

7. MITIGATION MEASURES

Mitigation measures during construction and operational activities

7.1 Physical Disturbance

Physical disturbance would be controlled by restricting most of the activities in a limited area. Human impact will be confined to predefined areas whereas access will be leveled without causing much disturbance. Any structure will be placed in such a way that for maintenance or for replacement after expiry of its life it can be completely removed from the place to make the impact reversible. The equipment used during the construction phase would be removed from the site after completion of the building. The discharge pipelines will be laid avoiding the catchment area of the lakes.

7.2 Impact on Air Quality

Emission generated from the machinery and equipment predicted to have a cumulative impact on the environment will be controlled through optimization of the same. All the vehicles used for construction and operational purposes will be maintained efficiently to ensure low air emission.

7.2.1 Supply Ship

Since the supply ship will be berthed far from the site, the emissions from the ship at the idling stage are likely to be minimum producing insignificant impact on the station site. The expedition ship will be complying with the provisions of MARPOL Annex VI on air emissions. The possibilities of sharing the ship logistics after the construction stage will be preferred.

7.2.2 Helicopter

Helicopter will remain in the air only for 10 to 15 minutes for each sortie and will fly at 600 to 1000 feet above the msl so all the emissions will have very high probability of dilution and dispersion due to higher ventilation coefficient. It will be a line source emission not point source so it will have larger dispersal area and it is not going to affect directly or indirectly the flora or fauna or lake system of the area. The landing site shall be far away from the lakes.

Flying of the helicopters during the operational stage to the interior mountains will not have any direct impact on the site because of the distances involved.

7.2.3 ATV

Vehicles meeting the USEPA-2006 standards will be used to ply at the site which will help to reduce the emission in air. Emissions will be restricted to the order of 1.6 grams of hydrocarbon, 42.9 grams of carbon monoxide, 0.3 grams of nitrogen oxides and 0.1 gram of particulate matter per mile of run.

7.2.4 Generators

Fossil fuel generators mainly based on gasoline will be used to facilitate the construction work. Emissions from the generators are not very significant as the ventilation coefficient is very high. Gasoline of low sulfur and lead free type meeting the environmental norms of USEPA and CPCB will be used. The generators will be placed suitably taking into consideration the prevailing wind direction to avoid any contamination to the lakes. The upkeep and maintenance of the generators will be given high priority to keep the emissions at minimum.

Further to reduce emission, these generators will be operated on ATF rather than on diesel (Table 10). Generator will also be fitted with particulate arrester and stack height will be sufficiently high for proper dispersion of pollutants.

Table 10 : Emission from generators during station operation

Generator	Fuel Consumption (m3/year)	Total Emission of Pollutant (kg)				
		PM 10#	SO2	NOx	CO	TOC
*Emission Factor (kg/m3) of fuel burn		1.0248	0.744	11.724	0.8064	0.2856
75 kVA Genset (8 hours run For 365 days)	41	42	30	476	33	12
62.5 kVA (24 hours run for 365 days)	105	108	78	1232	85	30
Total	146	150	108	1708	108	42

Building will be designed as energy efficient and interiors of the building will be decorated to make best possible use of day light and avoid heat loss. Occupant shall be given proper training to use energy efficiently. The intake and discharge pipes will be heated only during the operations to save the energy. Wherever possible all the flow of recycled water, fuel and collection of the gray and black water will be gravity based.

7.2.5 Cranes and Forklift

Only one forklift will be operated which will run on gasoline. Impact on the air quality from the forklift use is not considered to be significant.

7.3 Impact on Water Quality

7.3.1 Waste from ship

The expedition ship will abide by MARPOL and Antarctic shipping guidelines thereby taking due care about the provisions of the environmental protocol. No waste produced in the ship will be discharged in the Treaty area. Treated wastewater will be discharged as per the prevailing provisions.

During the operation, stress will be on summer scientific activities around three months at the Larsemann hills site, but the ship will move away from the area as soon as material transfer is over. It will come again to collect the waste material from the site at the end of summer. So in all the ship will remain at the site for only 10-15 days.

7.3.2 Water quality at site

During the construction phase, water will not be drawn from the lakes, except for minor concreting. The ship will be used as a platform for most of the activities thereby reducing the water requirement for human consumption.

Potable water requirement from the lakes shall be supplemented by withdrawing and treating seawater with ultra filtration system. Seawater will be pumped from sea to the station building where it will be made available for further use after desalination. Snow traps will be laid at appropriate locations to increase the melt water content of the lakes.

Method of wastewater treatment and disposal will be in compliance with the basic requirements of the Protocol on Environmental Protection to the Antarctic Treaty. Rotating biological contactors or submerged aerated media processes will be installed to achieve an effluent quality of <20mg/L BOD₅ and SS and <200cfu/100ml faecal coliforms. The system will be able to disinfect the pathogenic bacteria before final discharge into sea. Basic specified criteria includes high effluent quality, compactness, low power use, low sludge

generation, reliability, simplicity of operation and the ability to treat variable wastewater loads. Extra care would be taken to check and eliminate the leakages.

7.4 Noise Environment

The ship will be berthed away from the peninsula to minimize the disturbance due to the noise. The helicopters will shut off their engines at the site to minimize noise disturbance. The silent generators adhering to the USEPA and CPCB standards will be used to keep the noise levels at minimum.

7.5 Impact of Oil Spill

During the construction phase, few barrels of Jet A-1 will be stored at the site over a platform to avoid any direct touch with ground and facilitate recovery of oil leakage if any. Care will be taken to avoid any oil spill during refueling or decanting from the barrels which will be checked frequently for any leakage. Sorbent material will be kept at fuel-handling sites. An oil spill contingency plan will be in force at the station to take care of any unforeseen eventuality.

According to the requirement during operation stage, around 200 kl of ATF will be stored in 10 numbers of 20 kl double skinned tanks. Gasoline will be stored in 10 numbers of 205 liters drums and other lubricants will also be stored in the drums. Part of the fuel will be stored at an alternate fuel depot at a safe distance from the previous one as a safety measure. Due care will be taken to ensure that these depots do not fall on the catchment area of the lake system

7.6 Impact of other waste

Since prefabricated material will be used for the erection of the building, the generation of the solid waste is expected to be at minimum. All the packing material will be stored in boxes and backloaded to ship. Maintenance-free battery will be used to minimize chances of any acid leak.

A comprehensive waste management plan will be enforced wherein collection, segregation and disposal techniques will be taken care of. Waste will be removed from the Treaty area and will be brought back to India for disposal. A compactor for reducing the volume of the solid non-combustible waste and plasma pyrolysis system for organic waste will be used. The ash will be collected and sealed in drums for disposal. Medical waste will be disposed as per the USEPA/CPCB Guidelines. Sludge obtained from the Rotating Biological Contactor and other allied units will be dewatered through centrifuge. Solid sludge will be collected in drums, sealed and removed from the Treaty area subsequently.

7.7 Impact on Flora and Fauna

Utmost care will be taken to avoid any interference with the local wildlife. Precautions will also be taken to avoid introduction of any alien species of microorganisms to the environment. Care shall be taken to irradiate the food material and other packing material with UV light to kill microorganism present if any, before taking to site.

7.8 Impact on Scientific activities

All the experiments related to astronomy, geomagnetism and atmospheric sciences will be conducted in separate laboratories, away from the station. All the electrical equipment installed at the station will meet the Electromagnetic Compatibility standards.

7.9 Aesthetic and Wilderness Value

The station design and the location will have minimum impact on the aesthetic value as the compact structure in a low-lying area will not have a strong visual impact. Wind turbine of smaller capacity will be preferred to reduce the impact value of the larger capacity turbine.

Impact Matrix

Impacts associated with station's operation and construction activities are identified and defined in matrices (Table 11). Impacts, mitigation measures related to the impact and ranking of the activities are defined below, according to its extent, duration, intensity and significance:

<i>Extent</i>	<i>Site Specific</i>	<i>Area adjoining to operational or construction site</i>
	<i>local</i>	<i>Within Larsemann Hills, approach way from ship to site and other modules</i>
	<i>regional</i>	<i>Prydz Bay Area</i>
	<i>continental</i>	<i>Antarctica and southern ocean</i>
	<i>global</i>	<i>All continent and sea</i>
<i>Probability</i>	<i>unlikely</i>	<i>Should not occur under normal operation and condition</i>
	<i>Low</i>	<i>Possible but unlikely</i>
	<i>Medium</i>	<i>Sometimes may occur</i>
	<i>High</i>	<i>Likely to occur during span of project</i>
	<i>Certain</i>	<i>Certain to occur</i>
<i>Duration</i>	<i>very short</i>	<i>Few minutes to hours</i>
	<i>short</i>	<i>Few hours to Few weeks</i>
	<i>medium</i>	<i>Few weeks to Few months</i>
	<i>long</i>	<i>Few months to Few years</i>
	<i>very Long</i>	<i>Decade to Century</i>
<i>Significance</i>	<i>A</i>	<i>Insignificant low impact not injurious to land and environment</i>
	<i>B</i>	<i>Measurable impact, but with proper planning is not injurious to land</i>
	<i>C</i>	<i>High Impact on environment, but can be curbed by taking proper precautionary measures</i>
	<i>D</i>	<i>Impact on environment but considered good</i>
	<i>E</i>	<i>Impact that will be detrimental to environment</i>

Table 11 : Impact Matrix and Mitigation Measures during Construction and Operation

Environmental Parameters / Indicator	Potential Impact from activities	Extent	Duration	Probability	Significance	Mitigation Measures
Physical Disturbance <i>Construction</i>	Erection of the structure, pipe laying, access pathway, wind turbine	Local	Long	Certain	B	Physical disturbance would be controlled by restricting most of the activities in limited area.
<i>Operation</i>	Occupied area of building, fuel and food depots, piping and off-loading platform, cable laying, laboratories etc.	Local	Long	Certain	B	<ul style="list-style-type: none"> • All activities will be carried out in defined area. • Laying of pipes will avoid use of frequent transportation for fuel and related activities. • Structure shall be removed after useful life is over.
Air Quality <i>Construction</i>	Supply Ship, Helicopter, Generator and Vehicles, Use of fossil fuel	Local to global	Medium	Certain	C	Abiding by MARPOL 73/78. Annex IV will ensure use of quality fuel and thereby controlled emissions.
<i>Operation</i>	Generator, incinerators for organic waste burning, supply ship, helicopter	Local to global	Medium	Certain	B	<ul style="list-style-type: none"> • Abiding by MARPOL 73/78. Annex IV will ensure use of quality fuel and thereby controlled emissions. • Ship and helicopter will be operated for very short duration. • Plasma-pyrolysis will be used for organic waste burning.

Environmental Parameters / Indicator	Potential Impact from activities	Extent	Duration	Probability	Significance	Mitigation Measures
						<ul style="list-style-type: none"> • Alternate energy source will reduce the fossil fuel consumption
Water Quality <i>Construction</i>	Solid-waste and wastewater release from the ship, which will introduce nutrients, heavy metals, faecal coliforms to the marine ecosystem	Regional	Short	Low	B	<ul style="list-style-type: none"> • Organic waste, except plastic will be burnt in incinerator, rest of the solid waste will be stored for proper disposal out of Treaty area • Treated and disinfected sewage will be stored in the tanks for disposal.
	Lakes at the site may be affected due to dispersal of solid waste and mixing of the carbon soot from the emission of vehicles, generator	Local	Medium	Medium	B	Keeping generator away from lake in downwind direction
<i>Operation</i>	Consumption of drinking water from the lake will reduce water level in the lake, wastewater pipe may leak from discharge pipe and mix with lake and contaminate water	Local	Long	Low	C	Potable water requirements will be supplemented by desalinated water from sea. Generator operation and solid waste burning will be carried out in the downwind direction from lake of prevailing wind.
	Solid-waste and wastewater release from the ship, which will introduce nutrients, heavy metals, faecal coliforms to the marine ecosystems	Local	Short	Low	A	Organic waste, except plastic will be burnt in incinerator, rest of the solid waste will be stored for proper disposal out of Treaty area

Environmental Parameters / Indicator	Potential Impact from activities	Extent	Duration	Probability	Significance	Mitigation Measures
	Wastewater discharge into sea will introduce heavy metal, bacteria, nutrient and deplete dissolved oxygen which may be detrimental to phyto and zoo plankton of marine ecosystem	Local	Medium	Medium	C	Treated and disinfected sewage will be stored in the tanks for disposal.
Noise Quality <i>Construction</i>	Noise will be produced during helicopter flying, generators and vehicle movement. High noise will disturb the fauna of the area like breeding activity, migration and other biological activity	Local	Very short	Certain	A	During construction phase noise intensity will be of short duration. However limited flying hours, silent generators and adequate construction method will mitigate noise levels and its duration
<i>Operation</i>	Noise will be produced during ice breaking, helicopter flying, generators and vehicles. High noise will disturb the fauna of the area like breeding activity, migration and other biological activity	Local	Long	Certain	B	The ship will be berthed away from the peninsula to minimize the disturbance due to the noise. The helicopters will shut off their engines at the site to minimize noise disturbance. The silent generators adhering to the USEPA and CPCB standards will be used to keep the noise levels at minimum.
Oil Spill <i>Construction</i>	Decanting of fuel and refueling.	Local	Long	Low	B	<ul style="list-style-type: none"> Sorbent material will be available at site. Proper attention and high

Environmental Parameters / Indicator	Potential Impact from activities	Extent	Duration	Probability	Significance	Mitigation Measures
						standards of valves, tanks and drums shall be used for storage of the fuel. <ul style="list-style-type: none"> • Suitable platform to put drums will be made with due care to follow drainage towards sea rather than lakes. • Oil spill contingency plan will help to combat any accidental spills.
<i>Operation</i>	Decanting of fuel and refueling.	Local	Long	Low	C	<ul style="list-style-type: none"> • Sorbent material will be available at site. • Proper attention and high standards of valves, tanks and drums shall be used for storage of the fuel. • Suitable platform to put drums will be made with due care to follow drainage towards sea rather than lakes. • Oil spill contingency plan will help to combat any accidental spills.
Solid-waste <i>Construction</i>	Waste generated will be of different categories. If left unattended, it may be hazardous to the environment and have both short and long term effects.	Local	Medium	Low	B	<ul style="list-style-type: none"> • All the packing material will be stored in boxes and back loaded to ship. • Maintenance free batteries will be used • Comprehensive waste management plan will be enforced. Waste will be removed from the Treaty area.

Environmental Parameters / Indicator	Potential Impact from activities	Extent	Duration	Probability	Significance	Mitigation Measures
<i>Operation</i>	Waste generated inside the station will be of different categories. If left unattended, it may be hazardous to the environment and have both short and long term effects.	Local	Medium	Low	C	<ul style="list-style-type: none"> • All the packing material will be stored in boxes and back loaded to ship. • Maintenance free batteries will be used • Comprehensive waste management plan will be enforced. • A compactor for reducing the volume of the solid non-combustible waste and plasma pyrolysis system for organic waste will be used. • Medical waste will be disposed as per the USEPA/CPCB Guidelines. • Sludge obtained from the Rotating Biological Contactor and other allied units will be dewatered through centrifuge. • Solid sludge will be collected in drums, sealed and removed from the Treaty area.
Aesthetic and wilderness values <i>Construction</i>	Vehicle movement, and other construction activities will lead to loss of wilderness and aesthetic value	Local	Long	Certain	A	<ul style="list-style-type: none"> • All the activities will be confined to defined areas. • Removing the equipment and machinery after use will reduce the impact on wilderness value

Environmental Parameters / Indicator	Potential Impact from activities	Extent	Duration	Probability	Significance	Mitigation Measures
<i>Operation</i>	Emerged building, modules, platform, windmill etc. will lead to loss of wilderness and aesthetic value	Local	Long	Certain	B	<ul style="list-style-type: none"> • All the activities will be restricted to designated areas • Removing the equipment and machinery after use will reduce the impact on wilderness value • Building and modules will be removed when the useful life span is over • Wind turbine of smaller capacity will be preferred to reduce the impact value of the larger capacity turbine