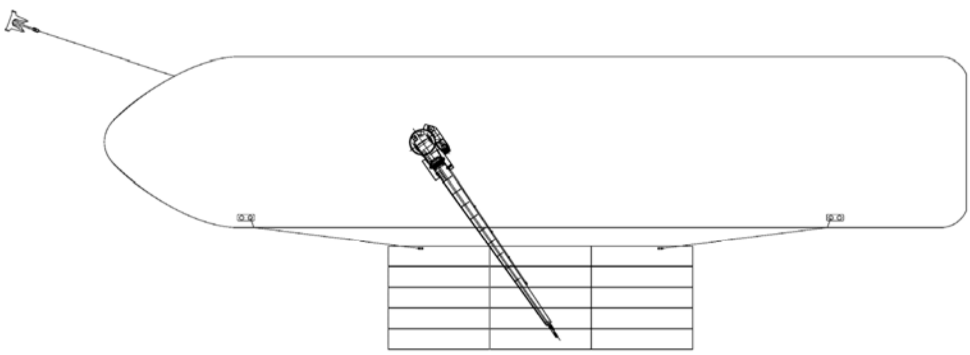


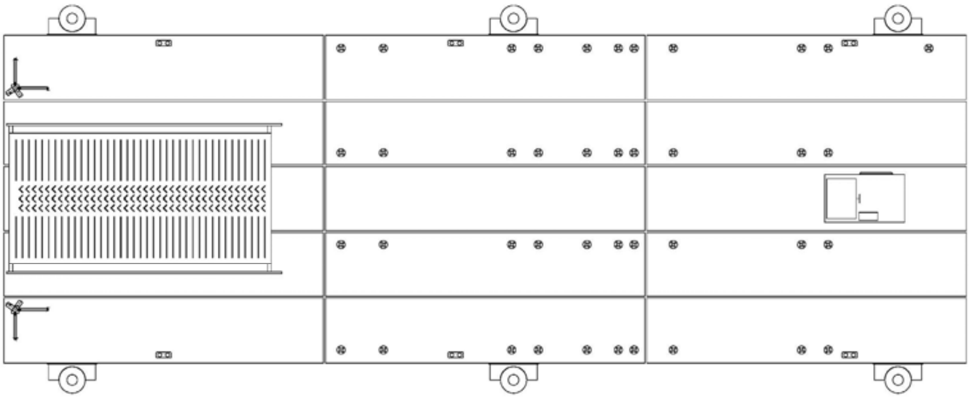
Figure 2-29 Location of the proposed dock

The typical barges used in the new station will be small motorized barges，so the designed length of the floating dock is 36 meters and the width 12.5 meters.

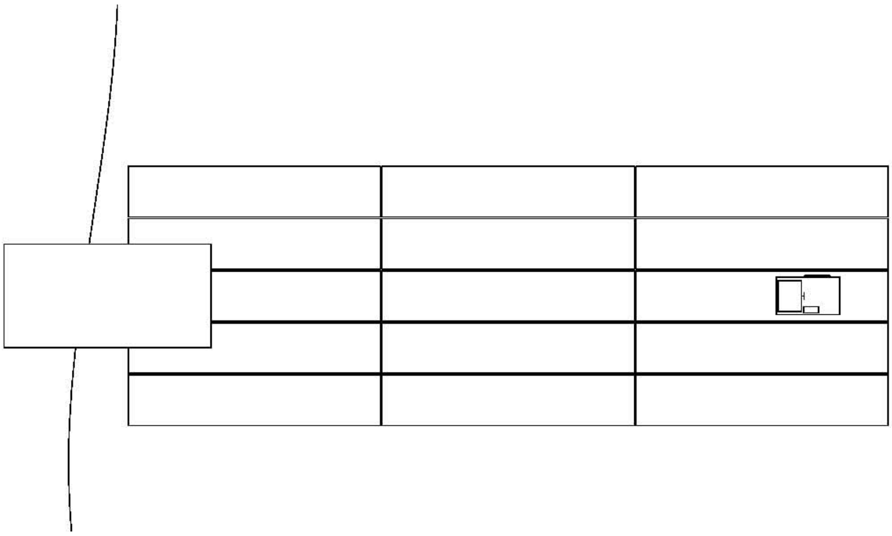
Firstly, the floating dock will be unloaded from R/V Xuelong using large lifting equipment and then connected. Crawler crane will also be unloaded onto the floating dock from XUELONG RV using large lifting equipment.



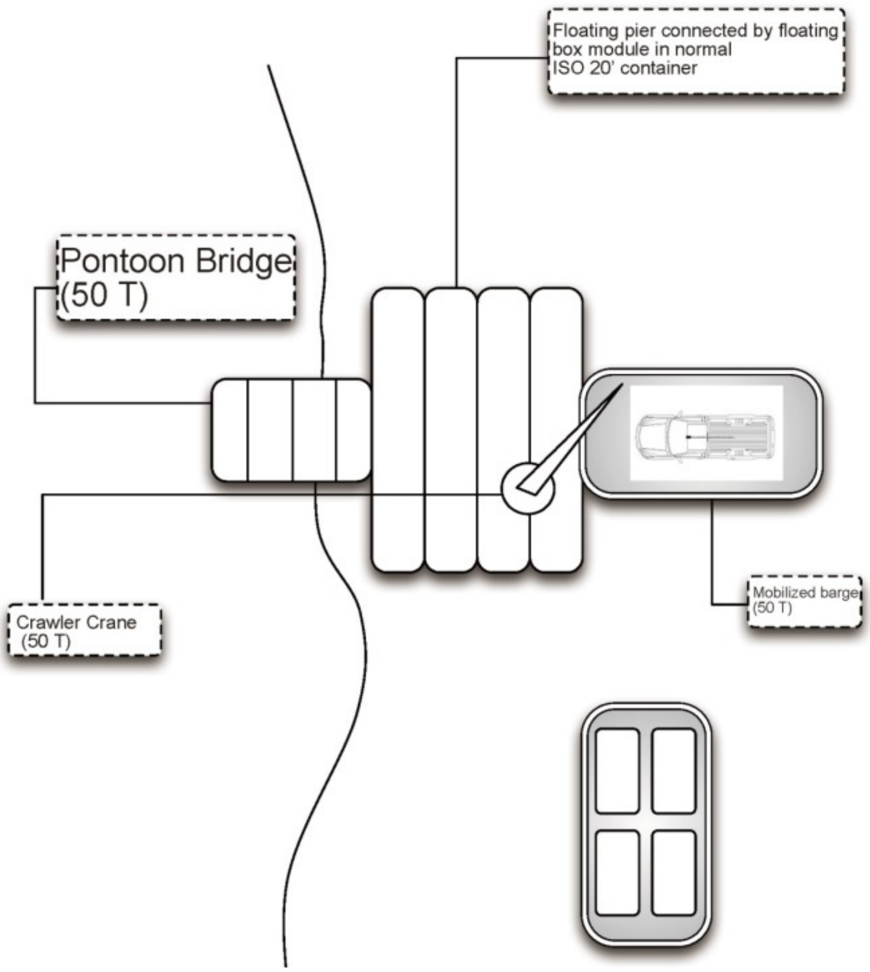
Secondly, the floating dock will be hauled to the proposed site by barges and anchored.



Thirdly, the floating dock will be anchored to the proposed site and set struts to make the steel bridge connected with the land.



Fourthly, the floating dock will be ready for operation. All the goods will be unloaded by the large lifting equipment of XUELONG RV to the barges, which will then transport to the floating dock and parking. After that, the crawler crane on the floating dock will shift the goods from the barges onto the dock, and then the trucks will transport the goods from the floating dock to the proposed site on the land through the steel approach.



2.5.13 Test and acceptance

Test and acceptance of the prefabricate buildings will be made one by one in accordance with the performance in the design. The major buildings of the station will be pre-assembled and comprehensively tested at home first. In addition, the test will be made on some key systems such as the power generation system, solar energy photovoltaic system, wind power system and sewage treatment system to ensure their designed function and reliability.

2.5.14 Transportation during construction period

Having passed the test, the buildings are dismantled and packed for shipping in ISO-norm containers. No damage is ensured to the building materials in the course of normal shipping. After the installation and internal of containers are completed, then the containers can be transported directly.

During the construction period, on the way to the proposed site, foods for the staff will be mainly airline food that is ready once heated. The packing articles are compressed and stored. The vehicle convoy will also bring with it a packet free of water toilet and all the human excretions will be packed and brought back. The vehicle convoy will bring with it a small solar energy boiler for melting snow and heating water by solar energy for daily brushing and washing. At present, the solar energy water boiler has been on trial in the inland Antarctic.

2.5.15 Engineering work in situ

In consideration of the extreme geographical and climatic conditions, especially the low temperature and strong wind at proposed site as well as to reduce the environmental impact to a minimum, the construction will be done mainly by assembling prefabricated containers in the field to reduce as much workload as possible.

The solar-wind energy power generation system will be built up with the battery boards prefabricated at home and by assembling them in situ. The parts are connected with plug-pull connectors before the shipping. This way of design will not only be convenient to the installation, but also reduce the risks of electricity shock against the expeditioners in the field.

2.5.16 Upgradeability

The Proposed station is designed to have a minimal lifetime of 25 years. The design has taken into full consideration its upgradeability and capacity extension, such as the routine facilities (including kitchen, sanitary facilities and offices) and emergency shelters. In design, the station will be suitable for accommodating more people. For the supply of energy to the station, the issues of keeping sustainable power and heat supply have been considered. Therefore, it will be easy to use new technologies in the future, to reduce the fuel consumption and pollutant emission.

2.5.17 Archive management

To manage the station more properly, relevant data and documents will be recorded and preserved, which include users' manuals, maintenance manuals, assembly drawings and instructions, spare part lists and emergency procedures. Two sets of backup data will be available for the filing in the proposed station and the domestic management platform for guaranteeing the exchange of ideas and solving technical problems.

2.5.18 Decommission of the station

The design of the station will take environmental protection, safety, energy saving and economy as the principles. It will use as much as possible the sustainable and high energy efficiency technology as well as the renewable energy so as to reduce the waste to the maximum extent. Once the station has to be closed due to technical reasons or other requirements, the station will be easily decommissioned, disassembled and removed, and no obvious remnants of the occupation will be left. The eventual clean-up of the removed station should also be subject to EIA.

2.5.19 Objectives of minimum environmental impact

2.5.19.1 Design criteria

- The estimated maximum computational load is 240kW in summer and 175kW in the winter, excluding a few scientific equipment and support vehicles. The station is designed to use hybrid Solar-Wind-Diesel system during the process of operation. For long terms objectives, the solar energy and wind power will provide majority of power for the whole station and the diesel will only be used in emergency situations.
- An experiment on photovoltaic solar energy and wind power for heating and storage by phase change-thermal storage system will be conducted in 2-4 years.
- The station will use as much recycled water and solid waste as possible, minimize the disposal of solid wastes and discharge treated wastewater up to the standards.
- The station has been designed to guarantee keeping the environmental impact to a minimum degree during the construction, operation and decommissioning

2.5.19.2 Construction and operation principles

The principles of construction, operation and decommission have to meet the requirements of the Protocol on Environmental Protection to the Antarctic Treaty and follow the relevant Chinese domestic laws and regulations.

The management of construction, operation and decommissioning of the station will be under the Framework of the Environmental Management Plan. During all stages including construction, operation and decommission, it has been planned to minimize health and safety risks. The training courses and necessary protection equipment will be provided for all personnel involved to reduce the likelihood of major health or safety incidents. The construction team will be managed by CAA. The key-construction team has already been involved in the pre-construction in Beijing and Shanghai in order to become acquainted with the construction of the station. Expeditioners and constructors will be briefed by the staff of CAA prior to their departure for Antarctica to ensure that they understand and fully comply with the relevant provisions of the Protocol on Environmental Protection to the Antarctic Treaty and its Annexes and related domestic laws. Environment officers will also be appointed to practice and monitor the environmental protection in situ.

2.6 Area of disturbance

2.6.1 Operation area

The area of disturbance includes construction site, material storing area, the route between the R/V Xuelong and the new station and the area around the station. The maximum range of field scientific activities in summer will be 100 km around the station.

2.6.2 Duration and intensity of the construction

The construction of the station is planned to start in the austral summer of 2015/16 and will complete within two austral summers in 2015/16 and 2016/17. The minimum lifespan of the new station will be 25 years. Of course, the duration of the construction depends on weather conditions and transport availability. The capital construction projects consist of the main buildings (scientific research section, technology-supportive section and medical service, etc.), accommodation building, hybrid Solar-Wind-Diesel power supply system and logistical support building, garage and storehouse, emergency system, fuel storage and independent science observation section.

The construction plan will be carried out by PRIC in accordance with Chinese relevant laws and regulations. PRIC will issue bidding calls for the construction and the company which wins the bidding will be the contractor for the construction. A supervising company will undertake the responsibility for supervising the construction. Polar Research Institute of China and the supervising company will jointly check and accept the construction. A small part of scientific facilities will be installed simultaneously with the construction and most of the scientific facilities will be installed in 2016/17, namely the first planned season for scientific and logistic operation.

2.6.3 Measures in line with standards

CAA is developing a series of measures and standards for the management of the operation of the new station in order to guarantee safe and effective operation of the station. The measures and standards will minimize the risks in Antarctic expedition and environmental impact to the maximum extent.

CAA, with the support from station leaders, will oversee and ensure the effective enforcement of the environmental management plan, scientific programs, the rescue plan, medical service plan and other emergency response plans dealing with emergency matters.

2.7 Waste collection and disposal system

A Waste Management Plan (WMP) will be drawn up that will comply with all the requirements of Annex III of the Protocol on Environmental Protection to the Antarctic Treaty. The plan will comprise waste reduction, storage and disposal, removal of treated waste out of Antarctica, as well as the training and education on environment protection to the expeditioners.

The Waste Management Plan will consist of two parts. The first part will cover the management of the waste produced due to the construction of the station and the associated activities. The second part will cover the management of the waste produced due to ongoing operation of the station. The Plan will be regularly reviewed and updated.

The Waste Management Plan covers: waste minimization, waste storage, management and responsibilities, waste handling and disposal, and prohibited products to be brought into and used in Antarctica.

2.7.1 Waste sorting

In the station, all the wastes will be classified and separately stored in different cans. The station will adopt a waste management system. All the solid wastes can be classified into five categories, namely the recyclable wastes, organic wastes, hazardous wastes, unclassifiable wastes and fuel drums, and they will be stored in different rubbish containers respectively. The integrated containerized in-vessel anaerobic fermentation tank will be applied for the treatment of the food and other organic wastes. All the human excrement will be treated by anaerobic fermentation tank, while the residue sludge will treated by the magnetic pyrolysis furnace.

Theoretically all kinds of organic matters including plastic products, paper, plant straw, chemical compounds, rubber products (except wheel hubs), animal bodies and animal excrements can be thoroughly thermal decomposed into ashes, the volume of ashes which is about 2% of original weight and volume.

Inorganic matters, metal, liquid and fluid container etc. cannot be thermal decomposed.

Fresh water animals and plants whose moisture contents are more than 35%, kitchen waste, etc. cannot be thermal decomposed until they are combined with other organics containing less water. If the moisture content of the waste is too high, it must be dried first.

When the combination of organics and inorganics are pyrogenic decomposed, the organic parts turn to ashes and inorganics including metal and glasses can be sifted out for reuse. Compared to the traditional waste disposal methods, the magnetic pyrolysis furnace has significant advantages as follows:

- High efficiency

It takes only one and half hour to dispose one ton of garbage averagely, and the weight of remained dust is one-three percentage of the original weight and volume.

- Low energy consumption

The traditional incineration furnace needs to maintain the temperature higher than 1000 ℃ by heavy oil, and magnetic pyrolysis furnace can be operated under lower temperature, which conserves energy greatly. And the products after the magnetic pyrolysis can be reused as energy source. The additional energy source is only used in ignition and exhaust smoke purification.

- Low investment and separate

The investment cost of the magnetic pyrolysis furnace is only one-third of the incineration facility when disposing the same amount of garbage.

- Environmentally friendly

The magnetic pyrolysis furnace can get rid of generating dioxin which is produced between 340-850℃during the traditional incineration and that will do great harm to the human health and environment in Antarctic.

Table 2-12 Comparison between the incineration and magnetic pyrolysis

Item comparison	**Incineration**	**Magnetic pyrolysis**	**remarks**
Occupation of land	large	**small and separate**	
Site selection	difficult	**easy**	Incineration could do long-term harm to local water and soil environment
Construction investment	quite high	**low and separate**	
Environmental pollution	Serious	**tiny effect**	Utilizing **magnetizing pyrolysis as a solution has no concern for follow-up pollution**
Energy consumption	high	**relatively low**	Low energy consumption and could be driven thoroughly by electricity, which is suitable for garbage digestion in outbreak control in the wild and military process.
Garbage classification	strict classification	**no need**	

The amount of unclassifiable waste will be controlled to the maximum extent. These wastes will be sealed and stored timely. The wastes will be taken and stored in the turnover wastes van in the waste container, and will be compacted if necessary.

The wastewater will totally be treated and recycled, and the limited residual treated wastewater meeting the standards will be discharged into a point optimal for rapidly mixing and dilution.

Packing material should be minimized as much as possible in the process of logistic preparation so as to reduce the production and transportation of the waste.

The container will be brought back to China by R/V Xuelong. When R/V Xuelong arrives, the container full of wastes will be exchanged for an empty one. Additionally, the transport boxes are designed to be easy-moved out of the container for relocation when necessary.

2.7.2 Fuel drums

The empty drums will be reused repeatedly in situ after a serious quality check. Those which do not comply with the requirements will be compacted and transported back to China.

2.7.3 Hazardous wastes

The hazardous wastes include waste batteries, light tubes, adhesion agent and dissolvent agent, other hazardous rubbish, and waste fuel and oil products. The former four wastes will be stored in waste boxes separately while the waste fuel and oil products will be stored in waste fuel drums. These wastes will be fixed in a designated place in a wastes collection container.

Purchase and use of hazardous products will be strictly restricted so as to keep the hazardous products in a minimum quantity. For instance, it will be encouraged to use rechargeable batteries. The hazardous products and their empty packaging will be stored in specific areas and subject to strict monitoring. Those hazardous wastes will be packed in a uniform way before transportation so as to ensure that they will not drop or leak out. They will be shipped back to China and disposed by qualified departments.

3. Alternatives to the Proposed Activity

Several alternative plans of locations and designs have been examined for the construction of the new station, taking into account scientific, environmental, logistic, engineering, health and safety requirements.

3.1. No-action Alternative

Starting the scientific expedition in the Antarctic in the 1980s, China has established the Great Wall Station on King George Island, the Zhongshan Station in Larsemann Hills area in East Antarctica and the Kunlun Station in Antarctica inland. These three stations have become not only good bases for Chinese scientists in the full year’s scientific activities, but also a platform for international cooperation.

Without the proposed activities at the new station, the realization of the Chinese commitment toward active Antarctic research in Ross Sea area is unlikely, and the demands for more information on the change of the Antarctic Ross Sea environment by both Chinese and foreign researchers will remain unmet. International collaborations in Northern Victoria Land with nearby research stations operated by the countries as the United States, New Zealand, Italy, Germany and Korea are expected significantly synergistic for the Antarctic research.

Italy’s Mario Zucchelli Station, Germany’s Gondwana Station and Korean Jang Bogo Station are located in the northeast of the proposed site. However, Mario Zucchelli Station and Gondwana Station are being operated only in the summer and are relatively small-scale facilities. As such, they cannot provide sufficient support for the various Antarctic scientific research activities that China is planning to undertake. Korean Jang Bogo Station is just under construction.

Indeed the no-action alternative, being void of the temporary and cumulative impact caused by the construction and operation of a new station, guarantees full prevention of the impact on Antarctic environment. However, advantages that the new station would bring were assessed to prevail over the negative impact on the Antarctic environment by the station, which will be minimized with the proposed construction and operational design of the station that highlights energy optimization. The new Station will provide comprehensive, in-depth understanding of the role of Antarctica in global environmental changes and enhance China’s contribution to the conservation of the Antarctic environment as a member state of the Antarctic Treaty. Therefore, the establishment of the new station is highly recommended.

Meanwhile, the proposed station would adopt sustainable and efficient technologies, which can minimize the potential environmental impact. Therefore, China considered that the decision to establish the proposed station is in compliance with her ATCP status and the principles set up in the "Antarctic Treaty", while the alternative, not to build the station is not beneficial to the related scientific studies such as the role of Victoria Land Region in global change.

3.2. Alternative locations around Ross Sea region

The Ross Sea and Weddell Sea are the only two areas of the Southern Ocean with a wide and deep continental shelf as shown in Fig 3-1. In most of other parts of the Antarctic coast the shelf is narrow or absent. The Ross Ice Shelf is the world’s largest floating ice sheet and overlies half a million square kilometers of the southern Ross Sea as shown in Fig 3-2. A series of open water areas called polynyas, including the large Ross Sea polynya, permit light to enter the water column in early spring. These polynyas are also the source of a large portion of Antarctic Bottom Water as a key component of the global climate system.

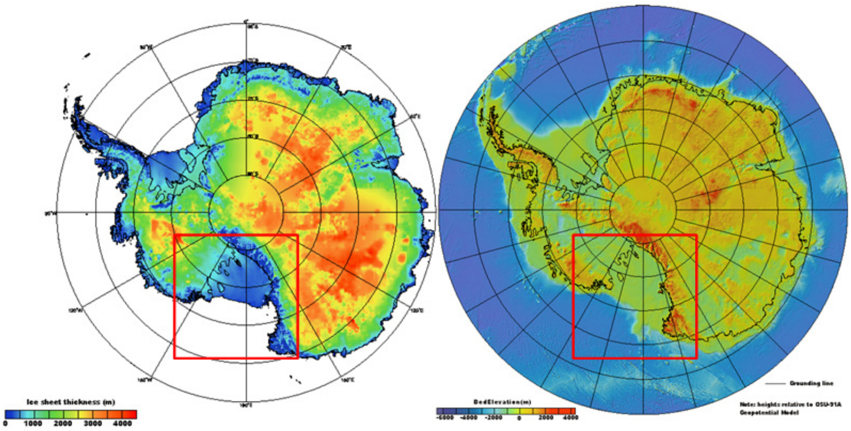


Figure 3-1 Observed ice sheet thickness and bed Elevation of the proposed area

(Base Map from Ice Bridge NSERC L1B Geolocated Meteorologic and Surface Temperature Data)

Compared to the existing Chinese Antarctica research stations, Great Wall Station is located on the King George Island in West Antarctic with a latitude of 62° S, Zhongshan Station is located on the Lasermann Hills in East Antarctic with a latitude of 69° S, and the proposed Ross Sea region is a special convergence zone between East Antarctic and West Antarctic with a latitude from 70° S to 90° S. The scientific researches available around the proposed Ross Sea region will fill in the blanks in several fields, such as the relationship among the Ross Sea Shelf, Ross Sea polynyas and global climate change, and comparable study on the biodiversity between Great Wall bay, Prydz bay and Terra Nova bay in Ross Sea region.

China conducted preliminary surveys and evaluated three candidate regions for a new station around Ross Sea region in Antarctica. Proposed location 1 is on Oates Coast, proposed location 2 is in Terra Nova Bay of Victoria Land and proposed location 3 is located near the Cape Berks of Marie Byrd Land as shown in Fig 3-2.

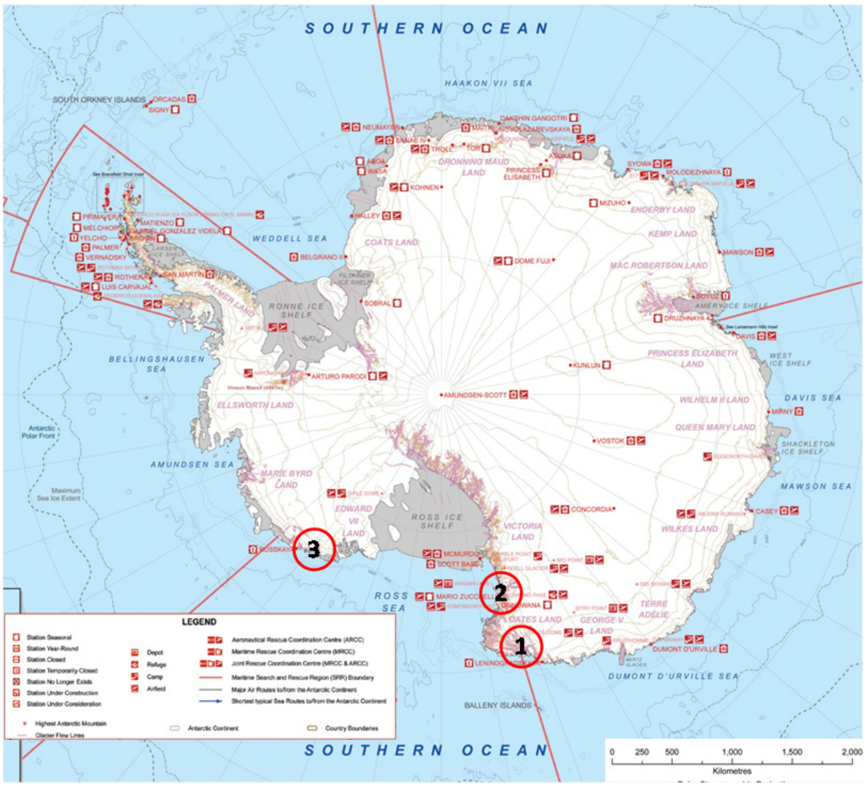


Figure 3-2 Alternative proposed locations around Ross Sea region

(Base Map: COMNAP 2009)

3.2.1 Description of proposed location 1 in the Oates Coast region

Proposed location 1 is located in the Oates Coast region, a portion of the coast of Antarctica between Cape Hudson and Cape Williams. The area has rapidly changing weather conditions with frequent and long strong wind events from June to September. The largest wind gust was recorded by Leningradskaya station on July 9, 1989 when under conditions of persistent (several hours) storm force winds, the instrument twice recorded the maximum gust of 78.3 m s^{-1}. During the entire operation years of the Leningradskaya station no complete ice clearance of the area in question was recorded. Moreover, on average up to 60% of its area was typically occupied by residual drifting ice off the southern periphery of the massif. Finding a new inland route is also expected to be difficult. The personnel and cargo would be delivered to the station only by helicopters.

Fig.3-3 is the climatological sea ice concentration distribution of Ross Sea during December-January. Compared to climatological sea ice concentration distribution, in the Ross Sea, the outer edge of sea ice in 2012 summer is not very different, but some of the sea ice concentration was quite different from others.

Sea ice concentration climatology of Ross Sea in Dec, Jan, Feb, Mar

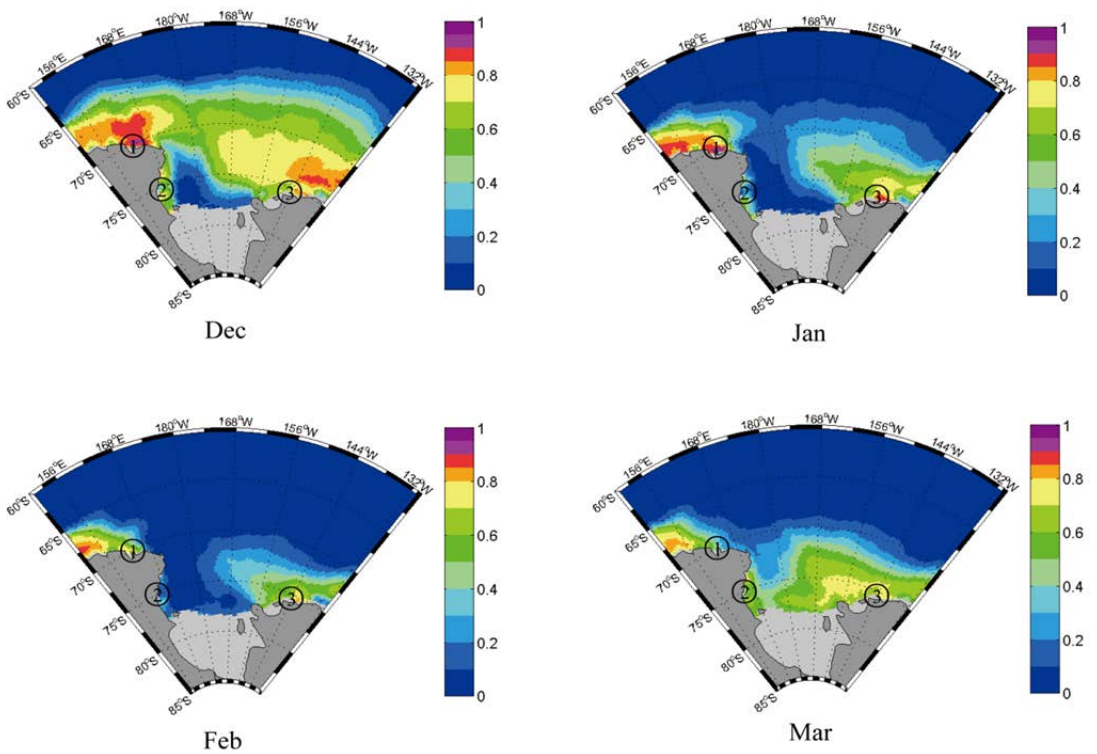


Figure 3-3 Climatology maps of sea ice concentration

(Observation data in January, February, March, Ross Sea (mean value in 1978-2012), the three proposed locations are showed as above)

For the proposed location 1, in December 2012, the outer sea ice density reached 90% or more (Fig. 3-4, Dec), while the climatological sea ice in December of that location was between 60% and 80% (Fig. 3-4, Dec). During January 2012, the sea ice scope outside proposed location 1 reduced, but the intensity remained above 90 percent, which is still 10%-30% higher than climate-state intensity (Fig. 3-4, Jan, Figure 3, Jan).

In February 2013, outside the preselected area I there was still sea ice with the intensity of 80%-100% and 400km north-south width (Fig. 3-4, Feb), while in February the climatological data show that there was only sea ice with the density of 50%-70% and the north-south width of 200km (Fig. 3-4, Feb). The sea ice outside the proposed location 1 have started to freeze since March 2013, and significantly expand outwards, but according to the climatological data in March, the sea ice in the region remain intact, and there is no apparent freeze (Fig. 3-4, Mar) .

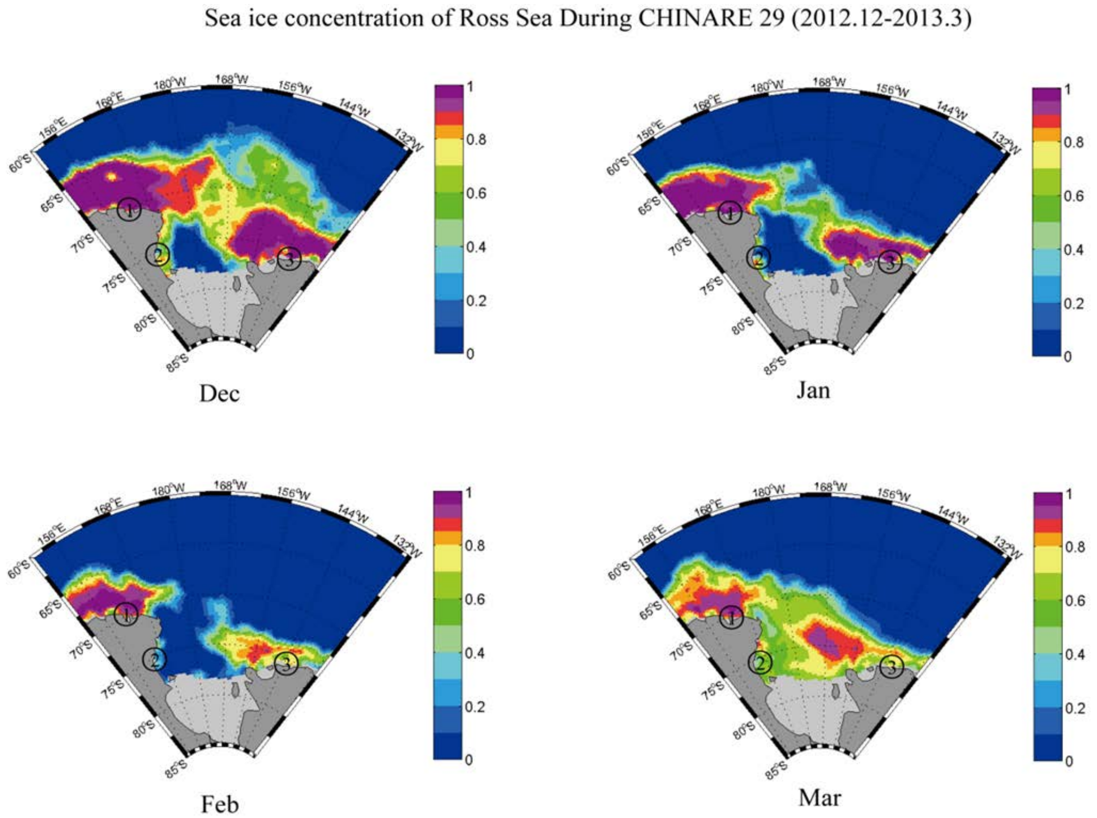


Figure 3-4 Average sea ice concentration maps of Ross Sea

(Observation data in Dec. 2012, Jan.2013, Feb.2013, and Mar.2013, the three proposed locations are showed as above)

The alternative locations mentioned above were ultimately evaluated inadequate on various deciding factors for constructing the station and accommodating its research activities, such as accessibility, weather conditions, safety, logistics, and impacts on the ecosystem.

3.2.2 Description of proposed location 2 near Terra Nova Bay of Victoria Land

In contrast, **Proposed Location 2** is located in the region near Inexpressible Island surrounding Terra Nova Bay which seems appropriate for the new station as it provides ample space for construction and relatively easy logistics with the absence of conspicuous local flora and fauna.

For the proposed location 2 as is shown in Fig 3-3 and Fig 3-4, during December 2012 and March 2013, its outside sea, namely Terra Nova Bay, the change of whose sea ice conditions was in line with the change of climate states, but compared to the situation of the climatology in March 2013, the Ross Sea ice expands to freeze rapidly and obviously. Thus, the intensity and scope of the Ross Sea ice has obvious inter-annual variability.

More details have been described in section 4.

3.2.3 Description of proposed location 3 near the Cape Berks of Marie Byrd Land

Proposed location 3 is located near the Cape Berks located between Ruppert Coast and Hobbs Coast of Marie Byrd Land in the west Antarctic. This area is surrounded by some nunataks, and volcanic conditions should be considered in this area. The coast of this area is the snow-glacial barrier with the height from 2 to 40 m. From the western side of Berks cape the coastline turns sharply southward.

Extremely severe weather conditions occur due to the combination of low temperatures and very strong winds. Typical for the proposed area the extremely severe weather conditions are formed by combination of low temperatures with hurricane winds. The mean annual air temperature is -12.4℃ during all periods of observation. The warmest month is January, while the coldest one is August. The absolute temperature minimum is -46.40℃, and absolute maximum is +7.40℃. In this area the blizzards are often observed (about 150 days a year) accompanied by snow fall and by restriction of visibility up to minimal values. Due to orographic features the easterly winds prevail.

The hardness of wind regime is the peculiarity (distinctive feature) of the climate in the region. The mean annual wind speed there is 12.9 m/s. The monthly mean maximum wind speed of 18.1 m/s was registered in March, and the minimum of 9.6 m/s was observed in January. The maximum wind speed (excluding January and February) fluctuates in limits of 46-61 m/s. The registered wind gust maximum velocity was 77 m/s, and it was impossible to register the stronger wind gusts due to wind anemometers destruction. Sometimes, there is possibility of two and more cyclonic disturbances passing within a period of about a day which pose great challenges to stable operation for the station. Thus, it increases the difficulty for station operating year round especially in case of emergency.

The annual wide, solid strip of fast ice and chain of stationary polynyas, formed along the coastline in the summer period which is the main feature of the ice regime in this area. In the spring–summer period about half of the fast ice is destroyed. In the case of breakdown of multiyear fast ice, the frequent hurricane force winds block (prevent) the formation of stable ice for a long time. Due to the heavy ice conditions the disembarkation at the proposed station could only be carried out by helicopters.

For the proposed location 3 as shown in Fig 3-3 and Fig 3-4, it was surrounded by hundreds of kilometers of ice with the intensity of more than 80 percent during December 2012 and January 2013. The sea ice intensity was reduced to 80% or less in February and it grew rapidly in March. According to the climatological data of Figure 3-3, only in February, the ice concentration off the coast of proposed location 3 is low, and that was covered by about 80 percent of the sea ice in other months.

3.2.4 Comparison of the proposed three locations

In consideration of the station construction and research accommodation, such as accessibility, weather conditions and safety, logistics convenience, and impacts on the ecosystem, the alternative locations mentioned above were ultimately evaluated as shown in Tab 3-1. Comparing all the criteria, it is more appropriate to choose the proposed location 2 in conclusion.

Table 3-1 Comparison of the proposed three locations

Comparison Criteria		Location 1	Location 2（Selected）	Location 3
Accessibility	**Ice condition**	No complete ice clearance	**Long open-time with polynyas**	Heavy and stable in the most time
	Ship access	Limited	**Easy**	Limited
	Helicopter access	Limited	**Easy**	Limited
Weather condition and safety	Mean annual temperature	-14.6℃	**-18.5℃**	-12.4℃
	Extreme low temperature	-37.4℃	**-42.3℃**	-46.4℃
	Mean annual wind speed	8.4 m/s	**12.0 m/s**	12.9 m/s
	Extreme wind gust speed	78.3 m/s	**43.5 m/s**	77 m/s
	Relative humidity	55% - 93%	**40% - 51%**	64% - 90%
logistics convenience	Self-supporting	Limited	**Easy**	Difficult
	International cooperation and supporting	Difficult	**Easy**	Difficult
Biodiversity		Poor	**Average**	Average
Land availability		Limited	**Available**	Available
Investigation reference		Literature study and The 29th Antarctic research activity of china	**Literature study and The 29th and 30th Antarctic research activity of china**	Literature study

3.3. Alternative sites on Inexpressible Island near Terra Nova Bay of Victoria Land

According to the site survey in December, 2012, four possible sites on the Inexpressible Island were considered as shown in Fig 3-5: site A was coastal area in the northeast with a habitat of penguins, site B was 200 meters away from the shore with a smooth platform, site C was near a fresh water lake and almost 2 kilometers away from the shore, and site D was on a small hill in the west side and 2.5 kilometers away from the shore.

Site A is with a shallow shore as shown in Fig 3-6 giving the advantage to be easier accessible and has a few fresh water lakes which can be used as water resource as shown in Fig 3-7. However, near the shore area, there is a penguin colony. Thus, the choice for using this site A was excluded.

Site C is close to two big fresh water lakes, which were considered to be accumulated snow-melted water. And there is a flat area that could be a potential site for the station to be built as shown in Fig 3-8. However, the distance away from the shore means much more ground preparation of construction work to be done so that materials could be transported to the site, thus much disturbance to the local topography is expected, which might result in too much environmental impact. To avoid the adverse result, this site was not chosen.

Site D is much inland from the shore and situated under the West Ridge at the Inexpressible Island as shown in Fig 3-9, where the strong katabatic wind could be shielded away leaving this area to be advantageous for station building and operation. Site D is also close to fresh waters thus providing water resource for the future facilities. However, the difficulties for transporting materials from the shore to the site means a few of labors have to be utilized thus resulting in much disturbance to the local. For the same reason to withdraw the Site C, Site D was excluded from this station sites list.

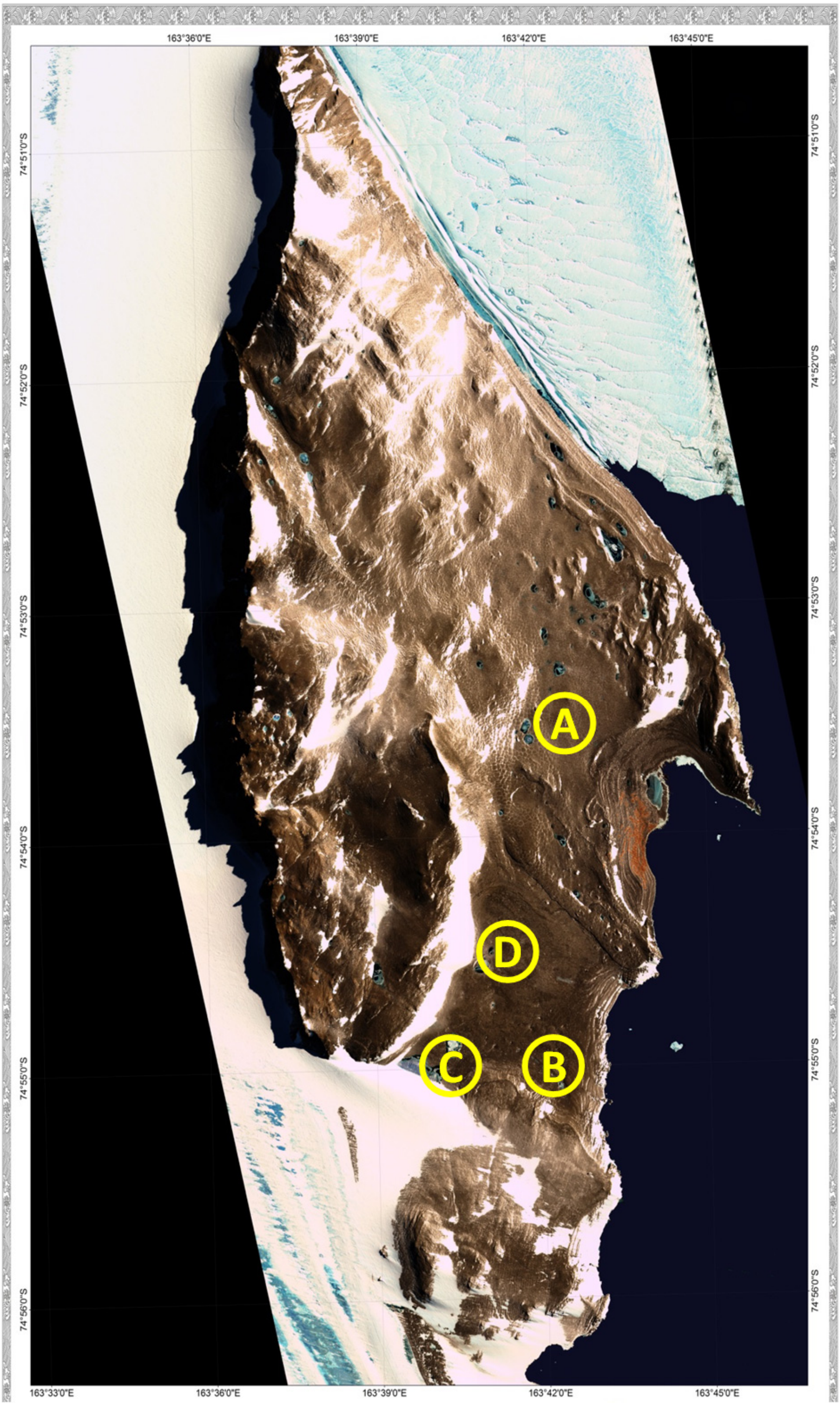


Figure 3-5 Alternative proposed sites on Inexpressible Island

Figure 3-6 Shore condition near site A

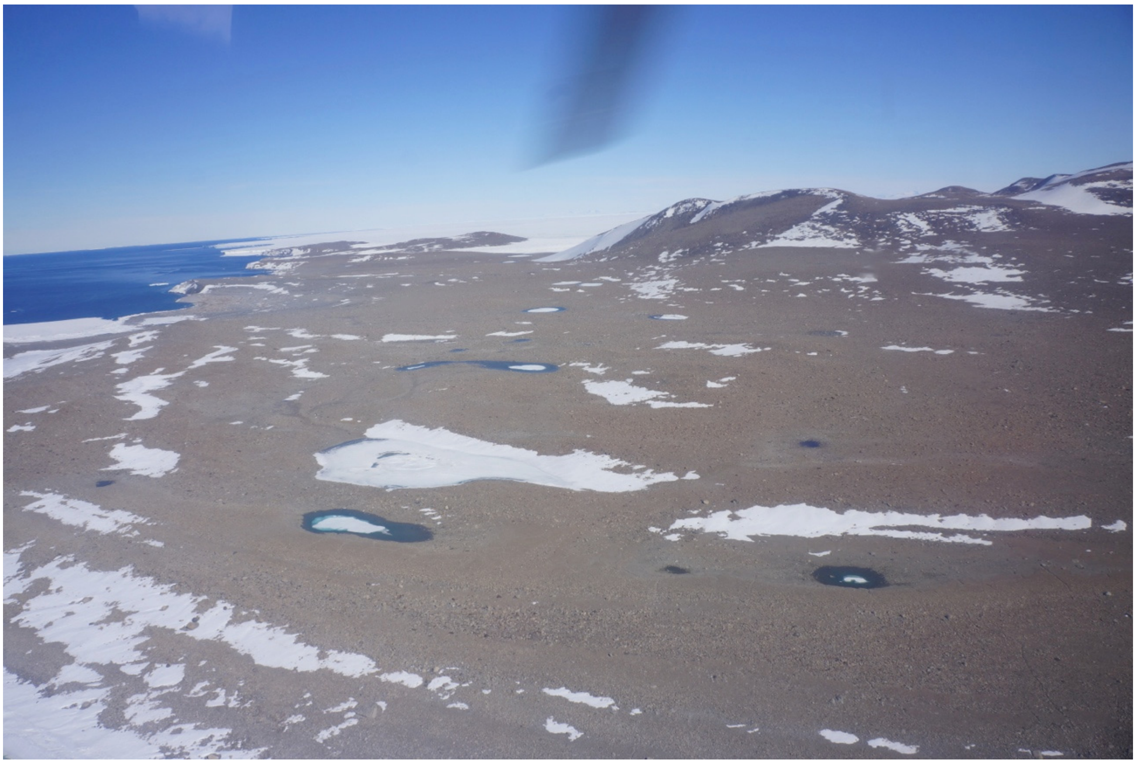


Figure 3-7 Lakes within site A

Figure 3-8 Topography in site C

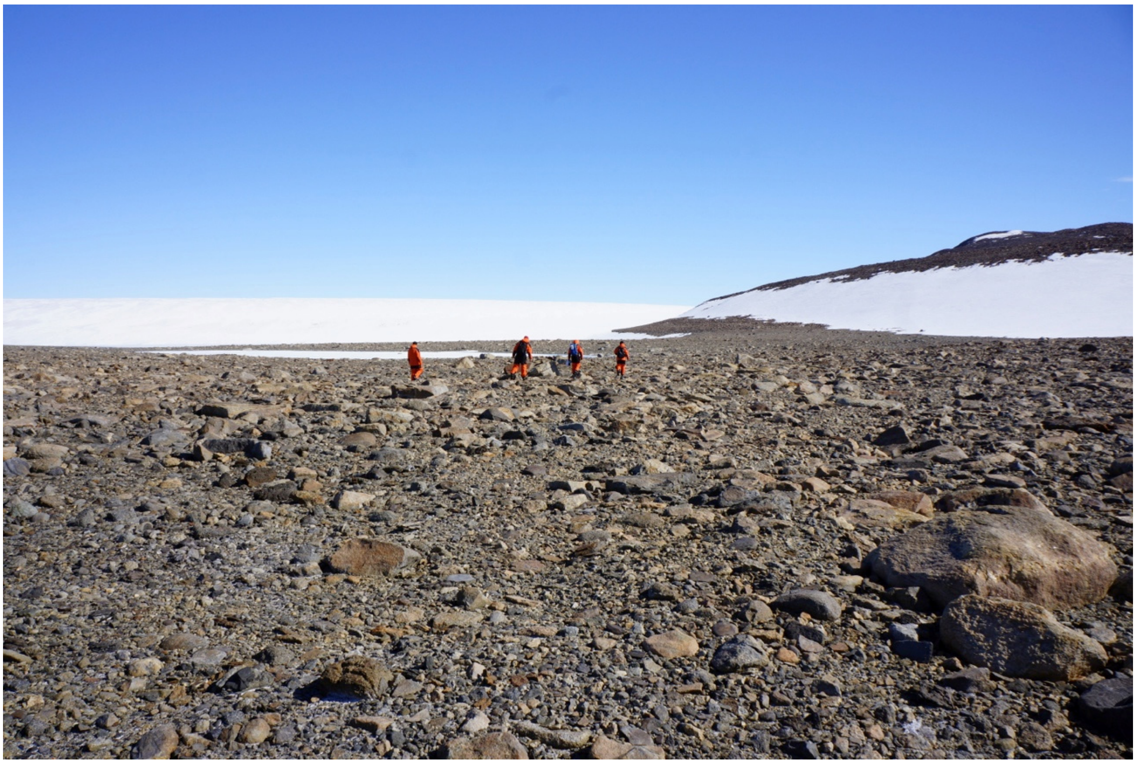


Figure 3-9 Topography in site D

The survey team then have to look at the potential site-location B, which is a block of flat area and about 200 meters away from the shore as shown in Fig 3-10. From the point of view of logistics, this will give more advantage in respects to the unloading work and few ground pavement work will be needed. There is a relative high rock ridge separating the penguin colony from the location B, thus leaving very little direct impact on the colony. During the 7 days' stay around location B, few penguins were observed on shore.

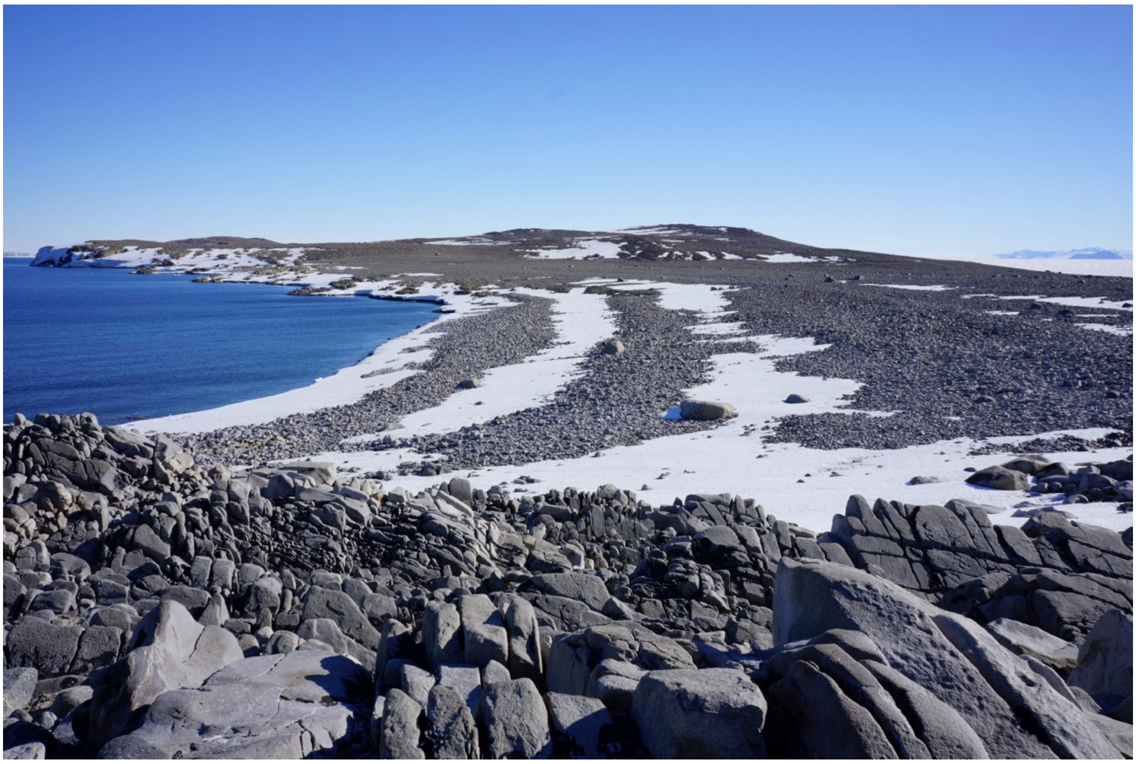


Figure 3-10 Site B overlooked from the rock ridge

On consideration of the potential environmental impact and convenience of the station construction and operation, comparable criteria as biological sensitivity, fresh water availability, landing possibility, logistics convenience, site elevation, land flatness and snow accumulation risk were used. The alternative sites mentioned above were evaluated as shown in Tab 3-2.

By comparison, it is more appropriate to choose proposed site B in conclusion. Considering the fresh water availability in site B, the advanced desalination technology will be used as described in Section 2.

Table 3-2 Comparison of the proposed sites on Inexpressible Island

Comparable criteria	Site A	Site B （Selected）	Site C	Site D
Biological sensitivity	High	**Low**	Middle	Low
Fresh water availability	Easy	**Moderately difficult**	Easy	Moderately difficult
Landing possibility	Easy	**Easy**	Difficult	Difficult
Logistics convenience	Easy	**Easy**	Moderately difficult	Difficult
Site elevation	Middle	**Low**	Low	High
Land flatness	Smooth	**Smooth**	Uneven	Uneven
Snow accumulation risk	Low	**Low**	Middle	High

3.4. Alternative designs

3.4.1 Alternative designs of layout

Radiation connection (A), series connection (B) and parallel connection (C) have been designed as alternative layout for the proposed new station as shown in Tab 3-3. Considering the advantages of safety in emergency, wind resistance and snow accumulation possibility, the radiation connection model (A) has been suggested. The advantages of the model A have been summarized as follows:

a. More flexible partitioning. Considering the big difference of accommodation needs in summer and in winter, the flexible portioning of the radiation connection of separated buildings makes it possible to shut off some modules during winter to save energy. Because Antarctic science investigation has a distinct seasonal characteristics（few people and activities in winter and many people and activities in summer）, the design of any polar station must consider operating requirements for the peak time(in summer) of the scientific investigation and the long stay period at the same time. Therefore，separation of some functions and independent arrangement contribute to meet the usage mode which varies greatly. In the new station, there are nearly 80 scientific research personnel in summer but less than 30 people in winter. The changing number of personnel and activities put forward the request to energy conservation and functional changes. However, with dispersal layout, we can decide which part to be open or closed according to the number of people and tasks. We can maintain only 5 degrees Celsius at indoor temperature to prevent frostbite in the closed area in winter. Thus the energy and space can be used more efficiently.

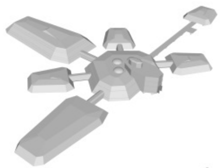
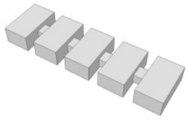
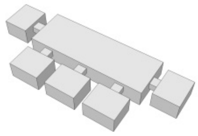
b. Strengthening the wind resistance. In this layout we can also effectively reduce the wind resistance，minimize the wind pressure and the snow-covered weight on construction unit structure sustains.

c. Reducing the single building weight. Distributing by volume can reduce weight of single building, and in the meantime, because individual building has different foundations and they are connected by corridor flexibly, we can much effectively overcome the problem of differential settlement caused by local complex terrain.

d. Shortening the distance of escape. Distributing volume and utilization of corridors are beneficial to the integrated design of fire protection and escape from the building in that it largely shortens the distance of escape from any individual building to outside.

e. Easier transportation, installation and maintenance. Distributing by volume and utilization of corridors are also beneficial to the decrease of the volume and scale of domestic factories' performed units, which can make transportation better. At the same time, the on-site set up of these performed units would be more flexible, which is convenient for the field construction of the whole station. Distributing by volume and utilization of corridors are beneficial to the post-stage maintenance and management.

Table 3-3 Alternative designs of layout

	Layout model A	Layout model B	Layout model C
	 A.	 B.	 C.
Connection type	Radiation connection	Series connection	Parallel connection
Corridor	Long close outdoor corridor	Short close indoor corridor	Short close indoor corridor
Safety in emergency	Safe, separated buildings is easier to escape and evacuation	Long distance for evacuation	Passing through the main building and not conductive to evacuation
Wind resistance	Strong	Weak	Moderate
Snow accumulation	Difficult	Easy	Moderate

3.4.2 Exterior designs

The shield shape is better for reducing the wind resistance coefficient as shown in Fig 3-11.

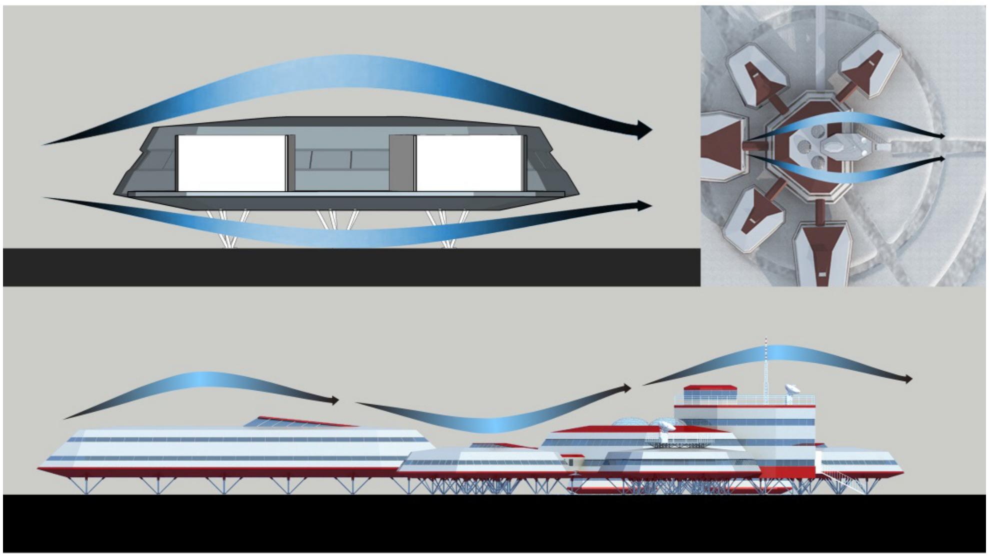


Figure 3-11 Aerodynamic simulation of the shield shape

In terms of processing and welding the surface, it also has some advantages. As for each shape of the wing, the flat is shield-shaped, with the top and bottom a little bit protrude, and the vertical surface outward-inclined. On the form of each part there are no corner pockets, which can keep out the wind. The combination of a number of wings makes the shape be radial, and the connection between them is corridor. What`s more, the wind can blow over and under the building, or through the gap of the building, so it can reduce the possibility of the wind vortex generation and snow accumulation.

Because of the use of slab, the slope assembly of the vertical surface becomes not complicated and it`s easy for unitized process. The shield shape has also increased the possibility of natural lighting as shown in Fig 3-12.

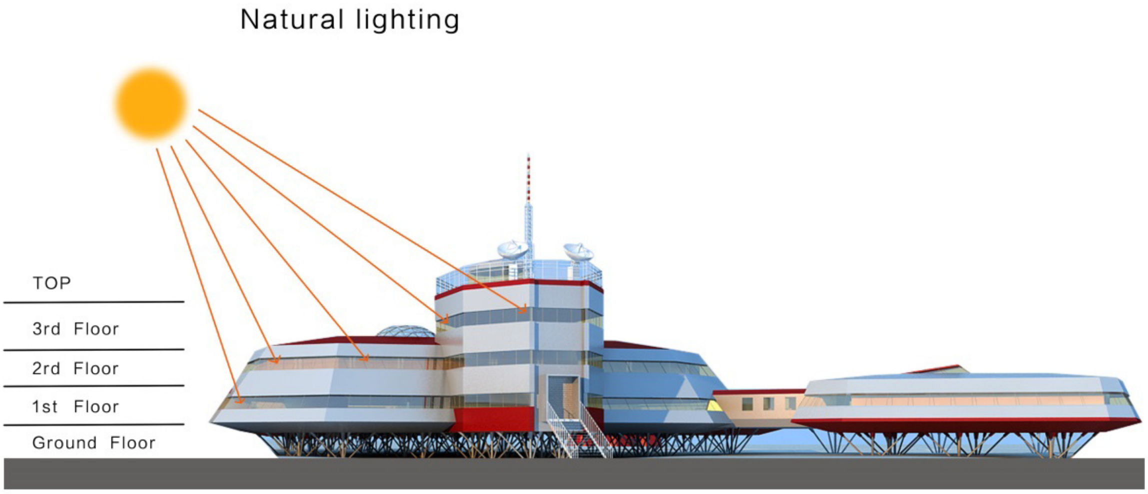
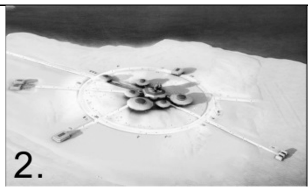
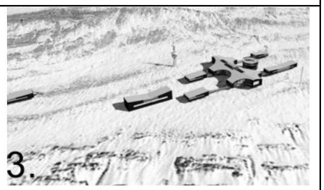


Figure 3-12 Natural lighting for the shield shape buildings

For the selected radiation connection layout, three alternative exterior designs (shield, round and box shape) for the buildings have been compared as shown in Tab 3-4. In conclusion, the shield type is determined.

Table 3-4 Alternative exterior design

	1. Shield type	2. Round Type	3. Box Type
			
Drag coefficient	Moderate	Low	High
Snow accumulation prevention	Effective	Effective	Invalid
Effective indoor space availability	Moderate	Low	High
Natural lighting conditions	Good	Moderate	Moderate
Construction difficulty	Easy	Difficult	Moderate
Field work period	Short	Long	Short

In conclusion, Scheme A-1 was selected as the priority, the reasons are as follows:

1. Designing of the body can reduce the wind resistance, and is more conducive to extreme low temperature and strong wind climate.
2. Epidermal cell structure of the plate is more conducive to processing and transportation, and more convenient for integrated handling of multi-layered facade materials.
3. Split designing can strengthen the ability to adapt to the diversify terrain.
4. Corridor structure allows more flexible functional layout.
5. Overall structure designing is more convenient to deal with the phased construction.
6. It is much more energy efficient and more conducive to maintenance of fire safety and post-repair.

3.5. Transport alternatives

During the construction and operation stages of the new station, both personnel and cargoes will be shipped from home to the new station by the R/V Xuelong. The alternatives of air and marine transportations were compared for the routes from Zhongshan Station to the new station.

3.5.1 Air plus land transportation

Air transportation route to Gerlache Inlet north of Mario Zucchelli Station and then the cargos and personnel will be transited through the land transportation. People and cargos are needed to be carried by snowmobiles and sleds for about 30 km to the proposed site. When frozen layer in Gerlache Inlet is thick, large-size airplanes such as C130 can land as well. However, this is limited to the freezing season, but not the whole summer. According to the currently available data, thick sea ice rarely forms in this region during the austral summer when most of the transportation will be made.

3.5.2 Marine plus land transportation

U.S. National Snow and Ice Data Center (NSIDC) provide ice drift distribution data near the proposed site between 2002 and 2010. The data shows that an icebreaker can gain access to the Terra Nova Bay area between mid-December and late-February, and hence availability of the cost-effective marine transportation of construction staff, material and equipment during the period.

According to the expedition result of the R/V Xuelong from 2012 to 2013, ships can approach up to 3 miles near the coast of the proposed site. The ships may then be anchored at appropriate distances from the coast, and barges can be hired to relay the cargos and equipment to land vehicles for the final hundred meters to the site. A helicopter can be used as a contingent option if ice drift impede access during this period. This option of limited cargo capacity, however, may eventually require barges and slow the overall construction rate.

3.5.3 Evaluation of means of Transportation Alternatives

Disadvantages of people and cargos being transported by aircraft in this region during summer time include aforementioned limitations of sizes and types of aircraft depending on the conditions of the runway as well as the limitations on takeoff and landing time on sea ice runways. Furthermore, uneven weather conditions of the Antarctic region increase the uncertainties of scheduling, causing aircraft delays.

Besides, small cargo capacities of aircrafts may not be suitable in carrying heavy equipment such as cranes. Aircrafts are also not as cost-effective as ships. Therefore, marine plus land transportation was selected over air plus land transportation in consideration of cost, convenience, and on-time performance under uneven weather conditions.

3.6. Wind turbine alternatives

The proposed site is located in the area with abundant wind resources. Three types of wind turbines have been compared as the traditional horizontal type, the H vertical type and the rotator vertical type. Wind turbine selection is based on the matching of the voltage level, demand power, determined installation conditions, space saving, convenient for construction, low maintenance and minimization of noise as compared in Tab. 3-5.

Both the vertical type turbines have the advantages for easier transportation, construction and maintenance. The vertical types are expected to maintain a high-efficiency power generation in each wind direction. The low speed rotation and low frequency noise will significantly reduce the interference to the human beings and the animals such as penguin and skua.

The suggested rotator type turbine has all the advantages of the vertical type turbine, and above all, the relative compact size and streamline designing demands less installation space and much easier for transportation and installation in the proposed site.

Table 3-5 Comparison of different types of wind turbine

Turbine Type	Horizontal	Vertical H	Vertical Rotator
			
Producer	JIALI China	MUCE China	UGE America
Type	FD 18	FDM 50	UGE-9M
Single rated power	50 kW	50 kW	20 kW
Numbers	6	6	15
Efficiency	Efficient only to a limited wind direction	Efficient to all wind direction	Efficient to all wind direction
Survival wind speed	40m/s	45m/s	50m/s
Diameter	18m	12m	9.6m
Height	18m	14m	6.4m
Wind resistance	weak	moderate	strong
Noise (dB)	50	38	35
Extreme low temperature	-35℃	-35℃	-40℃
Ground projection impact	Dizziness	None	None
Failure rate	high	low	low
Maintenance	Difficult	Moderate	easy
Tip speed ratio	6	1.5~2	1.5~2
Landscape aesthetics impact	discord	moderate	harmony

3.7. Alternative waste management plans

Waste management alternatives for the site construction and operation were compared considering potential impact to Antarctic environment, particularly to atmospheric environment, as well as the operation and management costs.

3.7.1 Incineration

On-site treatment of combustible waste with an incinerator accompanied with ash retrieval can effectively reduce the overall volume of waste. It can also prevent possible scavenging by Skua inhabiting near the proposed site.

However, gas emissions from an incinerator are expected to adversely impact the Antarctic air quality. Its operation will also increase the fuel use. A high temperature combustion method and multi-filtering system will minimize pollutants such as dioxin to be generated, but the additional cost associated with the operation of such systems on top of the incinerator itself is expected substantial.

3.7.2 Off-continent disposal together with in-vessel composting system

Waste produced during construction and operation of the station, after necessary treatment, can be stored and transported outside of the Antarctic region. The integrated containerized in-vessel composting system will be applied for the treatment of the food and other organic waste. This alternative is desirable as it does not adversely impact the air quality and is also cost effective compared to the on-site incineration. The on-site treatment for storage including sorting, compacting, drying and packaging can be done with appropriate work area and an operation manual provided.

3.7.3 Magnetization pyrolysis furnace

Magnetization pyrolysis is an integrated technology of thermal energy, magnetic energy and radiation. Under certain conditions, organic waste will be rapidly decomposed into the gas, water and inorganic substances such as ash by magnetic ionized air, making full realization of reduction, harmless and resource purposes. Most of the waste produced during the operation of the new station has been estimated as organic waste, paper and plastics. Magnetization pyrolysis is particularly effective to these items. Compared to the incineration process, no dioxin will be produced and lower temperature is needed. Compared to the off-continent disposal, the magnetization pyrolysis process can reduce the volume and weight of the original waste to 2%, which will greatly reduce the storage and transportation costs.

In order to keep the clean Antarctica baseline environment, considering the quantity of the solid waste during the year-round operation and the difficulty for storage and transportation in Antarctica regions, magnetization pyrolysis furnace will be suggested for the new station.

4. Initial Environmental Reference State of the Proposed Region

4.1. Location

The Ross Sea is the one of the last stretch of ocean which is minimally affected by direct human impact. It is also one of the fastest changing environments on earth in the context of global climate change, making it a spectacular laboratory to examine the effects of climate change on the polar biota.

The proposed site is located in the junction of the Ross Sea and Victoria Land, west of Terra Nova Bay, with a geographic coordinates of 74 ° 55' S, 163°42'E (Fig.1-1).

The new station is designed on the Inexpressible Island, whose south latitude is from74 ° 50 'S to 74 ° 57' S, and from 163 ° 35 'E to 163 ° 46' E, The island is about 50km^2 along a north-south direction. The island is surrounded by two glaciers divided from the Priestley Glacier in the north, and faces the Terra Nova Bay to the east. (Fig.4-1).

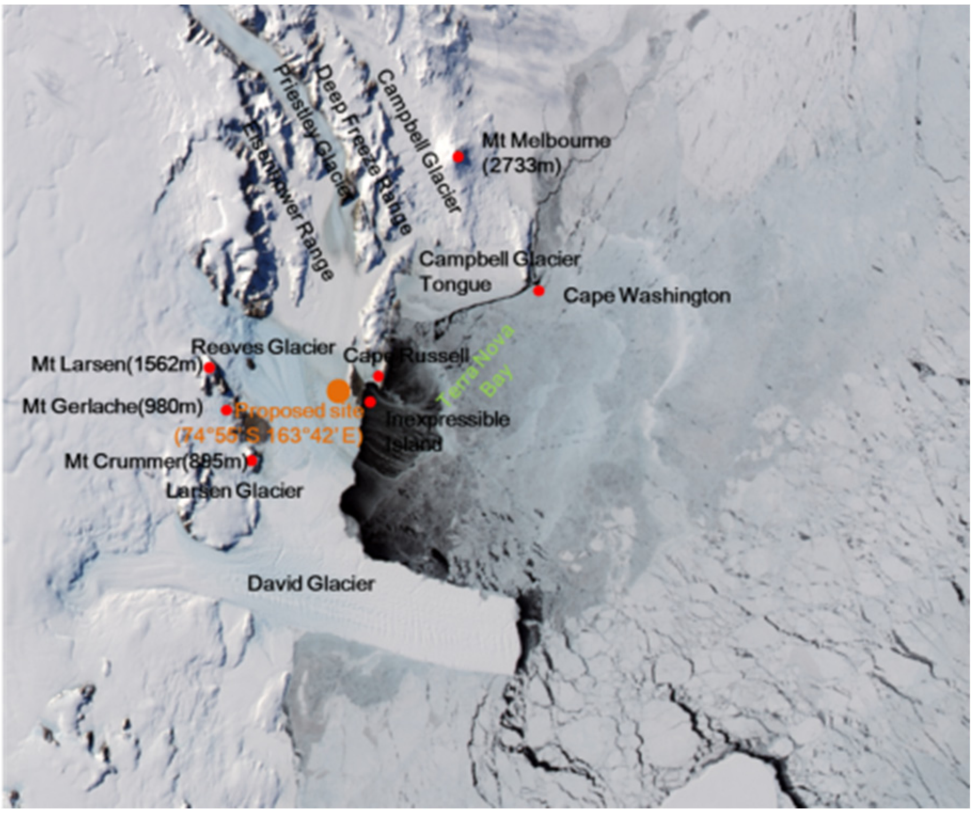


Figure 4-1Proposed site and surroundings

Table 4-1 Details of surroundings

Name	Location	Description
Mount Melbourne	74º21'S, 164º42'E	A massive stratovolcano that makes up the projection of the coast between Wood Bay and Terra Nova Bay, on Victoria Land.
Eisenhower Range	74º15'S, 162º15'E	a mountain range, about 72 km (45 mi) long with an altitude of 3,070 m (10,072 ft), which rises between Reeves Névé on the west, Reeves Glacier on the south, and Priestley Glacier on the north and east, on Victoria Land. The range is flat topped and descends gradually to Reeves Névé, but is steeply cliffed and marked by sharp spurs along the Priestley Glacier.
The Deep Freeze Range	74º15'S 163º45'E	A rugged mountain range, over 128 km (80 mi) long and about 16 km (10 mi) wide, situated between Priestley and Campbell glaciers on Victoria Land, and extending from the edge of the polar plateau to Terra Nova Bay.
Cape Russell	74º54'S, 163º54'E	A rock cape in Terra Nova Bay along the coast of Victoria Land, forming the southern extremity of the Northern Foothills.
Mount Larsen	74°51'S, 162°12'E	A mountain, peaked at1,560 m, with sheer granite cliffs on the northern side, situated 0.6 nautical miles (6 km) southwest of Hansen Nunatak at the southern side of the mouth of Reeves Glacier.
Mount Gerlache	74°59'S, 162°26'E	A prominent mountain of 980 metres (3,220 ft) high, standing on the northeast side of Larsen Glacier between Widowmaker Pass and the Backstairs Passage Glacier, in Victoria Land, Antarctica.
Mount Crummer	75°3'S, 162°34'E	A massive, brown granite mountain, 895 metres (2,940 ft) high, immediately south of Backstairs Passage Glacier on the coast of Victoria Land.
Campbell Glacier Tongue	74°36'S, 164°24'E	The seaward extension of Campbell Glacier into the northern Terra Nova Bay, on the coast of Victoria Land.
Campbell Glacier	74°25'S, 164°22'E	A glacier, about 60 nautical miles (110 km) long, originating near the southern end of the Mesa Range and draining towards southeast between the Deep Freeze Range and Mount Melbourne and discharging into the north Terra Nova Bay.
Priestley Glacier	74°20'S, 163°22'E	A major valley glacier, about 96 km (60 mi) long, originating from the edge of the polar plateau of Victoria Land. The glacier drains southeast between the Deep Freeze and Eisenhower ranges to enter the northern end of the Nansen Ice Sheet.
Reeves Glacier	74°45'S, 162°15'E	A broad glacier originating from the interior upland and descending between the Eisenhower Range and Mount Larsen and merging with the Nansen Ice Sheet along the coast of Victoria Land.
Larsen Glacier	75°6'S, 162°28'E	A glacier flowing southeast from the Reeves Neve, through the Prince Albert Mountains and entering the Ross Sea just south of the Mount Crummeron Victoria Land.
David Glacier	75°19'S, 162°00'E	The most imposing outlet glacieronVictoria Land fed by two main flows which drain an area larger than 200,000 square kilometres of the East Antarctic plateau, with an estimated ice discharge rate of 7.8 +/- 0.7 km^3/year.
Terra Nova Bay	74°50'S, 164°30'E	A bay which is often ice free, about 64 km (40 mi) long, lying between Cape Washington and the Drygalski Ice Tongue along the coast of Victoria Land.

In addition, three other stations have been built on the northeast part of the proposed new station. They are Italian Mario Zucchelli Station, German Gondwana Station and South Korean Jang Bogo Station under construction. They are 27 kilometers, 35 kilometers and 36 kilometers apart from our proposed station, respectively.

4.2. Topography and Geology

The island is relatively higher on the west than on the east, with a northwest-southeast mountain ridge on the west side, while plain and hilly land on the east. The site area is centered at 74°55' S, 163°42' E, which is about 2.2 km^2 and the regional elevation difference is within 15 meters. The height difference between ground and west ridge is about 110 meters. The contour map of the area is shown in Fig.4-2.

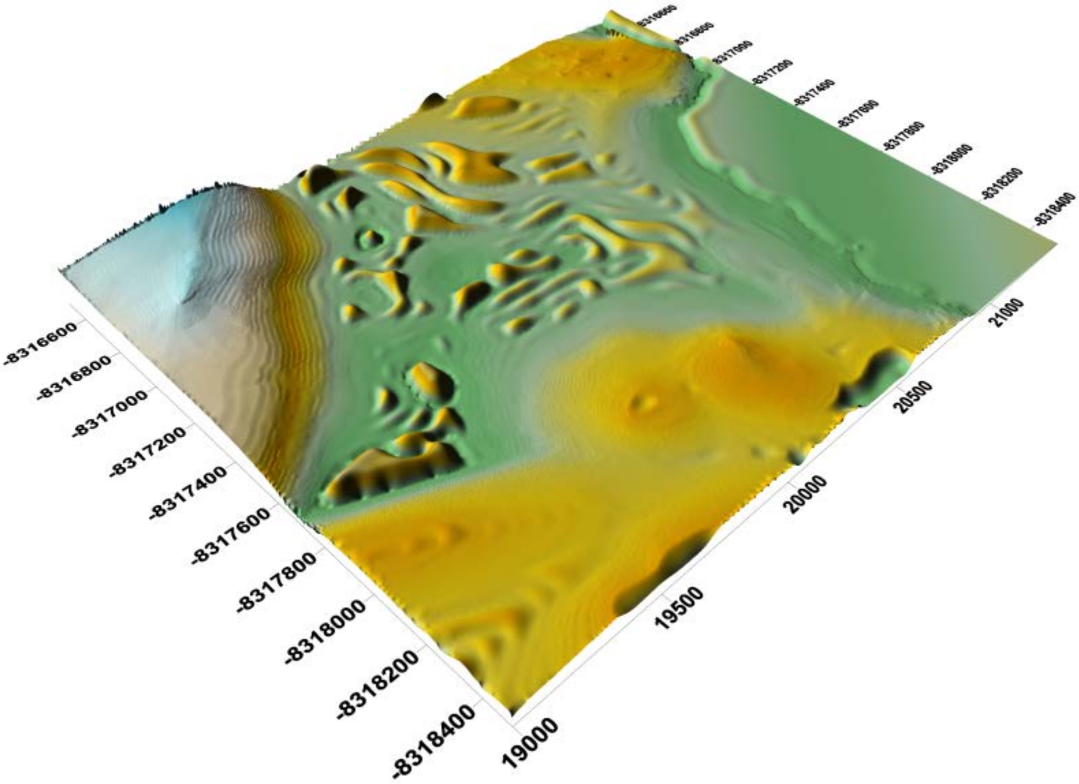


Figure 4-2 Topography of the proposed site

Perennial snow appears in the joint area of the ridge and the station. There are three fresh water lakes with perennial unfrozen water on the island.

The geological feature is complicated with most of the area covered by moraine rock, and bedrock only appears in some coastal region and at the foot of the hill. Fig.4-3 is the remote sensing image map of the area in February, 2012 usingWorldView2. By using hand-held gamma ray apparatus, the highest value measured on the island is 29 PPM.

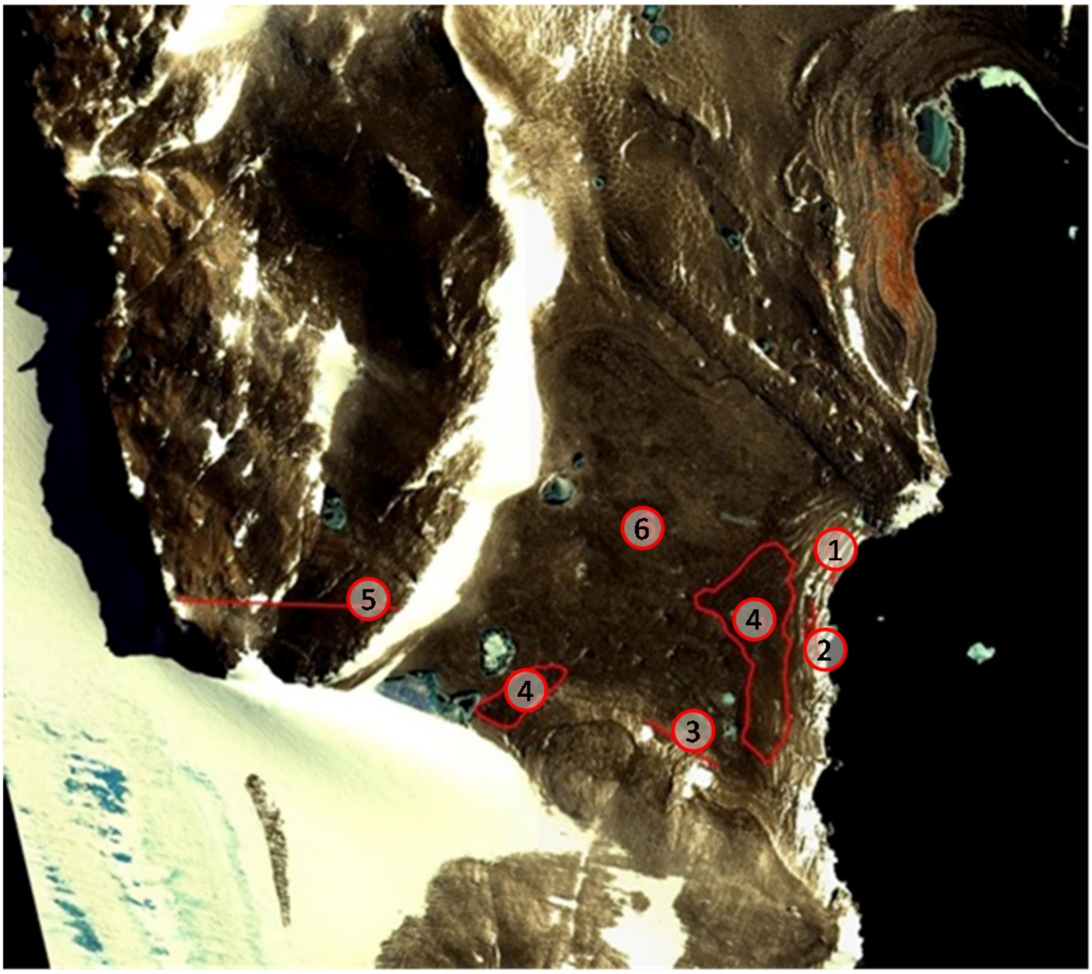


Figure 4-3 Remote sensing image map of the proposed area

(Base Map: WorldView2 February, 2012)

Diagram "1" is part of the coastal areas covered by moraine rock, basically all round stones in different sizes (Fig.4-4). "2" and "3"represent bedrock from the coast and the hill, which are all granite, and the coast bedrock are weathered much more intense (Fig.4-5). Diagram "4" is moraine conglomerate, including some individual big moraine rock, and the whole moraine conglomerate area is relatively flat (Fig.4-6). Diagram "5" represents the mountains (Fig.4-7). "6"(Fig.4-8) is covered by moraine rock, which is also the main lithologic feature of the area. The biggest moraine rocks is a few meters high, while the smallest is like the moraine conglomerate.

Figure 4-4 Moraine rock for coastal areas

Figure 4-5 Bedrock in coastal areas

Figure 4-6 Areas ofmoraine conglomerate

Figure 4-7 Rocks in mountain ranges


Figure 4-8 Typical moraine rock for the proposed area

4.3. Sea ice

According to the sea ice conditions, the earliest suitable time for expedition sailing into the Terra Nova Bay is in late December. Sea ice continues to decrease in January, and reaches its minimum coverage of the year in February, the most suitable time for ship based in situ investigation. Sea ice begins to freeze in March, and sea ice covers the entire Ross Sea till late March. The maximum sea ice is in August as shown in Fig. 4-9.

Except that small amount of ice flows on west of 180 degrees, Ross Sea coast is basically open waters, while east sea of 180 degrees melting slows down, there is still 50% -80% of the intensity of the concentrated ice zone, Terra Nova Bay area is basically the open waters. The Ross Sea's sea ice begins to re-freeze in March from the Ross Ice Shelf with rapid expansion, on south of 70 ° S, where is almost no open waters. Area between 170 ° E-180 ° E, 75 ° S north yet presents a low-density region. In the Terra Nova Bay's sea ice concentration increases to 50%.

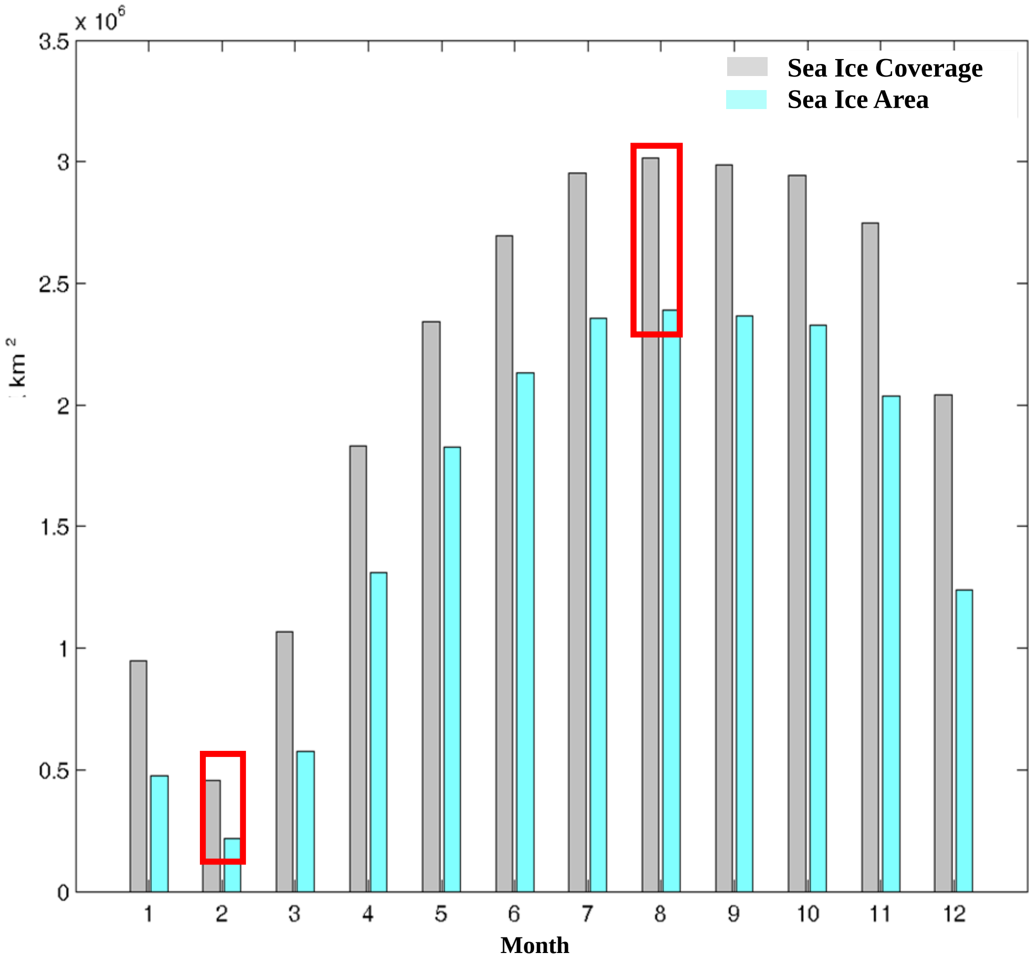


Figure 4-9 Monthly variation of sea ice coverage and area in Ross Sea (1978-2011)

The figure 4-9 shows that from November to March the Terra Nova Bay is mostly ice-free, with a peak in February. The beginning and ending dates of the sea-ice period shown in Tab 4-1 indicate the days when the bay starts to be covered by sea-ice (in late March), and when a large area is permanently ice-free near the coast (mid-November). The sea-ice period lasts for around 240 days, approximately the whole year except the polar day period (from mid-October to mid-February). The polar night starts in late April and ends in early August. Not surprisingly, years with the heavy sea-ice cover are characterized by increased cloudiness, a delayed phytoplankton bloom, and lower annual production than years with lighter sea-ice cover.

Table 4-2 Sea ice period and cloudy periods in Ross Sea

	2005	2006	2007	2008	2009	2010
Sea-ice period(days)						
Start (day)	78	86	77	74	75	85
End (day)	318	321	326	322	315	313
Total days	240	235	249	248	240	228
Percentage of the sea ice period covered per revisit time (%)						
Revisit<24h	89.8	82.9	84.8	84.1	81.8	93.2
Revisit<12h	77.7	71.4	70.6	65.8	70.3	79.6
Revisit<6h	70.8	63.6	64.2	60.1	62.4	72.0
Revisit<3h	62.4	57.0	57.5	50.3	48.1	62.5
Cloudy periods longer than 24 h (days)						
Total days	26.9	40.2	37.8	37.7	43.7	15.5
Small events	17.4	30	33	30	32	13.5
Large events	6	10.2	4.8	7.7	4	2
Unknown events	3.5	0	0	0	7.7	0

4.4. Glaciers and snow

4.4.1 Glaciers

According to data available from the National Ice Center, of the 53 icebergs larger than 1000 km^2 that have calved into Southern Ocean waters since 1976, more than 50% (28) traveled northward at speeds of below 1 km d^{-1}.

Reeves Glacier (74°45′S 162°15′E) is a broad glacier originating on the interior upland and descending between Eisenhower Range and Mount Larsen to merge with the Nansen Ice Sheet along the coast of Victoria Land. It was discovered and named by the British Antarctic Expedition, 1907–09, under Shackleton. The New Zealand Antarctic Place-Names Committee (NZ-APC) reported that the glacier was probably named after William Pember Reeves, former New Zealand Cabinet Minister, and the Agent-General for New Zealand in London, 1896-1909.

When Reeves Glacier flows into Nansen Ice Sheet it divides into three streams because of the interaction with Teall Nunatak and buried topography, which creates the divergence. The Priestley and Reeves glaciers are the main paths through which the cold, gravity driven air flows from the Antarctic plateau toward the bay.

Larsen Glacier (75°6′S 162°28′E) is a glacier flowing southeast from Reeves Neve, through the Prince Albert Mountains and entering the Ross Sea just south of Mount Crummer in Victoria Land. It was discovered by the South Magnetic Party of the Shackleton Expedition during 1907 to 1909, who followed its course on their way to the plateau area beyond. They named it Larsen Glacier because it flowed past the foot of Mount Larsen, which was constantly in view as they ascended the course of the glacier.

David Glacier is the most imposing outlet glacier in Victoria Land, Antarctica, fed by two main flows which drain an area larger than 200,000 km^2 of the East Antarctic plateau, with an estimated ice discharge rate of 7.8 ± 0.7 km³/year. The northern flow drains from Talos Dome to the Ross Sea, but the main branch of the stream is fed by a network of tributaries which drain a common area of the inner plateau around Dome C and converge in a spectacular icefall normally known as the David Cauldron. As the David Glacier flows into the Ross Sea, it forms a floating mass known as the Drygalski Ice Tongue.

4.4.2 Snow

Snow transportation by saltation (within 0.3 m in elevation) starts at wind speeds of between 2 and 5 m s^{-1}, transportation by suspension (drift snow) starts at velocities faster than 5 m s^{-1} (within 2 m), and blowing snow (snow transportation higher than 2 m) starts at velocities between 7 and 11 m s^{-1} (see Frezzotti et al. 2004 and references therein).

Snow accumulation at Terra Nova Bay is about 150–200 kg m^{-2} $year^{-1}$ (Stenni et al. 2000, Frezzotti et al. 2004) in a relatively undisturbed wind area. The Larsen site Q_T (2.5×10^6 kg m^{-1} $year^{-1}$), integrated over a 12 m height, is about four orders of magnitude greater than the annual snow accumulation. At the MidPoint site, Q_T is about 0.05×10^6 kg m^{-1} $year^{-1}$, three orders of magnitude greater than the snow accumulation (40–60 kg m^{-2} $year^{-1}$).

There is hardly snow on the most parts of the island. But there is perennial snow on the leeward, and the positions and ranges of the perennial snow in different years are nearly in the same places. In the rest areas, the snow-cover will disappear in a short period and leave a thin layer. The reason is presumed to be katabatic wind and temperature.

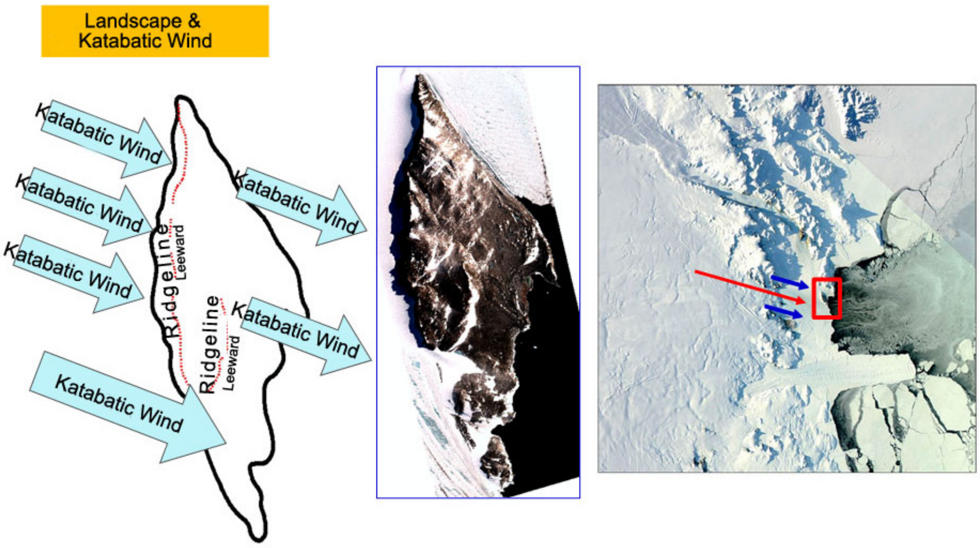


Figure 4-10 Katabatic wind in the proposed site

4.5. Climate

The proposed location area is on the Antarctic hinterland, facing the Terra Nova bay. Because of steep terrain from the inland to coast and the canyon effect caused by the nearby glacier canyon, downhill wind is most common in this region. Meanwhile, influenced by the local topography, great wind speed changes within short distances may occur.

4.5.1 Automatic Weather System

In December 2012, a new Automatic Weather System has been installed at the proposed site as shown in Fig 4-11. The AWS Manuela is close to the proposed site and the long term climate data is available.

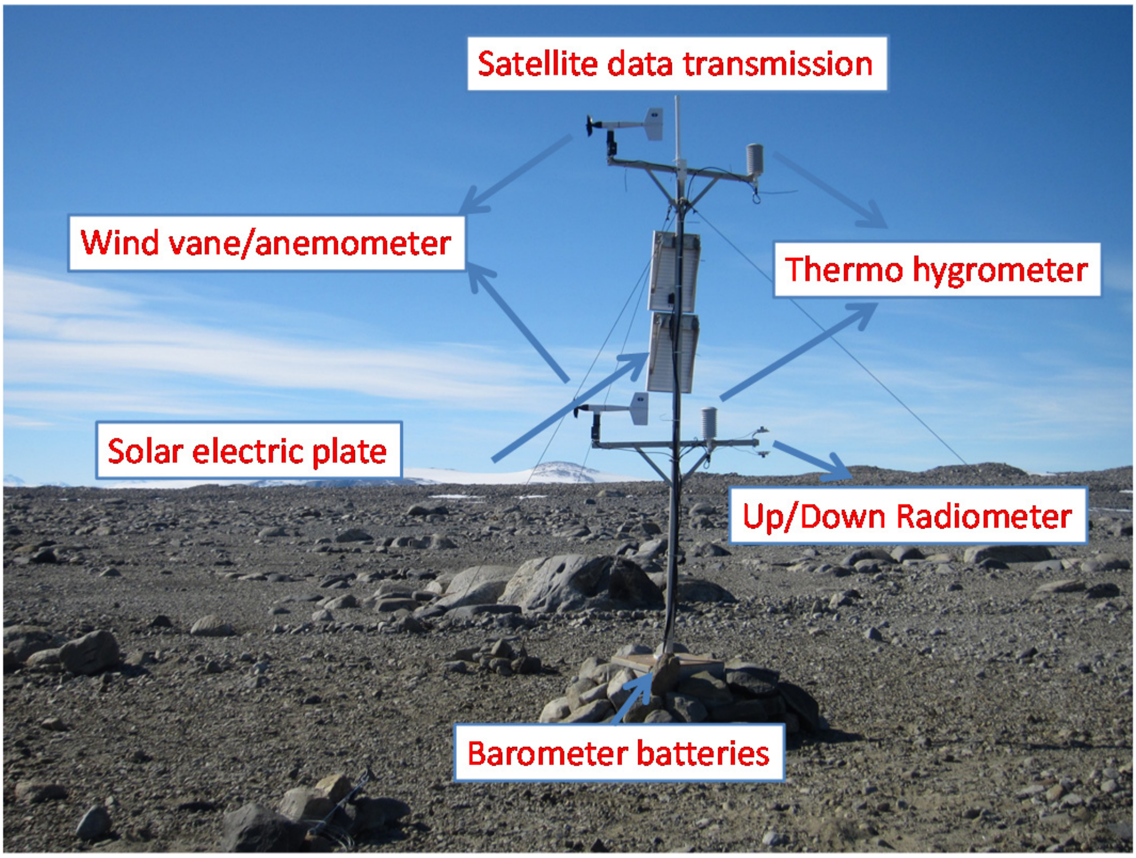


Figure 4-11Automatic Weather System installed at the proposed site

4.5.2 Temperature

The temperature variation from AWS Manuela (1998-2012) is given in Fig 4-12. Apparently the temperature has significant seasonal variation caused by the regular reciprocating motion between hemispheres of the sub-solar point. The average temperature of observed years is -18.5℃. The observed minimum annual mean temperature is -19.2℃ (1998) while the maximum is -17.4℃ (2012). The lowest value is -40.6℃ (Sept.2nd, 1992) of daily mean and -42.3℃ (Sept 1st, 1992) of instant value. In summer, the daily mean value is above 0℃ in most 17 years except in 1992, 2000 and 2011, with the highest value of 2.8℃ (Jan 11th, 2002) of daily mean and 6.9℃ (Dec 26th,

2010) of instant value. The average daily mean temperature above 0℃ lasting in a year is 2.4 days with the longest time of 11 days in 2010, while in other situations daily mean temperature below -35℃ lasting in a year is 4.2 days with the longest time of 9 days in 1997.

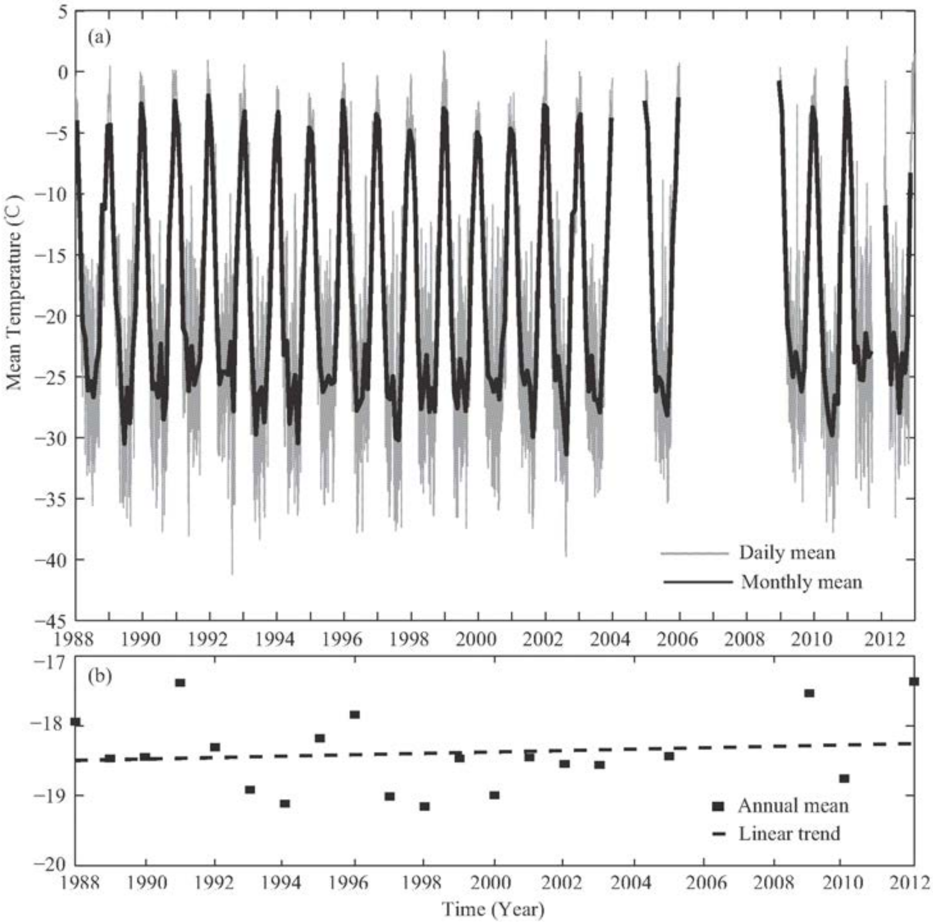
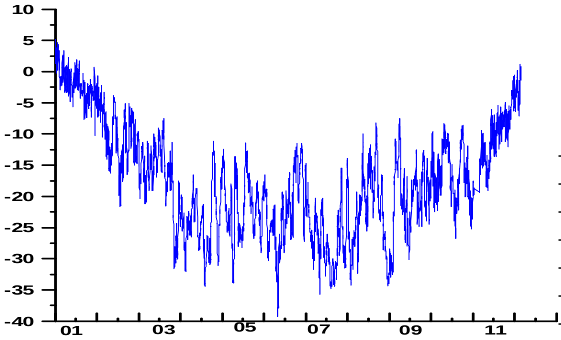


Figure 4-12 Time series of observed temperature at AWS Manuela (1988-2012)

(Daily mean (a, grey line), monthly mean (a, black line), and annual mean (b, dot) and linear trend (b, dashed line) were shown.)

As shown by the observed data from the Chinese new automatic meteorological station at the proposed site (from January, 2013 to November, 2013) (Fig.4-14), during the observation period, the diurnal variation of the temperature reached more than 45.5 ℃, peaked at 5.5℃ and lowest at -40.0℃, and averaged at -18.5 ℃. The mean temperature is as low as the observation data from Manuela, while the minimum temperature is the highest compared to other three stations.



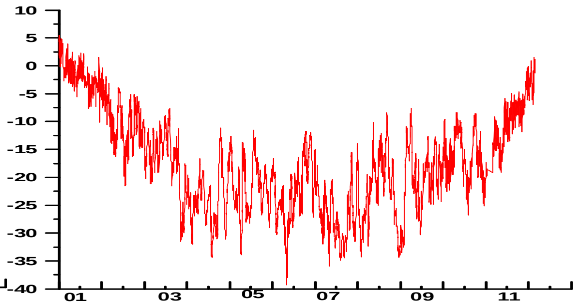


Figure 4-13 Time series of observed temperature during 2013

(2 meter left and 4 meter right)

4.5.3 Wind

According to the wind speed and direction observation data during 1988-2012 at AWS Manuela, the average yearly wind speed was 12.0m/s and the wind direction was 265.3° (westerly) as shown in Fig 4-14. Observed instantaneous wind speed could peak at 43.5m/s (July, 2003) and the maximum value of daily mean speed was 34.2m/s (July, 1989).

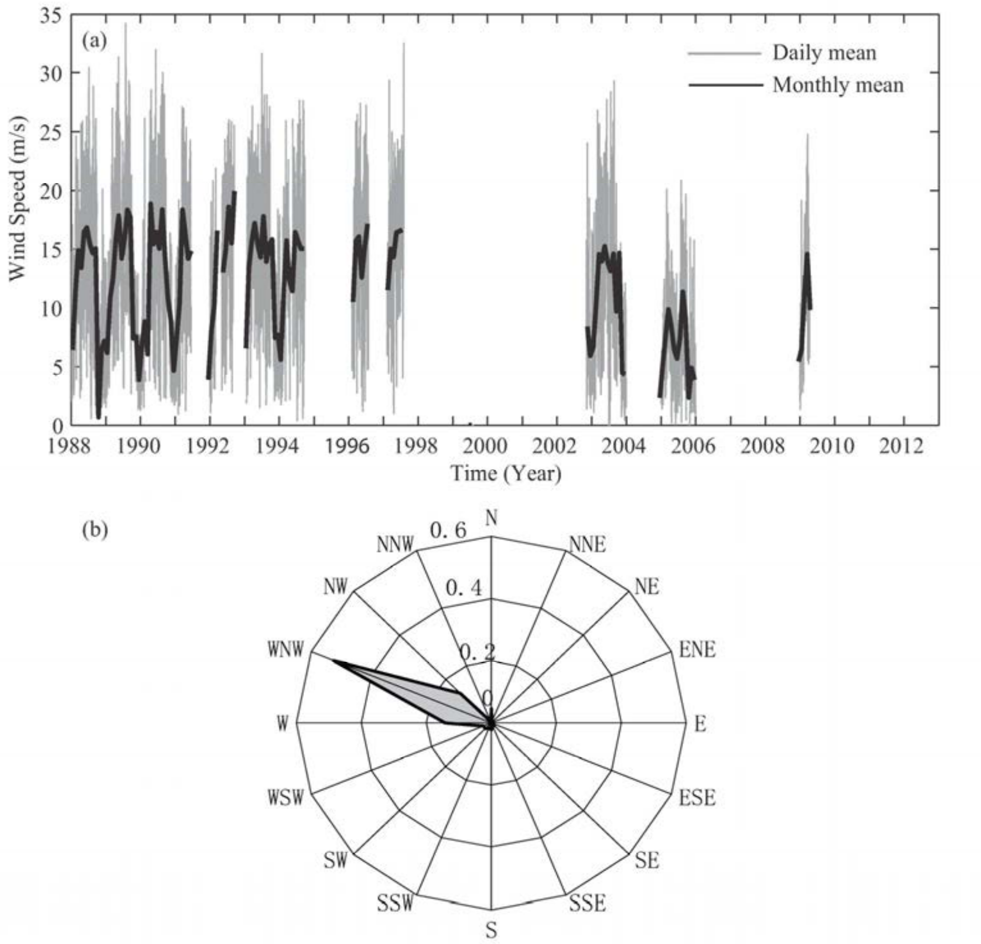


Figure 4-14 Time series of observed wind speed and direction at AWS Manuela

(Grey line is daily value and black line is monthly value.)

During November-January the wind speed was under 15m/s in 90% cases, indicating the main distribution range in these months. More than half cases in December and January, observed wind speed was under 5 m/s and never surpassed 35 m/s. In February the main distribution range was between 5~15 m/s in nearly 60% cases and never surpassed 35 m/s as well. During March to June, wind speed between 5~15 m/s and 15~25 m/s are regarded as the main distribution range. Wind speed at 35 m/s occurred in this period. During July to September, the wind speed between 15~25 m/s ranged 40% and that was regarded as the main case while 5~15m/s ranged 30% and that was regarded as the second distribution range. Wind speed between 25~35 m/s ranged more than 10% and in approximately 1% cases the speed could reach more than 35 m/s.

As is shown from the observed data from the Chinese new automatic meteorological station at the proposed site (from January, 2013 to November, 2013), during the observation period, the proposed area was dominated by the westerly and northwest wind. The average wind speed was 10.0 m/s. The wind was stronger at night with a speed of up to 35.0m/s.

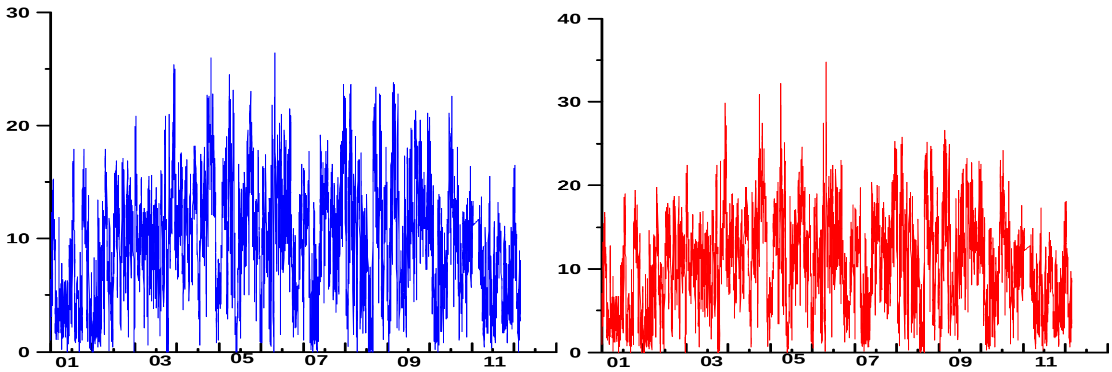


Figure 4-15 Time series of observed wind speed during 2013

(2 meter left and 4 meter right)

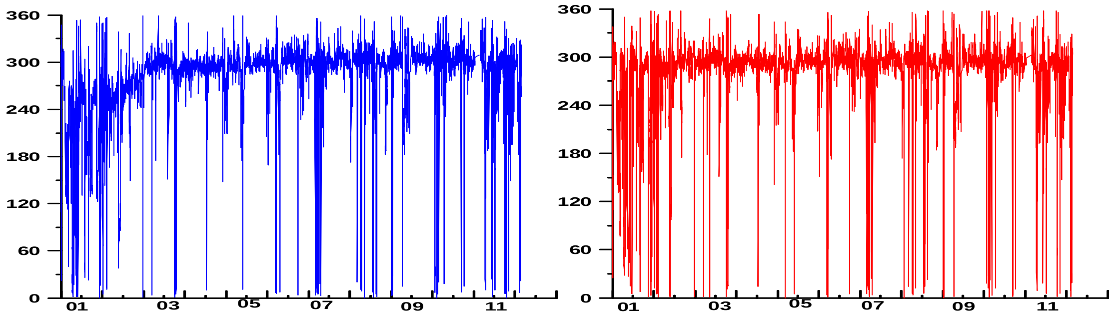


Figure 4-16 Time series of observed wind direction during 2013

(2 meter left and 4 meter right)

4.5.4 Katabatic wind

According to standard above, there were 298 strong katabatic events based on the available data of limited 10 years during 1988-2012. 49.8% of them occurred in winter (21% occurred in July) and the average lasting time was approximately 10 hours. There were no such events in December and January of summer time. The proportion of strong katabatic events was 2.5% in late summer (February) and lasted for 6.9 h in average.

More frequent katabatic events took place when it came to autumn (started from March). They accounted for 10.1% of all the cases in March and lasted for 9.7 h. The most frequent events at a proportion of 21% were observed in July lasting 11.6 h in average. The occurrence ratio and lasting time of strong katabatic events began to decrease after that and reached 1% and 4.5 h in November. We can see that these events take place mostly in winter and last for a relatively long time.

The average wind speed of strong katabatic event is between 25~30 m/s and sometimes it could be more than 40 m/s (see Fig 4-17). Both average and maximum wind speed start to increase from late summer (February) and decrease in winter (start from August). The instantaneous speed peaks in July while the average speed in August. Therefore the strong katabatic events take place more frequently with higher wind speed and long-lasting time in winter while it's opposite in summer.

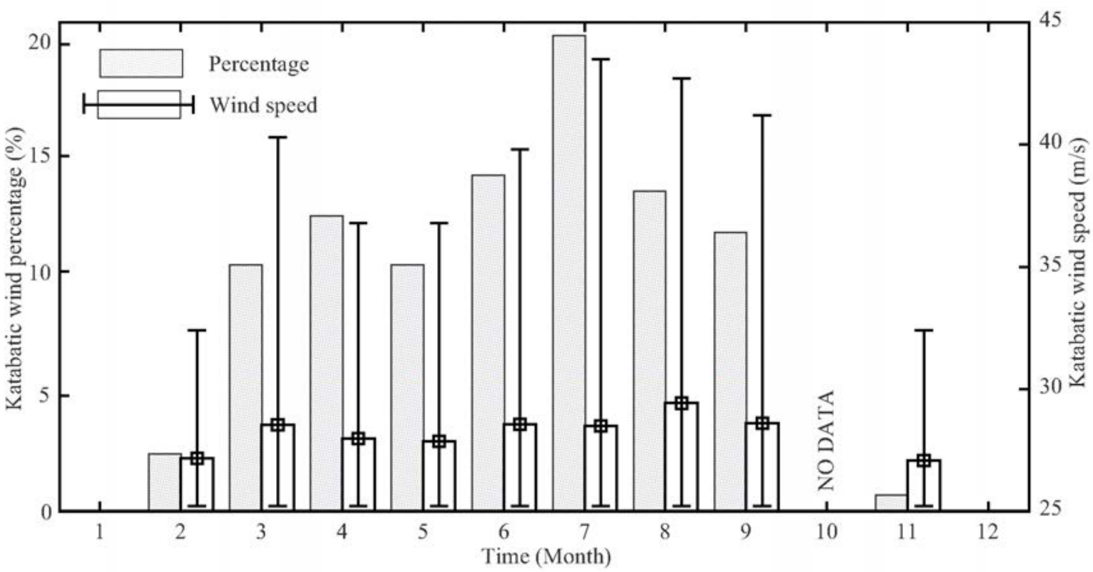


Figure 4-17 Statistics of the strong katabatic wind events (partly years of 1988-2012)

4.5.5 Humidity

The observed variation of relative humidity at AWS Manuela is shown in Fig 4-18. With a multi-year average value of 45%, the relative humidity was low in this site. In most time the humidity was between 30%-60% which ranged 72% and it only ranged 16% when the value was above 60%.

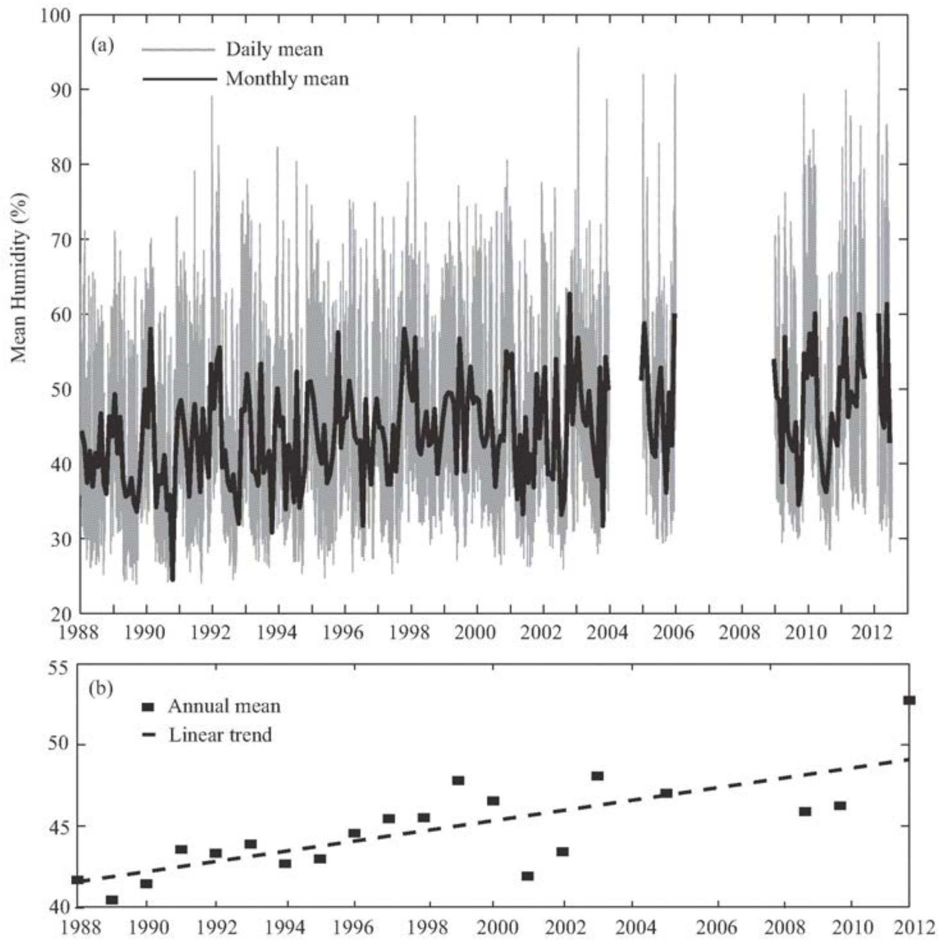


Figure 4-18 Time series of observed humidity at AWS Manuela (1988-2012)

(Daily mean (a, grey line), monthly mean (a, black line), and annual mean (b, dot) and linear trend (b, dashed line) were shown.)

As is shown from the observed data from the Chinese new automatic meteorological station at the proposed site (from January, 2013 to November, 2013) (Fig.4-19), during the observation period, the average humidity was 44.9 %, which was less than Zhongshan Station and represented the less precipitation in the site.

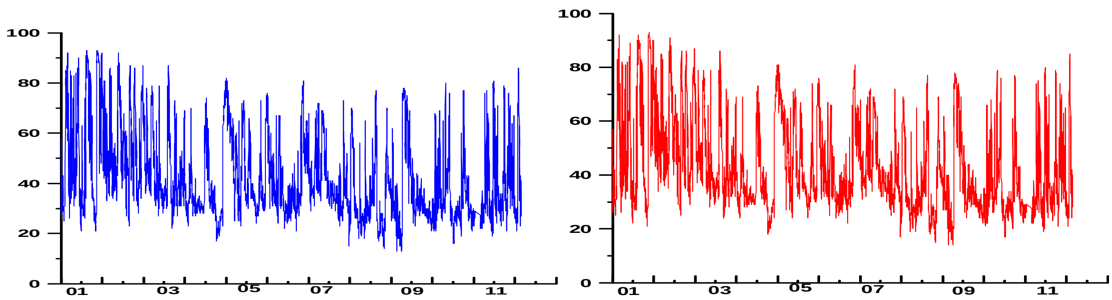


Figure 4-19 Time series of observed humidity during 2013

(2 meter left and 4 meter right)

Except in cloudy and snowy weather when relative humidity was higher than 60%, the relative humidity maintained at 30% - 50% in the rest of the time.

4.5.6 Air pressure

The observed air pressure variation at AWS Manuela is shown in Fig 4-20 with an average value of 979.7hPa. Without obvious monthly pressure change, the maximum value was 984.40 ± 6.55hPa in June and minimum was 977.36 ± 4.48hPa in November (the comparative lowest value was not considered because the data of October were only available for two years). The average atmospheric pressure was almost constant between 970-985hPa year-round with standard deviation between 3-6hPa in each month.

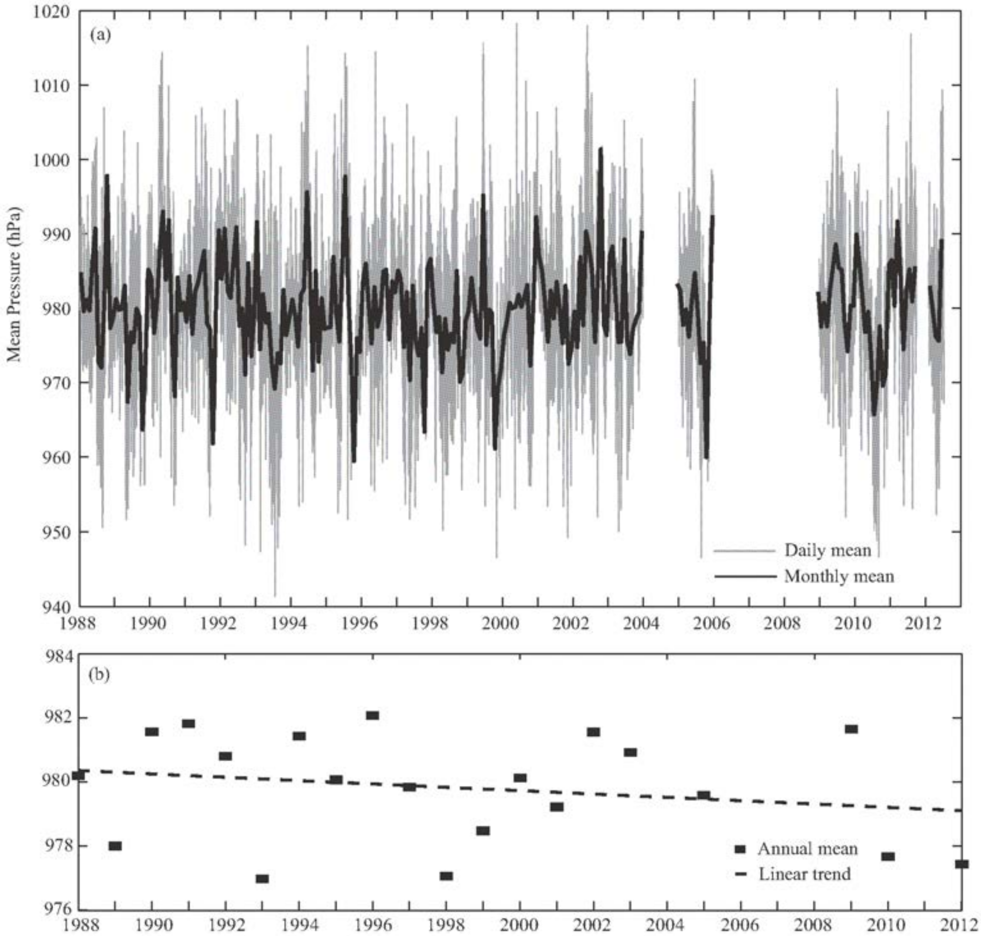


Figure 4-20 Time series of observed pressure from AWS Manuela, daily mean (a, grey line), monthly mean (a, black line), annual mean (b, dot) and linear trend (b, dashed line) were shown.

As is shown in the observed data from the Chinese new automatic meteorological station at the proposed site (from January, 2013 to December, 2013), during the observation period, the average air pressure was 988.0 hPa, and the maximum air pressure was 1021 hPa and the minimum was 955 hPa, which is similar to Zhongshan Station.

4.6. Flora and fauna

4.6.1 Flora

The new station is located on the island without large moss or lichen distribution according to the recent investigation. Lichen only occasionally occurred on shady and wet large rocks.

As to the investigation of 29th Chinese Antarctic Expedition, there is no moss and only a little lichen on some large rocks on the island. In the north of the Inexpressible Island, small quantities of rust-colored lichens are found on the shady sides of more than 10 big stones (Fig. 4-21). There are also dead and carbonized large lichens. Besides those, no deep red-brown lichen is found. The discovered lichen is located more than 2km to the proposed site in the north.

The observed lichen was clingy to stones about 1 to 2 mm high. This stone was near the snow melt water throughout the region with larger humidity at the coordinates of 74°53.730'S, 163°43.892'E.

Figure 4-21 Distribution of lichen in rust color

In the southern part of the Inexpressible Island (74°55'22.98"S, 163°42' 41.56" E), 2 small green lichen patches were found on an elongated rock about 45 cm long, 20 cm wide (Fig. 4-22).

Figure 4-22 Green lichen

4.6.2 Fauna

In the proposed site, animals found are mainly Adélie penguins, Antarctic skuas and Weddell seals.

There are about 20000 penguins along the northern coast of the island, and chicks make up about 30% of the total population. The overall distribution in the band area also presents a small circular community distribution pattern. The number of individuals in each community is about 200-300, as shown in Fig. 4-23 (Red region 2). According to GPS data and onsite estimation, the penguin community covers an area of 0.5 square kilometer approximately. The center of the penguin colony is located to the north of the proposed site, and the distance between them is more than 2.5km and separated by a buffering rock ridge with a elevation around 50 meters.

In the northernmost part of penguin colony, there is a small salt lake (Fig. 4-23, Blue region 1). In the shore of the lake eight seal bodies were found without any big seal communities, some has been air-dried and some are bare bones. The discovered seal bodies are also located to the north of the proposed site, and it is more than 2.8km between them.

On southernmost tip of the island as shown in Fig 4-23 (Red region 3), the thawed snow and ice form a small lake, where about forty adult penguins and no chicks were found. The distance to the proposed site is more than 1.5 km in the west.

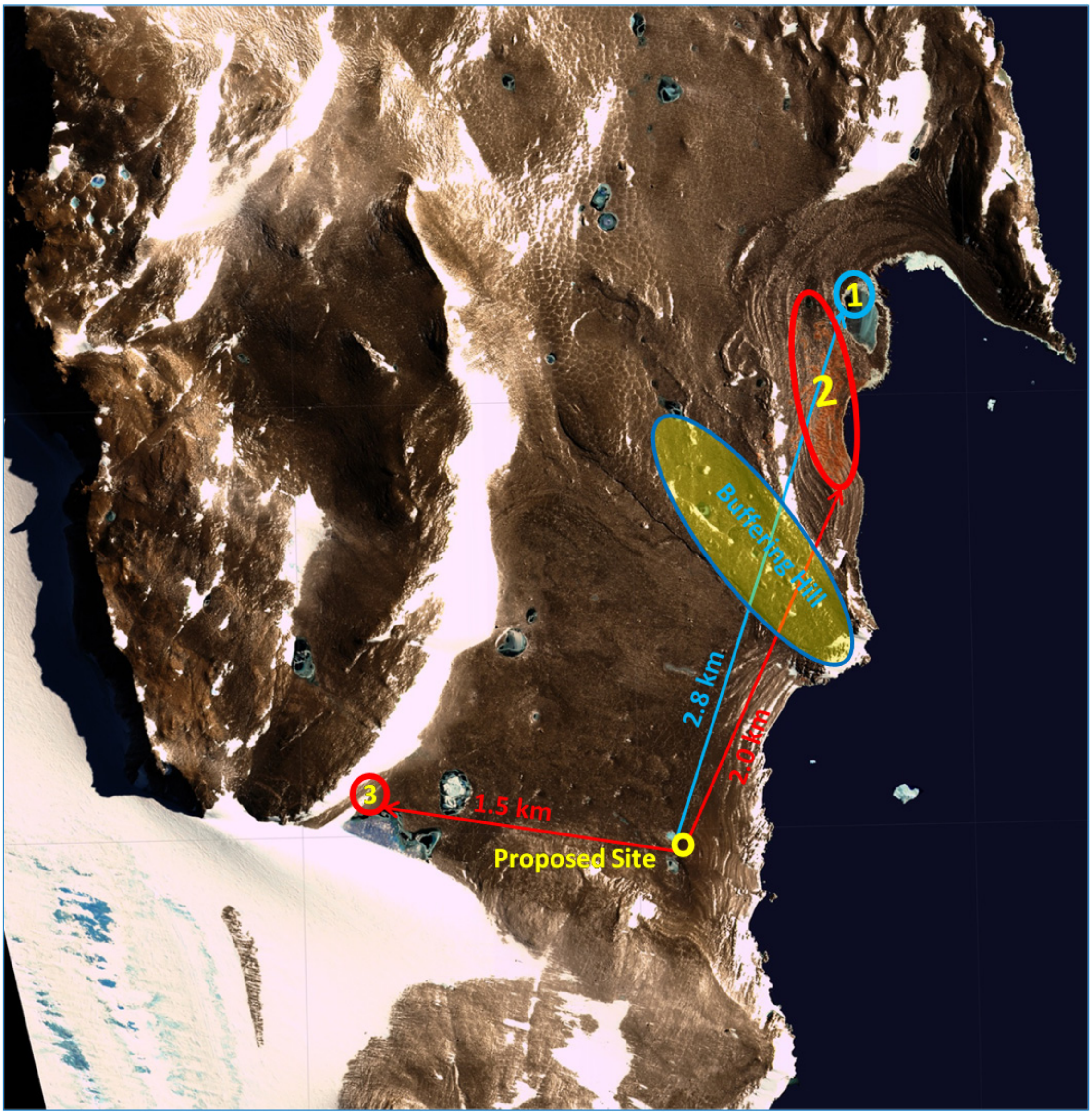


Figure 4-23 Fauna distribution on the Inexpressible Island

The influence on these animals will be seriously considered during the building and operation of the new station. Furthermore, the new station will be in favor for the observation and research of the ecosystem and its response to climate in this region. An Antarctic Specially Protected Area will be suggested to protect the penguin colony and detail management plan will be prepared by China in the future. During the construction and operation period, visitors without clear scientific research or monitoring purposes will be prohibited to getting close to the penguin colony.

4.7. Terra Nova Bay polynya

The TNB polynya is the key region of the Southern Ocean because of its crucial role in the sea-ice production and for dense water formation processes which affect the regional ocean properties. In last decades both meteorological and oceanographic conditions showed relevant changes.

The Terra Nova Bay (TNB) occupies an area of 6000 km^2 (65 km north/south by 92 km east/west) in the western Ross Sea near 75°S, 164°E. It is located in northern Victoria Land, along the western margin of the Ross Sea, bordered on the south by the floating Drygalski Ice Tongue, on the north by Cape Washington, and on the west by the Nansen Ice Shelf, which is fed by the Reeves and Priestley Glaciers. The TNB polynya is a large, stable, annually recurring feature in the western Ross Sea, which markedly influences sea ice dynamics and physical oceanography in that region.

Kurtz and Bromwich (1983) estimated the monthly mean extent of open water in the TNB polynya through the winter (March to October) of 1979 using infrared satellite images, and found that throughout the winter, the area of open water fluctuated quasi-periodically with a period of 15-20 days, and the average polynya area was 1000 km^2, maximum area was approximately 5000 km^2. The fluctuations were associated with the magnitude of the zonal geostrophic wind, with a closing polynya related to strong, persistent easterlies. Bromwich et al. (1984) used qualitative trajectory calculations to find that the katabatic winds maintain their identity for some distance seaward of the coast and this distance is on the order of the observed polynya width. Polynya size varies by migration of its eastern boundary, the maximum eastward extent of the polynya is limited by the length of the Drygalski ice tongue (Kurtz and Bromwich 1983, Bromwich et al., 1984).

4.8. Lakes

There are three large lakes in the proposed site area. The depth and ice information were investigated as shown in Fig 4-24.

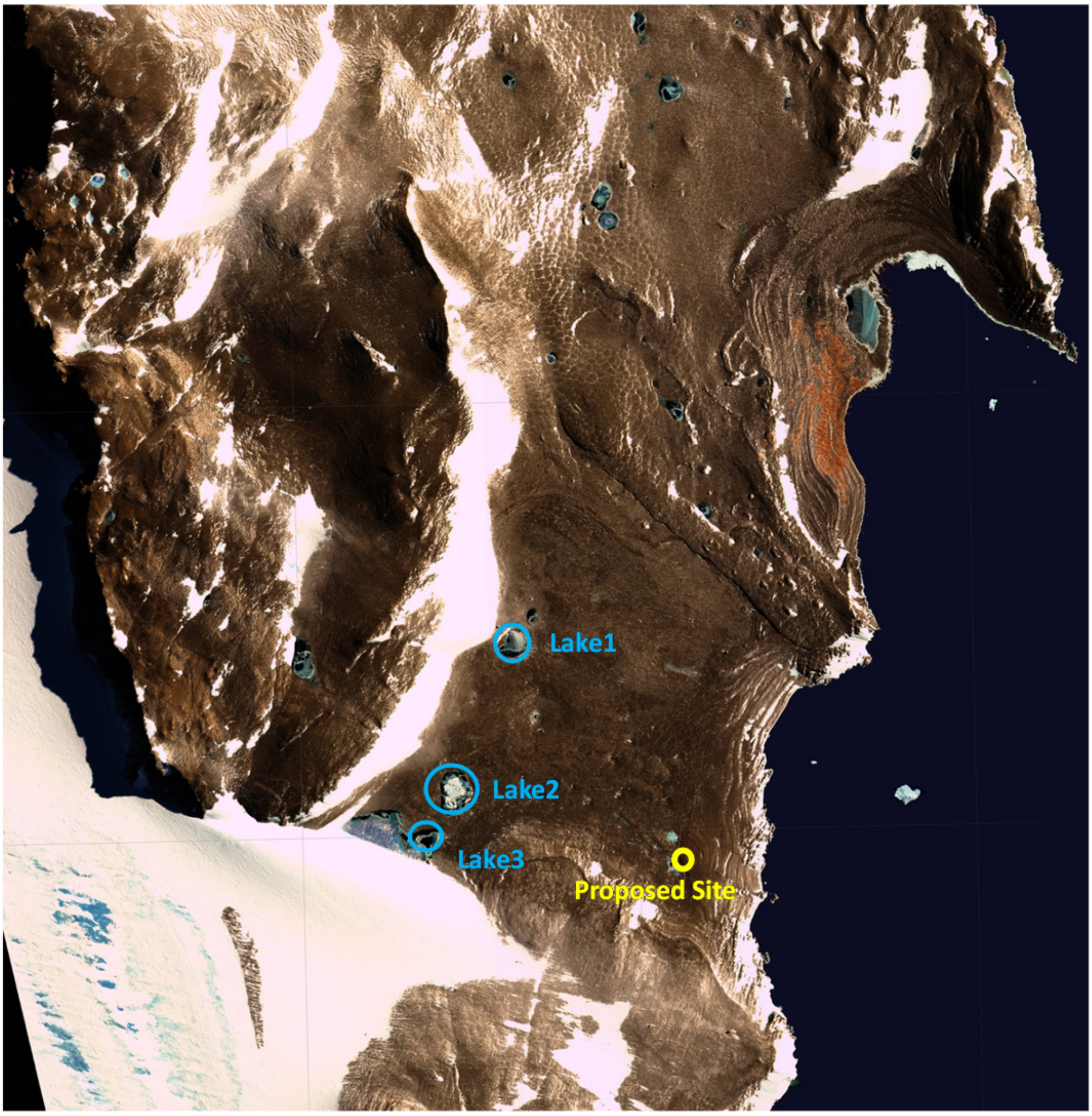


Figure 4-24 Location of the lakes on the Inexpressible Island

Lake 1 is about 546 m in perimeter measured by GPS on January3, 2013. It covers an area of about 21235 m^2. It is an independent circular lake, surrounded by glacier deposit. The depth of the lake is 270-280 cm, and the thickness of liquid water under the ice is 20-60cm.

The sampled ice thickness is 215 cm, and the air temperature is 4 °C. The measurement points are shown in Fig.4-25. Of the top 65 cm of the ice is about -0.20 °C, temperature declines with the increase of depth. In 200-220 cm, the temperature reduces to -1.1 °C.

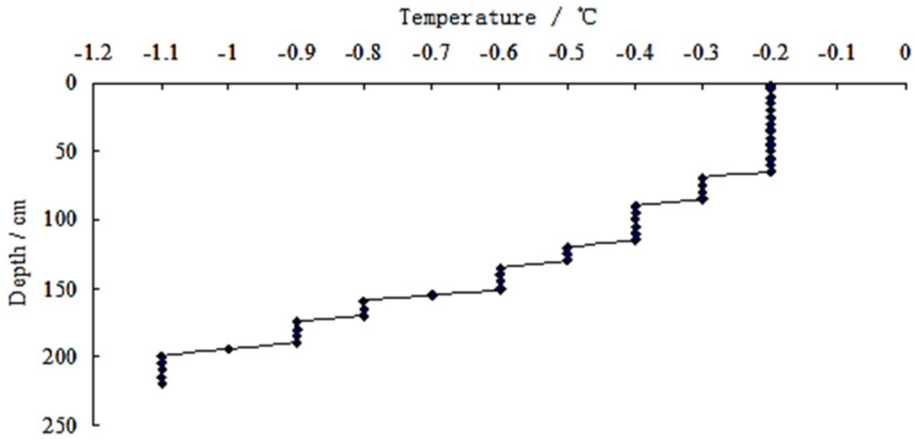


Figure 4-25 Temperature profile of Lake 1#

Lake 2 is about 1127m in perimeter measured by GPS on January3, 2013. It covers an area of 49540 m^2. The lake is connected to the glacier with a narrow channel. The ice thickness at the site is 169 cm, with a depth of 175cm, and the air temperature is 4 °C (Fig.4-26). The ice temperature is stably close to 0°C, indicating a melting process.

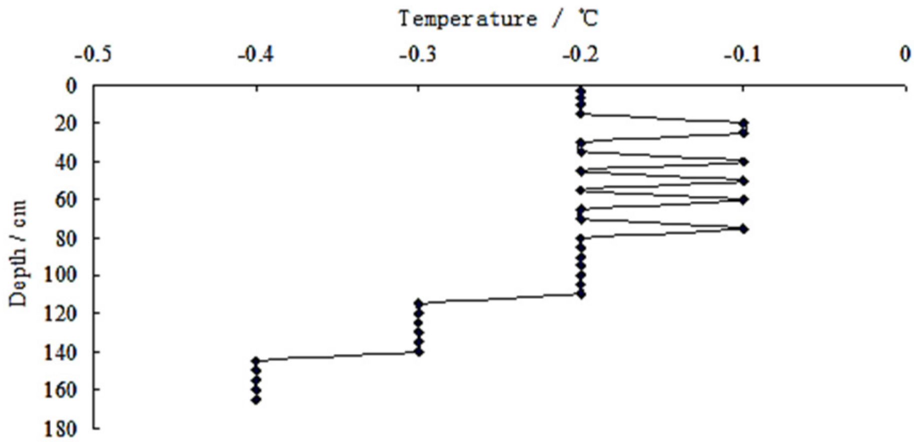


Figure 4-26 Temperature profile of Lake 2#

Lake 3 is about 408 m in perimeter, covering an area of about 11566 m^2measured by GPS. The ice melting at the lake 3 is severe, preventing the landing on the ice surface, thus no depth and ice information were retrieved.

4.9. Human activities

The island was discovered in 1901-1903 by Scott's *Discovery* Antarctic expedition .In January 1912, during the Scott's second Antarctic expedition (Terra Nova, Antarctic expedition), a six-member expedition team landed on the island. This group had to live on the island until September because Terra Nova ship failed to pick them up on time. The camping position has been listed as a historical site (HSM 14, 74°55'S, 163°43' E). The current human activities on the island mainly include research and tourism.

Two times of Italian helicopter operation were observed during the onsite investigation, including one operating for more than three hours to transport construction materials and other supplies to the island. The Italian station on the island mainly focuses on geological, seismic and oceanographic studies. During the onsite investigation, the South Korean scientist also visited the island once.

Tourism is the other main human activities on the island (see domestic Antarctic tourism organization IAATO's official website).The main purpose of the tourism on this island is to watch the Adélie penguins and historical relics.

4.10. Protected areas, historic sites and monuments

The historic sites on the Inexpressible Island are mainly associated with the 1910-1913 Antarctic expedition by British explorer Scott's Terra Nova.

In January 1912, Victor Campbell together with five other adventurers landed on Cape Adare for geological survey but failed to return in time. In November, 1912, the six people survived the winter and made their way home. They were shipped to the south of the Terra Nova, the Evan’s Cove.

This area has two historic sites. One is the snow house where they overwintered, as HSM14 (74°54' S, 163°43'E), the other is located in the northeast of the island, where they stored supplies as HSM68 (74°52' S, 163°50'E).

There is one natural reserves established by Italian initiative as ASPA 161 (74°45'S, 164°10'E, Terra Nova Bay, Ross Sea). It is located 23 km away from the northeast of the proposed station location.

4.11. Prediction of the future environmental trends without the proposed activities

Due to the short period of sea ice melting, the number of tourists in this area is limited. Only did the Italian groups do some scientific investigations on the island. Therefore, without new station construction, pollution and terrain changes related to the construction of the new station do not exist.

A small number of the Adélie penguins occasionally visit the fresh water lake on the island. Without the station-related activities, these penguins will not be affected.

A dock at the coast will be set up for the logistics of the new station. Without the related construction, such as leveling of the land, the terrain will not be changed.

The regular station operation and logistic related activities may involve the use the fresh water in the lake, and the sewage disposal. Without these activities, the surrounding marine environment will remain intact.

5. Identification and Prediction of Environmental Impact, Assessment and Mitigation Measures of the Proposed Activities

An Environmental Impact Assessment comprises three major phases: analysis of proposed activities and identification of the impacts on the current environment, prediction and assessment of the impacts, and suggestion for mitigation measures and following monitoring and verification. This draft CEE for the construction and operation of the new Chinese station is prepared according to this process.

The proposed region which will be mostly interfered by the construction and operation of the station covers the whole area of the station with a circumference of approximately 1 km^2. Additionally, the marine transportation route will also be considered. The following sections define the direct impact of the proposed construction, operation and logistic supporting activities of the station on the local environment (refer to Section 2). The inputs and outputs of the activities as well as their potential impact on the environment are assessed by means of the source-pathways-receptors process. And then, measures for the mitigation of the impact are presented. Assessment of the impact and measures of mitigation of them are provided in the Impact Matrices at the end of this chapter.

The direct environmental impact on ice, snow, air, ecosystem and other environmental attributes will caused by the activities as construction and operation of the station, emission of exhausted gas and oil spilling, discharge of treated sewage up to the standard after treatment, noise from vehicles and personnel, and influence from the interference of visitors.

Among the impact, air pollution and particle fallout are considered as the most important. However, the probability of large-scale oil leakage is relatively low. The adverse impact of residual water is relatively low as the related treatment meets the required standards and the discharge is little. Due to the limited snow-compaction and snow-collection, the impact on ice and snow is easy to recover. As far as the scientific research is concerned, the estimated impact include the air pollution caused by consuming fossil fuel which may affect atmospheric chemical determination, interference to snow surface which hence affect the meteorological observation. The potential impact of light haze deriving from the construction of the station which also affects meteorological observation and interferes of electro-equipment and vehicles of the station in electromagnetic observation.

As a matter of course, this plan also formulates the prevention and mitigation measures in order to avoid or reduce all the estimated impact.

All construction work and operation activities at the new station, as well as any other activities in the actual process beyond the original plan must meet the requirements of the Protocol on Environmental Protection to the Antarctic Treaty. CAA will carefully supervise the implementation of the plan, and provide environmental protection education and pre-departure training for the personnel who will participate in the station construction and scientific expedition activities.

Sustainable and highly efficient techniques are taken into full consideration on the aspect of materials selection, the utilization of renewable energy resources, the maintenance and management, the waste treatment, recycling and utilization, and the development, dismantlement and clearance of the station in the future. Therefore, it will be of great advantage to mitigation of environmental impact.

Description of indirect impact and cumulative impact are discussed in Section 5.6.

5.1. Methodologies and data

The following criteria are used to identify the character of the impact and to make the qualitative and quantitative assessment on the potential environmental impact in Sections 5.3. These criteria and assessment guidelines are applied to the impact matrix of Section 5.5.

Nature

"Nature" here means the character of the impact caused by the activities on potential receptors.

Extent

"Extent" here means affected geographical areas ranging from local, regional, Antarctic to global areas.

Duration

The duration of impact is classified as "very short term" (minutes to days), "short" (weeks to months),"medium" (years), "long" (decades), "permanent" and "unknown". There may be a lag time between the occurrence of the result and the time of the impact.

Intensity

General impact level is assessed at different degrees (low, medium and high). Low degree means that there is only small effect on the natural function or process, and this effect is reversible； Medium degree means that there is an effect on the natural function or process, but the process is not affected by a long-term change and this influence is reversible； High degree means there is a long-term or cumulative effect on the natural function or process, and such impact is probably irreversible.

Probability

Possibility of impact is described as different extents like low, medium, high and certain.

Significance

The overall significance of impact is assessed at different degrees (very low, low, medium, high and very high).

Description of impact

Specific impact is qualitatively classified as the direct impact, indirect impact and cumulative impact. Specific descriptions of these three categories of impact are shown in Article 3 of Annex 1 of the Protocol Environmental Protection to the Antarctic Treaty. Various definitions made by the CEP (2005) are adopted in this CEE.

(1) Direct impact: Any first order effect, impact or consequence that may be associated with activities.

(2) Indirect or second order impact: Any second order effect, impact or consequence that may be associated with activities.

(3) Cumulative impact: the effect, impact and consequence that may come from similar or varied sources, as well as the additive, antagonistic or synergistic effects that can occur.

5.2. Source, pathways and receptors

The source-pathways-receptors principle has been used for identification of the impact possibly associated with the activities and it is in compliance with the Environmental Protocol. The impact may be worse than estimated.

The sources of environmental impact arise from construction and operation of the station, emission of exhausted gas and oil spilling, discharge of treated sewage up to the standard after treatment, noise from vehicles and personnel, and influence from the interference of visitors.

The geographical areas to be affected mainly include the marine transport route and the proposed new station. The area where scientific activities are conducted will also be affected to some extent.

The location where the station will be built is close to the glacier. As ice is a kind of medium, the wastes produced or discharged on snow or ice in some areas may move to another area with the floating medium such as the ocean, though it may take a long time.

5.3. Environmental impact identification, prediction and assessment

5.3.1 Impact on air

Fuels to be used during the construction and operation at the station include:

- Antarctic Diesel (Vehicles and power supply)
- Aviation Kerosene (Helicopter)

- Lubricating oil and hydraulic oil (Mechanical equipment and vehicles)
- Magnetic pyrolysis furnace

The atmospheric emission during the construction period will mainly arise from the consumption of fuels used for vehicle's operation and power supply. Besides, carbon dioxide emitted from the process of sewage treatment will also give rise to slight impact on the atmosphere. During the operation period, magnetic pyrolysis furnace will be used instead of traditional incinerator to minimize the atmospheric emission arising from the waste disposal.

1. Estimation on fuel consumption

During the initial stage of station construction and operation, the fuel will be mainly used for five purposes: 1) for power generation, 2) for the operation of machinery and transportation vehicles, 3) for boiler heating, 4) for the operation of the aircraft, and 5)for scientific survey and equipment operation. After the successful installation of the hybrid Solar-Wind-Diesel power supply system, the solar energy and windmill will be fully used as primary energy. So the fuels will mainly be used for the operation of construction machinery, transportation vehicles, the aircraft and the scientific equipment and in emergency cases.

The approximate fuels consumption by the station during the construction and operation stages, before and after the use of the renewable energy is shown in Tab 5-1 and Tab 5-2. Data regarding the construction of Antarctic stations by other countries have also been taken for reference when making the estimation.

Table 5-1 Estimated fuel consumption required during construction of the station (tons)

Source	Fuel Type	Total Fuel Consumption(ton)	First year (ton)	Second year (ton)
Marine transportation (R/V Xuelong, Cargo ship, Tugboat, Rubber boat)	Antarctic Diesel	2000	1000	1000
Air transportation	Aviation kerosene	100	50	50
Generator used for (camps and facilities	Antarctic Diesel	90	45	45
Construction equipment and vehicles	Antarctic Diesel	30	15	15
Emergency fuel	Antarctic Diesel	20	10	10
Sub total		2240	1120	1120

Table 5-2 Estimated fuel consumption required during operation of the station (tons/year)

Source	Fuel Type	Before use of renewable Energy (ton)	After use of renewable Energy (ton)
Marine transportation (R/V Xuelong, Cargo ship, Tugboat, Rubber boat)	Antarctic Diesel	1000	1000
Air transportation	Aviation kerosene	30	30
Generators	Antarctic Diesel	200	80
Vehicles	Antarctic Diesel	15	15
Emergency fuel	Antarctic Diesel	10	10
Sub total		1255	1135

Because maritime transportation constitutes part of China's regular annual Antarctic expedition activities, and there are 120 berths on the Vessel of Xuelong, hence there will be no increase of berths during construction and operation of the station, the extra increase of the fuel is related to the additional fuel needed between the Zhongshan station and the proposed new station.

2. Assessment of the impact on air

Unloading from the vessel will be carried out mainly by barges, a small number of staff and some cargos would be carried to the new station by helicopter. The days for unloading depend on several factors such as sea ice, weather conditions, and time required for transporting oil or construction materials to the station. 15 days may be needed for unloading during the construction and operation of the proposed station. Emissions along the coast will spread out rapidly. Therefore no obvious impact will be brought on the wildlife, oceanic system or atmospheric quality.

During construction, there will be more human and vehicle activities. Without solar energy power and windmills during the construction period, the fuel consumption at the proposed new station as well as the atmospheric emission will be relatively high. However, once the solar energy power and windmills are put into operation, the fuels will mainly be used to support the field survey and the operation of limited vehicles, as a result, the atmospheric emissions will be reduced distinctly.

Other sources causing impact on the atmosphere are carbon dioxide arising from the sewage treatment. The fallout of burnt substances occurring in the station may possibly deteriorate snow and ice. Heavy particulates may deposit in the areas near the station, which may result in the adverse impact on the future study of snow and ice. The study conducted by the stations of other countries show that, pollution to snow and ice in downwind direction may reduce rapidly at the place of 10 km away from the location where the pollution originates.

1) Estimated atmospheric emission in the construction stage

The construction stage will cover two austral summer, and each construction stage will last for approximately 3 months. During the austral summer of 2015/16 and 2016/17, it is estimated that each year 1000 tons of Antarctic Diesel will be needed for marine transportation, 50 tons of Aviation kerosene will be needed for air transportation, 45 tons of Antarctic Diesel will be needed for the operation of the generator and another 15 tons of Antarctic Diesel will be needed for construction equipment. According to the emission factors given by the Appendix 5 of Korean Final CEE for JANG BOGO Station, the total annual emissions of various pollutants in each year during the construction will be as follows: CO, 1.37 ton, NO_x, 4.30 ton, SO_2, 33.53 ton, PM_{10}, 0.37 ton, CO_2, 958.79 ton as shown in Tab 5-3.

The total amount of pollutants during the construction stage will be as follows respectively: CO, 2.74 ton, NO_x, 8.60 ton, SO_2, 67.06 ton, PM_{10}, 0.73 ton, CO_2, 1917.58 ton as shown in Tab 5-3.

2) Estimated atmospheric emission in the operation stage

During the first few years of the station operation, the station will take the highly efficient fuel as the main power source and adopt the hybrid Solar-Wind-Diesel power supply system. It is estimated that 1000 tons of Antarctic Diesel will be needed for marine transportation, 50 tons of Aviation kerosene will be needed for air transportation, 200 tons of Antarctic Diesel will be needed for the operation of the generator and another 15 tons of Antarctic Diesel will be needed for vehicles. The total annual emissions of various pollutants in that year will be as follows: CO, 1.29 ton, NO_x, 6.57 ton, SO_2, 33.66 ton, PM_{10}, 0.56 ton, CO_2, 1036.78 ton as shown in Tab 5-4.

If the hybrid solar-wind-power system is successfully installed and operated, the renewable energy will be the main energy source for the whole station. Thus, the estimated consumption of Antarctic Diesel for the operation of the generator will decrease to 80 tons/year. The total annual emissions of various kinds of pollutants will be as follows: CO, 1.17 ton, NO_x, 4.81 ton, SO_2, 33.55 ton, PM_{10}, 0.41 ton, CO_2, 963.10 ton as shown in Tab 5-4. The reduction of the emission by renewable energy system will be as follows: CO, 0.12 ton, NO_x, 1.76 ton, SO_2, 0.11 ton, PM_{10}, 0.15 ton, CO_2, 73.68 ton.

Table 5-3 Estimated fuel consumption and total emission during the construction period

Source	Fuel Type	Total Fuel Consumption(ton)	1st year(ton)	2nd year(ton)	Emission Pollutants	Emission factor (g/kg)	1st Year Emission(ton)	2nd year Emission(ton)	Total Emission(ton)
Marine transportation	Antarctic Diesel	1600	1000	1000	CO	0.71	0.71	0.71	1.42
					NO_x	3.41	3.41	3.41	6.82
					SO_2	33.44	33.44	33.44	66.88
					PM_{10}	0.28	0.28	0.28	0.56
					CO_2	879	879	879	1758
Air transportation	Aviation kerosene	200	50	50	CO	12	0.6	0.6	1.2
					NO_x	0.19	0.0095	0.0095	0.019
					SO_2	0.72	0.036	0.036	0.072
					PM_{10}	0.2	0.01	0.01	0.02
					CO_2	859	42.95	42.95	85.9
Generator used for (camps and facilities	Antarctic Diesel	90	45	45	CO	1.01	0.04545	0.04545	0.0909
					NO_x	14.66	0.6597	0.6597	1.3194
					SO_2	0.93	0.04185	0.04185	0.0837
					PM_{10}	1.28	0.0576	0.0576	0.1152
					CO_2	614	27.63	27.63	55.26
Construction equipment and vehicles	Antarctic Diesel	30	15	15	CO	1.01	0.01515	0.01515	0.0303
					NO_x	14.66	0.2199	0.2199	0.4398
					SO_2	0.93	0.01395	0.01395	0.0279
					PM_{10}	1.28	0.0192	0.0192	0.0384
					CO_2	614	9.21	9.21	18.42
Subtotal					CO	-	1.3706	1.3706	2.7412
					NO_x	-	4.2991	4.2991	8.5982
					SO_2	-	33.5318	33.5318	67.0636
					PM_{10}	-	0.3668	0.3668	0.7336
					CO_2	-	958.79	958.79	1917.58

Table 5-4 Estimated annual fuel consumption and total emission during the operation period

Source	Fuel Type	Before use of renewable Energy(ton/year)	After use of renewable Energy(ton/year)	Emission Pollutants	Emission factor (g/kg)	Emission without renewable energy (ton/year)	Emission with renewable energy (ton/year)
Marine transportation	Antarctic Diesel	1000	1000	CO	0.71	0.71	0.71
				NO_x	3.41	3.41	3.41
				SO_2	33.44	33.44	33.44
				PM_{10}	0.28	0.28	0.28
				CO_2	879	879	879
Air transportation	Aviation kerosene	30	30	CO	12	0.36	0.36
				NO_x	0.19	0.0057	0.0057
				SO_2	0.72	0.0216	0.0216
				PM_{10}	0.2	0.006	0.006
				CO_2	859	25.77	25.77
Generators	Antarctic Diesel	200	80	CO	1.01	0.202	0.0808
				NO_x	14.66	2.932	1.1728
				SO_2	0.93	0.186	0.0744
				PM_{10}	1.28	0.256	0.1024
				CO_2	614	122.8	49.12
Vehicles	Antarctic Diesel	15	15	CO	1.01	0.01515	0.01515
				NO_x	14.66	0.2199	0.2199
				SO_2	0.93	0.01395	0.01395
				PM_{10}	1.28	0.0192	0.0192
				CO_2	614	9.21	9.21
Subtotal				CO	-	1.29	1.17
				NO_x	-	6.57	4.81
				SO_2	-	33.66	33.55
				PM_{10}	-	0.56	0.41
				CO_2	-	1036.78	963.10

3) Impact of emission

Substances derived from fuel combustion are: carbon dioxide, sulfur dioxide, nitrogen oxide and particulates etc. These substances will cause some impact on air quality. However, generally speaking, the impact is small. Firstly, the emission of all the fossil fuels during construction will only take place in two months in summer (including the time of transportation), which will be relatively short, secondly, there are relatively good out-spreading conditions during the operation stage around the station area where there are no plants or animals.

Therefore, the emitted pollutants will spread to a very low concentration condition.

R/V Xuelong sails along its regular navigational route, the people and cargoes only stopover in the facility zone for a short time, the proposed aircraft would only fly from the Xuelong to the proposed station for each austral summer, so the pollutants emission from the exhausted gas will spread out quickly and will not generate obvious impact on wildlife, ocean and atmospheric quality.

The estimated impact includes those on the snow and ice surface of the station area. This kind of pollution may affect part of the scientific value of the area. The particulates may exist in the snow and ice for a long time.

The pollutants will accumulate, and some emitted gas will affect the atmospheric environment of the area. CO (like NO_x, the catalyst consumed by ozone) will stay in the air for about 1 month, and will finally change to CO_2. CO_2 is the product of maximum quantity in the combustion process. It will not directly affect human's health. However, as a greenhouse gas it will obstruct heat spreading from the earth into the atmosphere, thus having the possibility of warming up the earth.

5.3.2 Impact on snow, ice and ocean

1. Risk assessment of oil spill

The aviation fuels, lubricating oil and hydraulic oil will be used for the transportation of materials during the construction and operation of the station. Most fuels will be transported in sledged fuel tanks and a small amount of fuel and oil will be stored and carried in oil drums during the investigation of the station. Fuel and oil consumption is shown in Section 5.3.1.

Fuel and oil spill may occur in the following processes: in the maintaining and refueling process of generators, vehicles and, the aircraft (including at the relay site), in the leakage of fuel tanks or oil drums, in an accident of vehicle driving process when carrying fuel tanks or oil drums, in the process of refueling, pipeline breaks or leaks, and the leakage of broken fuel tanks, etc. Among all the cases mentioned above, the refueling of vehicles and the leakage of broken tanks may be the main causes of the spill.

Besides, fuel spill accidents can also occur in the ship's navigation. However, as the navigation of R/V Xuelong has become one of the regular activities in China's Antarctic expedition, the fuel spill risk in the maritime transportation process is not covered in the assessment of this CEE.

Fuel has relative volatility and the spilled fuel volatilizes rapidly. However, its residues will still exist. Some fugitive emissions depend on the range of fuel spill. If fuel spills onto the snow or ice, it will move down and may be wrapped up and kept there until it is released again. Obviously, oil spill will cause pollution to the atmosphere, ice and snow. It may cause indirect impact on regionally scientific value and cumulative impact as well. The assessment on these risks of estimated oil spill is given in Tab 5-5.

Table 5-5 Assessment on the risks of estimated fuel oil spill at the proposed station

Type of spill	Probability	Max. Spill (L)	Type of fuel oil
Vehicle's collision on ice sheet or grounding	Low	30,000	Antarctic Diesel and other oil product
Catastrophic accident of bulk oil drum	Low	15,000	Antarctic Diesel and other oil product
Damage of fuel tanks or oil drums on the sea ice	Low	5000	Antarctic Diesel and other oil product
Breakage or spill of daily-used oil tanks	Low	<4000	Antarctic Diesel and other oil product
Breakage or spill of boiler tank	Low	<2000	Antarctic Diesel
Breakage or spill of waste oil drum	Low	<2000	Waste oil and lubricating oil
Pipeline breakage or leakage during refueling	Low	1000	Antarctic Diesel
Damage upon lifting of fuel tanks	Medium	200	Antarctic Diesel
Leakage of oil/fuel caused by generator	Medium	40	Antarctic Diesel/ lubricating oil
Small-sale spill during refueling vehicle or aircraft	Medium	5	Antarctic Diesel/ lubricating oil

2．Impact on snow and ice

Since most constructions of the station will be set up on the ground without snow in summer, the environmental impact resulting from the construction of the station will be limited.

The exhausted gas arising from all the activities will reach to snow area. However, it is in a small amount and due to the stable westerly wind directions, it will not deposit in any fixed snow surface in the upwind direction, and the downwind direction is open sea.

3. Impact on the ocean

In the construction and operation stages of the station, the personnel and cargoes will be transported by the Chinese R/V Xuelong which will sail once a year along her regular navigational route.

The operation of the vessel will give rise to solid and liquid waste. The discharge of the waste up to the standard after treatment will still bring about some impact on the marine environment and its ecosystem.

5.3.3 Impact on ecosystem

The construction and operation of the proposed station may not affect the surrounding ecosystem significantly because no conspicuous colonies or breeding grounds of designated species have been found near the proposed site.

The flora, most of which are lichens and mosses, is very sporadic with a low distribution density and a coverage degree of less than 1% nearby the proposed site. They are expected to be disturbed during the construction of the station, especially by the grading work. However, as there are very few lichen growths on the proposed site, the disturbance to vegetation will be transitory only for the construction and thus not be so significant.

The colony of Skua and Adélie Penguin located in the north coast of the Inexpressible Island will not be directly disturbed by the construction and operation of the station, but indirect impact are expected because of the relative proximity of the colony the shortest distance between the colony and the site is approximately 2.0 km. The distance between the small community of penguins in the west and the proposed site is approximately 1.5 km.

Several Weddell Seals were founded on the north end of the Inexpressible Island but no colony was found, hence they will not be directly disturbed by the construction and operation of the station, the distance is more than 2.8 km.

1. Impact on flora and fauna during construction

1) Skua

Several pairs of Skua were observed during the investigation in the season of 2012/13 approximately 1.5 km away from the proposed site. A few scattered nests in or near the proposed site are unlikely to be developed to a large colony in the future due to a lack of bedrock outcrops which are favorable for nests. However, the current existing skua nests within the site may be distressed during the construction.

2) Adélie Penguin

The nearest community of the Adélie penguin is located about 1.5 km away in the west direction. The proposed site was selected in a location approximately 2.0 km away from the boundary of the Adélie penguin colony, approximately 2.5 km from the center of the colony, in order to minimize any disturbances caused by the construction.

3) Helicopters

Helicopters are expected to have a minimum potential to have negative impact on the skua communities during the unloading process, but the duration is short.

4) Marine transportation and unloading

Marine transportations may disturb the marine environment and ecosystem. The unloading from the barge to land will have a particularly potential impact on the marine ecosystem along the coastal line.

2. Impact on flora and fauna during operation

1) Research activities and visitors

Human disturbances can be induced by a variety of research activities and summer visitors, but the impact on lichens and mosses is almost negligible given their locations and densities of distribution. In addition, the impact on skua and Adélie Penguin habitats will be indirect and minor during the operation of the station because the colonies are located at a safe distance from the proposed site.

2) Transportation and unloading in case of oil spill during transportation or unloading, the marine ecosystem may be subject to adverse impact.

3) Skuas are scavengers, therefore food or food waste left outside of the station may disturb their dietary habits.

5.3.4 Impact on wilderness and aesthetic values

The proposed site is an island where there are exposed bedrock outcrops and glacial moraines. The horizontal glacial sedimentary layers develop relatively flat topography, and the construction of buildings and routes may nevertheless result in, though minor and local, a visual disturbance to the natural landscape of the region.

The station layout is intended to have a minimum impact on the landscape and maintain the aesthetics of the region. The buildings and facilities at the station will be contained within the proposed site to reduce the influence on the local scenery as much as possible. Tracked vehicles will only be used on the designated routes to minimize the disturbances to the land surface.

The station will recycle water to its great extent, with only a small amount of standard-meeting treated water being discharged, the impact on the ice or snow is limited.

The use of vehicles and mechanical equipment by the station will leave traces on snow surface. However, these traces will soon be covered by snow, hence, having only transitory and minor impact.

The station will implement its Waste Management Plan to bring waste out of Antarctica. In addition, the Environmental Management Plan will also be implemented to reduce the negative impact on the local environment.

The environmental impact will be evaluated according to the dismantling and clearance of the station, whenever it is necessary. The impact shall be reduced to a minimum level and great efforts will be made to remove all the buildings and facilities as much as possible without leaving any obvious traces on the local environment.

5.3.5 Impact of wastewater treatment and discharge

Domestic sewage will mainly come from cooking, daily washing and brushing, laundering, bathing, dish-washing and human excrement (See Section 2).

According to the design of the station, the production of waste water will be minimized, and the sewage treatment system will be provided. In the system, the techniques of MBR (Membrane Biological Reactor), UF (ultra-filtration) and RO (reverse osmosis) will be used for filtration, sterilization and treatment, and the treated water up to the standards will be reused for laundering, bathing and sanitary cleaning, etc. The filter residues will be collected and treated on the spot by magnetic pyrolysis furnace after drying.

Wastewater produced with hazardous chemical components from laboratories will be contained, specially sealed and transported back to China. In addition, water-saving devices will be installed.

In the construction stage of the station, packing type water-free onboard toilet will be used with which all human excrement will be packed up and carried out of Antarctic area , In the operation stage of the station, a negative pressure flush-free system will be used to reduce the volume of excrement. The black water with human excrement will be treated by the anaerobic fermentation tank, and the sludge will be treated by the magnetic pyrolysis furnace installed.

In addition, oil-polluted matters left from washing will also be collected and carried out of Antarctica. As the baseline value of the environment in the environmental baseline value of proposed area is very low, the indirect impact and cumulative impact of the treated water discharged after the standard-reaching treatment of reverse osmosis will be the extension of the contamination area and lessening the scientific value of the contamination area to some extent. However, since the volume of water to be discharged will be very small, an advanced and efficient treatment system of ultra-filtration membrane plus reverse osmosis will be adopted, and the treated water will meet and surpass the quality standard Category Ⅲ of

P.R.C. Standards on Surface Water Environmental Quality (GB 3838-2002), equals to the water quality standard for drinking water source. In this way, the impact on the local environment will be very limited.

5.3.6 Impact of solid waste collection and disposal

During the stages of the station construction and operation, a certain amount of solid waste will be produced, and the solid waste produced during the construction stage will be obviously more than the operation stage.

According to the definition of Annex III (Paragraph 8) of the Protocol on Environmental Protection to the Antarctic Treaty and China's relevant management regulations on Antarctic garbage, solid waste is classified into the following categories:

- Recoverable garbage (Metal, plastic, paper, wood and glass, etc.)
- Organic waste (Mainly from foodstuff)
- Hazardous waste (Batteries, adhesive agent, waste fluorescent lamps and oil sludge etc.)
- Unclassifiable garbage
- Fuel drums

1. Solid waste produced in the construction stage

In the construction stage of the station, a considerable amount of innocuous solid waste will be produced, which will mainly be packing materials and building materials, including metal, plastics, glass and wood, etc.

Capital construction will also produce a relatively small amount of hazardous waste, such as adhesive agent, batteries, solvent, oily waste and paint as well as solid domestic waste and food waste. The estimated amount of wastes possibly produced in the construction stage of the station is shown in Tab 5-6).

Table 5-6 Estimated quantity of wastes to be produced in the construction stage of the station

Items	**Quantity**	**Unit**
Empty fuel drum	5	Drum
Packing materials	5	20 ft. container
Kitchen/food	2	20 ft. container
Hazardous waste	2	Small box
Others	1	20ft. container

2. Solid waste produced in the operation stage

Total domestic waste including combustible, non-combustible and recycled waste may reach as much as 20kg/day during winter and 60kg/day during summer. Besides food waste as much as 5kg/day during winter and 15kg/day during summer are expected according to the daily food waste unit. However, given the living condition in the Antarctic, the amount of food waste produced is expected to be significantly lower than the predicted value, so the estimated weight of the solid waste will be less than 9 tons per year. According to the calculation based on the figure above, the volume of solid waste produced yearly at the proposed station will be estimated up to 45m^3(Table 5-7). The waste produced by human during field operation for scientific expedition should be brought back to the station for appropriate disposal.

Table 5-7 Estimated amount of waste to be produced in the operation stage of the station

Items	Quantity	Unit
Empty fuel drum	9	Drum
Packing materials	2	20ft. container
Kitchen/food	1	20 ft. container
Hazardous waste	2	Small box
Others	2	20 ft. container

5.3.7 Impact of noise

1. Source of noise in general

The noise levels during construction and operation are estimated and associated mitigation measures are established accordingly.

Noise will come from:

- Unloading activities of vessels and aircrafts
- Land transportations
- The operation of aircraft, vehicles, generators and the facilities for science activities

2. Source of noise during construction

Noise will be generated from loading and unloading activities, equipment operations and other construction activities.

The noise level will arise from construction are estimated mainly considering according to equipment and other construction activities. However, the estimated noise levels, which are based on flat topography, are too conservative, as flat topography is the most preferable condition for the propagation of noise. Therefore, while noise disturbance may influence the habitats of birds and mammals, the colonies of penguins where are located approximately 1.5 km away from the proposed site and separated by the buffering rock ridges, will not be significantly impacted by the noise generated during the construction.

3. Source of noise during operation

The noise generated from the station during its operation and associated scientific activities may leave an adverse impact on fauna such as the skuas and penguins. The operations of ships and aircrafts will also produce inevitable noise, whose impact is temporary and limited most occurring during summer.

Windmills will also produce constant noise, and the estimated noise levels are expected to exceed 60dB temporarily at a distance of 300m. Therefore, the colonies of penguins which are located approximately 1.5 km away from the proposed site will not be significantly impacted by the noise generated during the construction.

Power generators and radiators will produce constant noise as well. However, their levels are expected to be significantly lower than 35dB, the indoor noise standard applied to the station in its operation stage.

5.3.8 Impact of man-made light

When the personnel live and work at the station, light source will be needed for illumination. As man-made light source will be added to the area where there is only original natural light, certain impact will be brought to the surrounding environment. However, man-made light source can only affect, to some extent, the scientific research projects which are sensitive to light. During the operation stage in the austral summer, the station will be in the period of polar daylight. Therefore, light impact arising in this period will be very small. During the operation stage in the austral winter, the station will be in the period of polar day night, therefore, light impact arising in this period will be significant.

5.3.9 Impact of alien species introduction

During the construction and operation of the station, the risks of introducing alien species or transmitting diseases into Antarctica will be very low. Firstly, all the team members to Antarctica must pass a strict physical examination, making sure the occurrence of infectious disease almost impossible. Secondly, cooked food and dried food will be adopted as much as possible. Thirdly, wastes will be put under effective control, properly preserved and be taken out of Antarctica as much as possible. Lastly, the temperature in the proposed area is very low, making it difficult for the introduced species to survive under such a condition for a long time.

5.4. Mitigation Measures

5.4.1 Mitigation measures for atmospheric pollution

Efforts will be made to use renewable energy as much as possible. The hybrid Solar-Wind-Diesel power supply system will be used in the new station. Utilization of renewable energy such as wind power and solar power will not only reduce the energy consumption of fossil fuel, but also lower the operation cost, reduce transportation risks and the labor intensity of the expeditioners, and play a good role in the protection of the Antarctic environment.

Meanwhile, high efficient fuel energy will be used as supplementary energy besides for some specific scientific purposes. The operation of the station and vehicles will all use high efficient fossil fuel-Antarctic Diesel. The Antarctic Diesel has appropriate density, high calorific value, and good combustion performance. The combustion process is fast, stable, continuous and complete. It has few carbon deposits but high cleanliness. It has no mechanical impurity or water content. Its content of sulphur, especially mercaptan is low, thus resulting in much less corrosion to machine elements. Light oil will also be used as ship oil to the utmost, so as to meet the criteria of air emission stipulated in Appendix VI of MARPOL. The fuel used will greatly reduce atmospheric emission and environmental impact.

Efforts will be made to select highly efficient equipment. The combustion efficiency and environmental protection are the principal standards for equipment selection. For example, a set of VOLVO generators will be selected as its low exhausted gas emission can meet the EU standards when diesel is used. Other selected power installations should also have excellent performance and advanced technology. In addition, the periodical maintenance and service shall be conducted, with the dust remover air cleaner fixed at the outlet ends. Vehicles will also be selected with high combustion efficiency and low environmental effect. Vehicles purchased or under the plan to be purchased shall also meet EU-Ⅴ Standards.

Efforts shall be made to adopt energy-saving measures and/or technology, e.g. reducing the use of vehicles. In the operation stage, only 1-2 heavy vehicles will be used, and periodical maintenance and service will be provided for the vehicles. Catalytic converters will be installed in the vehicles to reduce the pollutant emission. In the meantime, reducing the operation of mechanical equipment, and provide skillful maintenance and service for the equipment so as to prevent extra fuel consumption as well as leakage. Meanwhile, the centralized ventilation device with heat recovery will be adopted. Phase change materials will be tested to use in the new station such as the floor radiation, pipelines insulation, thermal storage tank etc. to improve the efficiency of insulation.

Additionally, perfect integrated energy management system will be set up in the station.

Sound energy management will not only reduce the atmospheric emission of pollutants but also reduce the operation cost.

5.4.2 Mitigation measures in case of fuel and oil spill

Fuel storage system in the new station will be divided into two separated systems as Antarctica Diesel storage system and aviation kerosene storage system, which are prohibited to be mixed with each other. Each system will have its own oil storage tanks, turnover oil tank, pipelines, pumps, underground anti-static devices, environmental leak proof sump, fuel trucks and Intelligent Monitoring System based on internet of things（including automatic control operations, security monitoring, safety warning and remote data transmission and so on）.

In respect of storage facilities, the sledged fuel tanks will be made by stainless steel, which is characterized by low temperature tolerance. Each tank is fixed with a fuel-collecting plate at its bottom. In respect of transportation, scientific plan will be made to reduce transportation of fuel tanks. In respect of fuel storage, the fuel storage area is separated with the refueling area where the fuel is used for operation. The sledged oil tanks are only used as fuel storage in the storage area, so there should be no fuel leakage without outside force. The refueling area is just outside the power generation house where only one sledged oil tank will be used. When the oil tank is empty, it will be moved back to the storage area and a new one will be transferred to the refueling area to replace it. In respect of connection for power supply, the sledged fuel tank is connected to the fuel pump in the power generation house through a pipe. There is a valve fixed at the end of each pipe, and the connection is done by a fast switching joint. The connection point between the fuel tank and the pipe is located just above the fuel colleting plate to ensure that there will be no fuel spill.

In respect of management, the standard procedures for the transportation, handling, transferring and using of fuels will be formulated and team members will be trained to conduct operation correctly in order to avoid the occurrence of fuel and oil spill.

For fuel spill handling facilities, vehicle convoy, the refueling area of the station and relay site will be equipped with appropriate fuel absorption felt, fuel spillage-preventing container and cleaning device, as well as the storage of polluted ice and snow etc., so that the spill can be handled in time.

Oil spill contingency and response plan will be formulated. COMNAP and SCALOP have drawn up the guidelines of Oil Spill Contingency Plan, covering small-scale area-based fuel and oil spill (Facility Plan) and large-scale hazardous spillage of fuel that needs joint efforts by several countries in Antarctica (Multi-Operator Plan). In the period of transportation and construction, the station will draw up fuel and oil spill contingency plan according to the guidelines of COMNAP and SCALOP, as well as the detailed implementation plan for itself.

Besides, it is necessary to conduct training for the staff involved in refueling and provide simulation training for dealing with oil spill accidents. Fuel and oil handling and fuel and oil spill response procedures will be reviewed periodically. All oil spill accidents will be reported to the manager of the station and CAA, and will be recorded in accordance with the monitoring requirements. The station will formulate safety measures for the spill accidents of other oils, such like machinery lubricant.

5.4.3 Mitigation measures for reducing impact on snow and ice

The issue of reducing impact on snow and ice has been taken into full consideration in the design of the station. For example, the logistic structures will be located in the area, where flat and smooth to reduce the physical impact on snow surface. The high combustion-efficient fuel- Antarctic Diesel will be used to minimize the impact on the snow and ice arising from the exhausted gas emission. All vehicles and mechanical equipment will be selected and procured under the condition that they must have excellent performance and are technically advanced. The land vehicle convoy will try its best to drive on the relatively smooth ground surface where less snow dunes so that the impact on the snow surface can be reduced as much as possible. Besides, the station will do its best to recycle water so as to minimize the water to be drained into the sea.

5.4.4 Mitigation measures for reducing impact on ocean

In line with the past practice of the vessel, most of the solid waste will be packed, compacted and brought back to China for disposal. The treated sewage and part of the foodstuffs will be discharged into the ocean under the condition that the requirements stipulated in Appendix IV of International Convention for the Prevention of Pollution from Ships (MARPOL) must be met. However, great efforts shall be made not to discharge in the Southern ocean area, especially the areas within 500 nautical miles away from the coastal line.

The vessel should keep the discharge record for some solid waste, ballast water, sewage and foodstuffs, etc.

The ship hull will be scraped and rubbed by sea ice, thus inevitably leading to the breaking-off of the antifouling paint on the hull. However, the antifouling paint used on the R/V Xuelong contains no poisonous organic tin compounds and other hazardous chemicals.

The time needed for unloading at the dock of the proposed station would be only15 days, which means the impact on the ocean will be very transitory and minor. As the environmental issues that may arise have already been specified in the relevant chapters of environmental impact evaluation, hence, they will not be .specified again here.

In addition to the above, the wastewater and spilled oil will eventually flow into the ocean, leaving an impact on the marine environment.

Therefore pre-manufactured floating pier and dock will be used to shorten the construction period as well as to reduce potential impact on the marine environment and preserve the natural coastal landscape.

5.4.5 Mitigation measures for ecosystem protection

1. Mitigation measures during construction

Impact on the local ecosystem due to the construction and operation of the station can be reduced if the mitigation measures are properly implemented.

1) Skua and Adélie Penguin

The direct and/or indirect impact on a few number of skua nests observed near the proposed site are inevitable during construction, thus additional protective measures are necessary to minimize the impact, such as the installation of barriers.

To conserve the skua community in the northern area apart from the proposed site, unnecessary visiting by either construction workers or other personnel will be strictly c restricted during the construction period.

In addition, all the personnel will be given a specific site-guidance on minimizing anthropogenic disturbance to the skua and Adélie Penguin colony. Biweekly monitoring on the skua and Adélie Penguin colony will be taken by biologists to devise additional effective mitigation measures in case unexpected impact occurs.

2) Helicopters

In order to minimize the impact of helicopter operations on the colonies of skua and Adélie Penguin, a flight route which can minimize the impact will be taken into account. Moreover, guidelines related to flying in the Antarctic, “Guideline for the operation of aircraft near concentrations of birds in Antarctica” will be followed (ATCM, 2004b). These guidelines will also be followed during the operation of the station.

3) Marine transportation and unloading impacts on the marine ecosystem may vary depending on the alternative access routes to the station. Considering the distributions of the flora and fauna, the best transportation route for the protection of biodiversity and ecosystem will be selected.

An Antarctic Specially Protected Area in the northern part of the island will be suggested to protect the penguin colony and detail management plan will be prepared by China in the future. General staff entering will be restricted without clear scientific research or monitoring purposes during the construction and operation period.

2. Mitigation measures during operation

1) Research activities and visitors

The impact caused by research activities and activities of the summer visitors are expected insignificant on the flora and fauna of the region. In particular, the major populations of skua and Adélie Penguin are not exposed to direct impact during operation. However, temporary indirect impact are still expected, thus the limits on the number and the scope of such activities will be planned in advance in the annual plans of operation of the station.

2) Transportation and unloading

For transportation and unloading, an oil spill contingency plan has been set up to protect the marine ecosystem. Prevention and treatment materials such as oil absorption fabrics and recovery equipment will be prepared for immediate responses to oil spill accidents.

3) Skua and Adélie Penguin in the northern coast will be observed as one of the possible indicators responding to any kind of impact and changes in terrestrial ecosystem. During the operation, the population fluctuation of skua and penguin will also be carefully analyzed to conserve the core spot of skua's and penguin's habitats as well as the scientific research. In detail, the size and distribution of skua and penguin populations around the station will be recorded annually by establishing a post-monitoring program in order to investigate any changes in the ecosystem.

In consideration of skua as a scavenger, food and food wastes will be managed and treated according to a proper management plan.

All the personnel including visitors will be given the guidance on minimizing the disturbance to the skua and penguin colony. Helicopter will not overfly the skua community or penguin colony and its operation will follow the guidelines related to flying in the Antarctic, "Guideline for the operation of aircraft near concentrations of birds in Antarctica" (ATCM, 2004b).

5.4.6 Mitigation measures against the loss of wilderness and aesthetic values

In the design of the station, the local environmental conditions will be taken into full consideration. The harmonization with the local environment will be made to the great possible extent so as to minimize visual impact.

The station will use renewable energy and highly efficient fuel as much as possible. Besides, highly efficient vehicles and mechanical equipment will also be adopted so as to minimize the emission to the atmosphere.

The station will reduce the use of vehicles, mechanical equipment and aircraft as much as possible and gradually mark out the driving lines of vehicles to ensure that the number of tracks can be kept at the lowest level.

The station will do its best to recycle water so as to minimize the impact on the local environment.

At the end of the operation of the station, all the equipment will be disassembled, dismounted and transported out of the station as much as possible, thus no obvious traces will be left. The dismounting and clearing work of the station will be done in accordance with the requirements of environmental impact evaluation.

5.4.7 Mitigation measures for wastewater treatment and discharge

Water-saving facilities will be provided in the design of the station in order to reduce the amount of water needed and to minimize the production of sewage. At the station, techniques of MBR, UF and RO process will be used to filter, sterilize and treat the sewage. The treated water up to the standards will be reused for laundering, bathing and sanitary cleaning.

Several methods for proper and safe disposal of the concentrated brine produced by the desalination process will be considered to reduce the environmental impact of desalination. The generated brine is expected to be relatively small in volume. Meanwhile, a discharge point optimal for rapidly mixing and dilution will be selected for the brine. In addition, pre--discharge mixing of the brine with treated sewage will be another alternative to reduce salt concentration.

5.4.8 Mitigation measures for minimizing solid waste

The following measures will be taken to reduce solid waste: drawing up scientific and detailed construction plans in advance and not taking unnecessary materials to the construction site, striving to prefabricate and assemble container buildings at home and reducing unnecessary packing materials to the minimum extent, not taking prohibited products (See Appendix III of the Protocol on Environmental Protection) to Antarctica, keeping the quantity of hazardous articles to the absolutely minimum extent, appropriately classifying, labeling and storing solid waste into a fixed position of the waste container for transportation, making the great possible effort to reuse the solid wastes, like empty fuel drums, formulate a waste management plan for the construction activity, training the personnel to have a good command of the classification, storage and disposal of wastes, appointing a team member as the environmental officer to direct and supervise the implementation of waste management procedures , and appoint another one as the waste manager to implement the waste management procedures properly and make regular supervision.

Eventually, all the solid waste and the human excrement will be brought back to China for the final disposal when the personnel leave the Antarctica.

A special magnetic pyrolysis furnace will be set up to reduce the volume of the solid waste as described in section 2. Food waste, which contains approximately 80% water, is planned to be dried and reduced in volume before put into magnetic pyrolysis furnace.

Hazardous waste produced from laboratories and waste oil will be stored separately and eventually transported outside of the Antarctica.

5.4.9 Mitigation measures for noise prevention

The simultaneous operation of construction equipment will be limited in order to minimize the impact of noise on the colonies of penguins, although the predicted levels of noise under the simultaneous operation condition are insignificant. In addition, construction machines of low noise and vibration-reduction technologies will be used and the idling of vehicles will be minimized.

Efforts will be made to minimize the operations of vessels, aircraft, vehicles and mechanical equipment etc. Noise-absorbing materials will be installed in power generator facilities. If it is necessary to operate aircraft, its flight will be kept within the height and space limitation stipulated in the Antarctic Flight Information Manual formulated by COMNAP, Maintenance and service will be provided regularly for vehicles, generators and mechanical equipment etc. so as to keep noise to the lowest level.

The windmills will be set up in the southwestern side of the station at least 300 meters away, and the distance between the windmills and the colonies of penguins will be more than 1.5 km.

5.4.10 Mitigation measures for man-made light pollution

Try to reduce the use of illuminating light, and scattering light, especially the light above horizon, as much as possible in the design of external light especially in the austral winter.

5.4.11 Mitigation measures against transmission of diseases

Paragraphs 4 of Annex II of the Protocol on Environmental Protection and the stipulations of the Appendix will be strictly observed. The introduction of alien species and the migration of diseases will be prevented to the great possible extent. A permit system will be applied, preventing any alien species from beginning brought into the Antarctica without permission. Permit should be issued in strict accordance with the regulations of the Annex II of the

Protocol and the requirements of the scientific program.

In order to prevent the introduction or dissemination of alien species possibly transferred by people, equipment or supplies, the regulation of Annex II (Article 4) of the Protocol on Environmental Protection to the Antarctic Treaty and Resolution 6 ATCM XXXIV-CEP XIV with Non-native Species Manual annexed to the resolution will be strictly followed (ATCM, 2011). Items such as shoes, clothes and organic matters will be thoroughly cleaned and sanitized before being transported into Antarctica. In particular, tracked and wheeled vehicles will be carefully rinsed on the ship before unloading.

Meanwhile, following the normal practices of the Chinese Antarctic Expedition team, a comprehensive and strict physical examination will be carried out for the team members so as to prevent the occurrence of infectious diseases, food stuff will be kept under control so as to ensure all the food stuff, including the food provided at the station and the food for field encampment, be safely stored and processed. A cleaning process will be applied to all clothing, scientific instruments, mechanical and field-operational equipment etc. before being transported into Antarctica and particularly, the railed and wheeled vehicles will be rinsed before entering Antarctica. All the wastes will be well managed and properly disposed of and be brought out of Antarctica to the great possible extent (as mentioned in Section 5.6 and 5.7).

5.4.12 Mitigation measures against station dismantling

The proposed station will be constructed using the modular construction system. A detailed dismantling program including plans to dismantle and reuse the station will be established in accordance with the guidelines of the Protocol on Environment Protection to the Antarctic Treaty.

More specifically, a detailed work schedule will be planned including the time schedule of dismantling, packing and transporting of the station. For the estimated environmental impact, relevant mitigation measures will be prepared for all the tasks associated with the dismantling process.

When the proposed station is dismantled, all the building modules and steel frames of the main buildings and other facilities will be removed from Antarctica. Considering the cost of complete removal, some structures may be left without potential environmental impact at the site. A comprehensive plan for phased dismantling will be established and implemented.

After the dismantling is completed, the region will be monitored for a certain period to assure the minimization of dismantling impact and determine whether additional measures are needed to recover the site.

5.5. Impact matrices

According to the analysis mentioned above, the table of impact matrix which summarizes the environmental impact of the construction and operation activities is established. The output and the resulting environmental impact of each activity are identified. Based on the references given in Section 5.1, the extent, duration, intensity, probability and significance of the impact are then ranked in Tab 5-8.

Table 5-8 Criteria for impact ranking

Title	Content	Details
	Activity	
Nature	Type of activity	
	Output	
	Description of the potential results of activities that may cause impact	
	Impact	
Extent	Geographical area affected	specific, local, regional ,continental and global
Duration	Duration of impact	Very short (minutes to days), Short (weeks to months), medium (years), long (decades) , permanent and unknown
Probability	Likelihood of impact occurring	Low, medium , high , certain
Intensity	Influence on the natural function or process and whether effects are reversible	Low, medium , high , certain
Significance	Importance of impact	Very low, low, medium, high, very high
Direct impact	Qualitative description of what is directly, indirectly and cumulatively impacted by the Activities /Output	
Indirect impact		
Cumulative impact		

Table 5-9 Impact Matrix 1

Activity	Output	Predicted impact	Probability	Extent	Duration	Intensity/ Significance	Mitigation or preventive measures
Loading, unloading and storage of construction materials at the proposed station	Exhausted gas emission	Very small, but cumulative contribution may lead to air pollution, deposition of particulates and heavy metal particles in certain area	Certain	Local	Long	Very low to low	●Use renewable energy as much as possible. ●Use combustion efficient fuel as much as possible. ●Minimize the use of the vessel, vehicles, mechanical equipment and aircraft.
	Disturbance to penguins, skuas and seals	Increase energy expenditure of animals	Low	Area-specific (vicinage of the proposed station including coastal sea area)	Very short	Very low	●An Antarctic Specially Protected Area will be suggested to protect the penguin colony. ●Educate the expeditioners to avoid the interference of animals to the great possible extent. ●Take periodical monitoring. ●Minimize the use of the vessel, vehicles, mechanical equipment and aircraft. ●Formulate the best transportation route.
Bulk fuels transfer and storage	Over 208L. fuel oil spillage and the max. spill volume could be 30,000L.	Contamination of snow and ice, air pollution caused by volatile agent, there will be no direct impact but may cause delay impact to marine environment, indirect impact to scientific value in certain area	Medium (leakage in small volume) Very low (leakage over 1000l., in large volume)	Area-specific	Long	Low (leakage in small volume)High (leakage over 1000l., in large volume)	●Use stainless steel oil tank with oil-collecting plate at its bottom to minimize the risks of spillage arising from oil tank breakage. ●Check the oil tanks and pipelines periodically. ●Formulate oil spill contingency plan, examine periodically the procedure of fuel handling and oil spill response. ●Train and educate relevant personnel to enable them to operate correctly and canonically and prevent the occurrence of oil spillage accident. ●Provide oil spill handling apparatus, oil absorption felt, oil spill prevention container and cleaner and storage to store oil-polluted snow etc. so as to timely tackle potential oil spill accident. ●Once oil spill accident takes place, report to the Head of the station, CAA, PRIC and undertake monitoring.

Table 5-10 Impact Matrix 2

Activity	Output	Predicted impact	Probability	Extent	Duration	Intensity/ Significance	Mitigation or preventive measures
General construction activities	Solid and liquid waste	Contamination to ice and snow. The solid waste and drained sewage up to the standards will cause impact to marine environment.	Certain	Local	Medium Impact caused by drained water may remain for a long time	Low	●Formulate waste management plan. ●Train relevant personnel to enable them operate according to procedure stimulated. ●The great efforts should be made not to use hazardous articles, if it is inevitable, hazardous articles to be taken to the new station region should be kept at minimum level. ●The great efforts should be made to reuse as much articles already taken there as possible. ●All solid wastes will be classified, stored and taken out of Antarctica during construction period. ●All human excrement will be packed, cased and brought out of Antarctica during construction period. ●Advanced technology will be adopted for sewage treatment, the waste water after treatment should meet the relevant standards before discharge, reuse gray water to the great extent to reduce water consumption and discharge.
	Physical impact to snow and ice	The construction site needs to be compacted. The driving of the vehicles will press the snow and ice.	Certain	Local	medium	Low	●Try to set up logistic base or scientific operation field at smooth area. ●Drive in flat and smooth area, mark out routes for driving operations to reduce the impact to snow and ice.
	Set up the Dock	Disturbance of ecosystem near the dock	Certain	Local	short	Low	●Floating pier and dock will be used.
	Construction of the station	Loss part of the of wilderness value.	Certain	Local	Medium	Low	●Environmental protection issue has been fully considered since the design of the station. ●To make maximum use of renewable energy, recycling water and equipment with advanced technology and high environmental efficiency. To reduce the environmental impact as much as possible. ●When the operation of the station to be terminated, the station will be completely cleared away from Antarctica as much as possible and no obvious trace will be left there.

Table 5-11 Impact Matrix 3

Activity	Output	Predicted impact	Probability	Extent	Duration	Intensity/ Significance	Mitigation or preventive measures
Operation of the vehicles, power generators and other mechanical equipment	Exhausted gas emission	Minor but cumulative contribution to local air pollution including greenhouse gas emission and the deposition of part of the particulates.	Certain	Local	Long	Medium	●Maintain the operation of vehicles, generators and other mechanical equipment to minimum level. ●Adopt vehicles, generators and other mechanical equipment with high combustion efficiency, advanced technology, excellent performance and low emission. ●Use highly combustion efficient fuel. ●Set up perfect energy management system. ●Using as much renewable energy as possible. ●If possible, install catalytic converters on vehicles and provide periodical maintenance and service as much as possible.
	Small volume oil spillage during refueling	Contamination of snow and ice, air pollution caused by volatile agent, there will be no direct impact but may cause delay impact to marine environment, indirect impact to scientific value in certain	High	Area-specific	Long	Very low	●Maintain the operation of vehicles, generators and other mechanical equipment to minimum level. ●Check the oil tanks and pipelines periodically. ●Formulate standard procedure for fuel transportation and management, provide training to relevant personnel to enable them to operate correctly and canonically and prevent the occurrence oil spillage accident. ●Formulate oil spill contingency plan, examine periodically the procedure of fuel handling and oil spill response. ●Provide oil spill handling facilities, fuel absorption felt, fuel spillage-preventing container and cleaner device and storage to store oil-polluted snow etc. so as to timely tackle potential oil spill accident. ●Once oil spill takes place, report to the Head of the station, CAA, PRIC and undertake monitoring.
	Physical impact to ice and snow	Operation of the vehicle and the taking off and landing of aircraft will exert pressure to the surface, which will cause physical impact to the snow	Certain	Local area	Short	Low	●Maintain the operation of vehicles, and aircraft to minimum level. ●Select flat and smooth area to drive vehicles and as runway for aircraft to reduce pressing on the snow and ice there.

Table 5-12 Impact Matrix 4

Activity	Output	Predicted impact	Probability	Extent	Duration	Intensity/ Significance	Mitigation or preventive measures
Operation activities of the station	Solid waste	It may contaminate snow and ice if it is blew away by wind.	Low	Local	Long	Low	●Formulate waste management plan. ●Train relevant personnel to ensure their work is done according to job specification. ●Solid wastes, especially hazardous waste, to be taken to the new station will be minimized, ●Try best to reuse articles already taken there. ●Most of the garbage will be recycled and sorted waste will be treated by the magnetic pyrolysis furnace. ●All the human excrement will be treated by anaerobic fermentation tank, the residue sludge will treated by the magnetic pyrolysis furnace.
	Sewage	Contamination of ocean and cause pollution to marine environment.	Certain	Specific area	Long	Low	●Adopt water-saving measures to reduce water consumption and discharge. ●Efforts be made to recycle water by advanced technologies and drained waste water should meet the relevant standards.
	Physical impact to snow and ice	The operation of vehicles will exert pressure to the snow and ice.	Certain	Specific area	Medium	Low	●Try to set up logistical base or scientific operation field in smooth area. ●Drive in smooth area and set routes for driving operation to reduce the impact to snow and ice.
	Light pollution	Possible impact to some scientific studies sensitive to light.	Medium	Local	Long	Very low	●Minimize the use of lightening lamps outdoor. ●Reduce the scattered light, especially the horizontal scattered light.
	Constructions and human activities at the station	The impact to the wilderness value	Certain	Local	Long	Low	●Full consideration was given to the view of the surrounding area during designing of the layout of the constructions of the station. ●Efforts were made to minimize visual impact to the surrounding area. ●When the operation of the station to be terminated, the station will be completely cleared away from Antarctica as much as possible and no obvious trace will be left there.

Table 5-13 Impact Matrix 5

Activity	Output	Predicted impact	Probability	Extent	Duration	Intensity/ Significance	Mitigation or preventive measures
Scientific activities	Observation of interaction studies	Physical impact to snow and ice, Air pollution caused by exhausted gas due to operation of generators, Potential oil spill may cause air pollution, ice and snow contamination, Oil sludge in ice and snow may cause marine pollution.	The physical impact to snow and ice and air pollution due to the operation of generators is certain to happen, The possibility of oil spill is low	Local	Long	Very low	● Use generators with high efficiency. ● Use renewable power source as much as possible. ● Provide training to personnel on fuel refilling and oil spill handling, equip with necessary oil spill dealing apparatus, oil absorption felt, oil spill prevention container and cleaner and storage to store oil-polluted snow etc. so as to timely tackle potential oil spill accident.
	Observation of flora and fauna	Disturbance to habitat and breeding activities	Medium	Regional	Long	Medium	● An Antarctic Specially Protected Area will be suggested to protect the penguin colony. ● Limit access to habitat. ● Limit activities aside from those with scientific purpose.
		Disturbance caused by sampling	Medium	local	Medium	Medium	● Observe Recommendation “Guidance for Visitors to the Antarctic” during operation. ● Prevent disturbance by conducting preliminary evaluation of the sampling plans.
	Other scientific research projects	Physical impact to snow and ice due to digging ice for placing equipment, Air pollution caused by operation of power generators if any, Potential oil spill may cause air pollution, ice and snow contamination, Oil sludge in ice and snow may cause marine pollution due to the movement of glaciers.	Medium	Specific area	Long	Very low	● The scientific programs will be overall planned. ● Maintain the minimum use of power generators. ● Use renewable power source as much as possible. ● Provide training to personnel on fuel refilling and oil spill handling, equip with necessary oil spill dealing apparatus, oil absorption felt, oil spill prevention container and cleaner and storage to store oil-polluted snow etc. so as to timely tackle potential oil spill accident. ● When the program to be completed, all the equipment and installations will be removed and the original conditions will be recovered as much as possible.

5.6. Indirect impact and cumulative impact

To minimize the negative environmental impact, the measures to prevent and mitigate them have been taken into full consideration in the design stage of the station, and the Environmental Management Plan (EMP) has been formulated. The design of the station ensures high efficiency in energy utilization. According to the design, renewable energy sources will be utilized to the maximum extent, high efficiency, low discharge and low noise equipment will be adopted as much as possible, modular buildings will be prefabricated in China to reduce the field construction workloads, water will be treated and recycled, the production of wastes will be minimized. These measures will prevent or mitigate the estimated negative environmental impact, and play an active role in environmental protection. The station adheres to the principles of environmental protection and energy-saving etc. in its design, and has established the waste management planning, ensuring low ecological footprint, low energy consumption and minimum waste output. Therefore, no obvious indirect environmental impact will arise.

Cumulative impact is the combined impact of past, present, and possible future activities. Cumulative impact and indirect impact may arise from the emission to the atmosphere, oil spill, and discharge of the treated waste water up to standards in the construction and operation stages of the station, which have been described in Section 2.

The indirect and cumulative impact may reduce the scientific value of certain local areas and contribute to air pollution in regional or even global levels. Such cumulative impact should be monitored continuously during the construction and operation of the station, and mitigated in a proper way once it is detected.

6. Environmental Management and Environmental Impact Monitoring Plan

6.1. Environmental management plan

In the systematic design of the station, environmental protection, safety, energy saving and economy are the basis to guide the decision-making. From this aspect, the personnel responsible for environmental impact assessment have been involved in the design stage of the project at beginning, and they have put forward a number of useful suggestions on how to reduce environmental impact.

Before the construction, PRIC will formulate the Environmental Management Plan, the purpose of which is in line with the stipulations specified in the Protocol and relevant Chinese regulations on environmental protection, to elaborate the management framework and detail plan, to define duties and responsibilities of relevant personnel, to fulfill mitigation measures and to ensure the minimization of environmental impact.

The Environment Management Plan will cover the management on the protection measures for penguins and skuas, refueling and fuels transportation, waste collection and disposal, sewage treatment and gray water recycling, equipment, field operation and the tackling of emergencies etc. It will guarantee the safety and orderly progress of various activities, and consequently prevent the occurrence of environmental accidents and minimize environmental impact.

In the meantime, CAA will launch education and training on environmental protection, job specifications, contingency tackling and equipment operation etc., for the personnel. In addition, environmental officers will be appointed to supervise the implementation of the contract and management plan.

In the station, environment monitoring, investigations and analysis of environmental impact will also be conducted to find out the disadvantageous impact as early as possible and to eliminate or mitigate them in time.

In case of any environmental or any other accidents, CAA will report to the SOA of China and inform every Contracting Party. Upon completion of the capital construction, CAA together with PRIC will draw up a report summarizing the conditions of environment, health, safety, accidents and monitoring etc.

The building of a new station will inevitably bring about some changes in the station area and its surroundings. The potential environmental impact and the corresponding mitigation measures have been specified in Section 5. In order to accurately understand the actual impact derived from the construction and operation of the station and the effectiveness of mitigation measures that shall be taken thereby, and meet the requirements of sustainable development, PRIC will formulate a perfect Environmental Monitoring Plan for the new station.

The baseline data and information for the program have been planned to collect during the 2012/13 and 2013/14 surveys as well as the meteorological data collected from the references. This monitoring will be continued as a part of the major scientific research after the completion of construction of the station. The program will be continuously reviewed and modified in coordination with other post-construction research activities. The COMNAP guidelines will be followed by the monitoring program (COMNAP, 2005b).

6.2. Environmental impact monitoring plan

PRIC will establish a station environmental monitoring plan to observe the actual impacts in Antarctica. The monitoring activities can be divided into two categories. One is to monitor the potential environmental impact, so as to discover as early as possible the disadvantageous impact and take actions immediately to reduce or eliminate such impact, thus improving the understanding of the interactions between the human and the Antarctic environment.

Another is to monitor and record the relevant operation information of the station, including fuel consumption data, fuel spill, personnel number of the station, waste products and their disposal route etc. This information will be used to verify the CEE and determine whether the impact conform to those estimated. With the development of the scope and intensity of the information acquired, the validity of the proposed mitigation measures will be reviewed and evaluated.

6.2.1 Objective

The monitoring objective is to evaluate and analyze the surrounding environmental impact caused by the construction, operation and scientific activities of the new station.

6.2.2 Scope

The atmosphere monitoring scope covers the full area influenced by the source of air pollution. Monitoring sites will be allocated around the pollution source, and samples taken outside of the influenced area will be used as background reference, snow samples will be taken from relevant points to measure their contents of metals which will be the basis for the environmental baseline study so as to provide reference data for the determination of the environmental standards.

The monitoring scope of ice and snow covers the surrounding area of the station and transportation route.

Oil spill Monitoring scope covers the area of the oil tank storage, the locality with fuel operation, the transportation routes and the relay site.

The scope of monitoring of the surface water samples covers the discharging pipe and its surroundings.

6.2.3 Elements

Table 6-1 Elements for monitoring during construction stage

Item	Object	Reporting	Frequency
Staff	Wastewater and solid waste(recycle)	Wastewater and waste logs	Once a month
Material	Construction material used/disposed/recycled	Construction material log	Once a week
Waste facility	Recycling and storage of construction waste	Recycling and storage status	Once a week
Equipment operation	Fuel supply and consumption for construction equipment	Fuel log	Once a month
	Oil change, waste oil and disposal for construction equipment	Motor oil log	Once a month
Noise protection facility	Temporary noise barrier	Barrier status	At installation
	Temporary noise barrier	Barrier status	At installation

Table 6-2 Elements for monitoring during operation stage

Item	Object	Reporting	Frequency
Ecology	Alien species invasion	Invasive species	Once a year
	Changes in habitat	Habitat observation -Skua and penguin community	Once per two weeks during construction
	(Lichen, Skua, Penguin, Weddell Seals)	Habitat observation of penguin colonies	Once a year during operation
	Community structure changes	On-site Fauna/flora	Once a year
	Population dynamics	Skua and penguin	Once a year
Coastal Seawater quality	TSS, DO, COD, pH, Temperature, Salinity	Seawater quality -Intake point(3 points near discharge)location (3 points near dock)	Twice a year
Snow	TSS, pH	Snow quality Main building Comparison point	Twice a year
Soil	TPH	Soil analysis -4 points at oil storage sites -4 points at waste oil storage sites	Once a year
Air quality	CO_2, $PM_{2.5}$, PM_{10}, NO_x	Air quality analysis -Main building -Skua and penguin colony	Twice a year
Noise	Noise level	Noise level at site near the skua and penguin colonies	At equipment in operation
Fuel use	Fuel supply and use	Fuel log	Once a week
Oil change	Oil storage facility	Oil and waste oil storage tanks	Oil leaks
	Oil change, waste oil and disposal	Oil log	Once a month
Water supply and discharge	Wastewater and gray water recycling system during operation, BOD, COD and SS.	Wastewater treatment log -Generation and discharge -Treated	Twice a week

Item	Object	Reporting	Frequency
		volume -Amount of gray water -Water quality report	
	Water intake, desalinated water production, water use BOD, COD and Cl.	Desalination log -Production -Transport -Use Water quality report	Twice a week
	Facility operation	Wastewater treatment operation log	Once a day
Waste	Recycling and monitoring of domestic waste	Recycling and storage status	Once a week
	Waste(recycle)	Waste management log	Once a month

7. Gaps in Knowledge and Uncertainties

From several expeditions conducted in the Great Wall Station, Zhongshan Station, Kunlun Station and the Ross Sea area from 1996 to 2013, CAA has acquired some knowledge on the physical environment of the proposed station area. However, it has not been simultaneously proceeded with the study and monitoring on the potential hazards probably caused by the construction and operation of the station. According to experience, the changes of environmental conditions like weather etc. may bring about some uncertain factors.

Besides, technically and operationally, there are also some uncertain factors, such as the change of future activities of the station, the application of more advanced techniques and the change in the content of scientific activities etc. The designed lifespan of the station will be at least 25 years, so it is impossible for the CEE to integrate the changes arising in the process of operation and installation derived from the technical progress that will be obtained in such a long time, therefore, it is necessary to make additional assessment on these changes.

Meanwhile, as the design of the station is still under continuous improvement, part of the details have not yet been entirely determined, such as geological survey in sub-glacier area, so there are still some uncertainties in the aspects of technology and operation.

Knowledge limitations and uncertainties have been fully considered in this CEE for the Chinese new Station in Antarctica Ross Sea area, including the unpredictability of environmental conditions such as weather, the changes in future activities of the station, the application of upgraded energy technology, the change of scientific activities, and small adjustments to the construction mode etc. These may lead to the delay of the construction and the slight changes in the conditions of scientific and logistic support in the future as shown in Tab 7-1.

Table 7-1 Uncertainties in CEE

Potential arising areas	Uncertainties	Intensity of impact
Weather conditions	Lack of full forecasting capacity to the changes of local weather, environmental conditions, and sea ice distributions. Associated transportation disruptions may affect the construction period	Medium
Fuel consumption	The ratio between the traditional generator power supply and renewable energy supply will be greatly related to the installation and operation conditions of wind mills and solar panels	Medium (exhausted gas emission)
Time schedule	Seasons needed for the construction of the new station (Estimated at 2 seasons, maximum 4 seasons maybe needed)	Medium(Fuel consumption)
Manpower	Number of personnel to be involved in the construction may be slightly different (5-8 persons).	Low (Fuel consumption, waste water discharge and solid waste disposal)
Design of the station	The actual size, layout and building's shaping of the station may be slightly different from current planned design.	Nil.
Total volume of freight	The total freight volume may be slightly different from the estimated figures	Low (Fuel consumption for land transportation)
Scientific activities	Some scientific programs related to international cooperation have not been finalized, so the resulted impact is not listed in this CEE, the impact on the environment will be assessed according to the proceedings of the programs.	Low

8. Conclusion

The compilation of the Draft Comprehensive Environmental Evaluation (draft CEE) has been organized by Chinese Arctic and Antarctic Administration (CAA) and drafted by Polar Research Institute of China (PRIC) and Tongji University for the proposed construction and operation of a new Chinese research station in Victoria Land Region, Antarctica. The Draft CEE has been prepared in accordance with Annex I of the Protocol on Environmental Protection to the Antarctic Treaty (1998). It also referred to the Guidelines for Environmental Impact Assessment in Antarctica (Resolution 4, XXVIII ATCM, 2005).

China considers that the construction and operation of the new research station will have more than a minor or transitory impact on the Antarctic environment. In construction and operation of the new station, great importance has been attached to environmental protection and energy saving. As much as possible renewable energy and the updated environmental technologies will be applied in order to minimize the impact on the environment caused by construction and operation. Furthermore, as a research hub supporting not only the activities of Chinese scientists, but also partnerships with leading foreign experts on climate change in the Antarctic region, the new station is expected to enable and inspire international collaboration and multidisciplinary researches.

China concludes that the global scientific importance and value to be gained by the construction and operation of the new research station in Victoria Land, Antarctica and the continued operation of the research facility outweigh the more than minor and transitory impact the station will have on the Antarctic environment and fully justifies this activity proceeding.

9. Abbreviations

ATCM Antarctic Treaty Consultative Meeting

ATCP Antarctic Treaty Consultative Party

CEP Committee for Environmental Protection

COMNAP Council of Managers of National Antarctic Program

SCAR Scientific Committee on Antarctic Research

SOA State Oceanic Administration

CAA Chinese Arctic and Antarctic Administration

CHINARE Chinese National Antarctic Research Expedition

SCALOP Standing Committee on Antarctic Logistics and Operations

The Environmental Protocol Protocol on Environmental Protection to the Antarctic Treaty

CCAMLR Commission for the Conservation of Antarctic Marine Living Resources

MARPOL International Convention for the Prevention of Pollution from Ship

EIA Environmental Impact Assessment

CEE Comprehensive Environmental Evaluation

IPY International Polar Year

ASMA Antarctic Specially Managed Area

ASPA Antarctic Specially Protected Area

EMP Environmental Management Plan

WMP Waste Management Plan

WMP1 Waste Monitoring Plan

BOD_5 Biological Oxygen Demand in Five Days

CO Carbon Oxide

CO_2 Carbon Dioxide

COD Chemical Oxygen Demand

DEM Digital Elevation Model

DGGE Denaturing Gradient Gel Electrophoresis

HC Hydrocarbon

NO_x	Nitrogen Oxides
SAR	Search and Rescue
SO_x	Sulfur Oxides
TCV	Traveling Convection Vortex
TMT	Technology, Media, Telecommunication
ULF	Very Low Frequency
VOC	Volatile Organic Compounds

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