Management Plan

for Antarctic Specially Managed Area No. 6
LARSEMANN HILLS, EAST ANTARCTICA

1. Introduction

1.1 Geography

The Larsemann Hills is an ice-free area of 40 km^2, located approximately halfway between the Vestfold Hills and the Amery Ice Shelf on the south-eastern coast of Prydz Bay, Princess Elizabeth Land, East Antarctica (69°30'S, 76°19'58"E) (Map A). The ice-free area consists of two major peninsulas (Stornes and Broknes), four minor peninsulas, and approximately 130 near shore islands. The eastern-most peninsula, Broknes, is further divided into western and eastern components by Nella Fjord. The closest significant ice-free areas are the Bølingen Islands (69°31'58"S, 75°42'E) 25 km to the south-west and the Rauer Islands (68°50'59"S, 77°49'58"E) 60 km to the north-east.

1.2 Human presence

1.2.1 History of human visitation

The Larsemann Hills area was first charted by a Norwegian expedition led by Christensen in 1935, and brief visits were made by several nations during the following 50 years, but human activity of a significant or sustained nature did not occur until the mid-1980s. The three year period from 1986 to 1989 saw rapid infrastructure development in the area: an Australian summer research base (Law Base), a Chinese year-round research station (Zhongshan) and two Russian research stations (Progress I and Progress II) were established within approximately 3 km of each other on eastern Broknes. During this period a 2000 m skiway was also operated by Russia on the ice plateau south of Broknes, and used for over 100 inter-continental and intra- continental flights. The Chinese station has been occupied continuously since, whilst Russian activities in the area have been intermittent. The Australian base has been occupied during most subsequent summers.

1.2.2 Science

Substantial station-based research is undertaken, including meteorology, seismology, geomagnetics, atmospheric chemistry, Global Positioning System (GPS) tracking, atmospheric and space physics, and human physiology.

Field-based research in the Larsemann Hills has focused on geology, geomorphology, Quaternary science, glaciology, limnology, biology, biodiversity (including molecular), biotechnology and human impacts. Land traverses to locations further afield have also been supported.

1.2.3 Tourist visits

Several ship-based tourist visits have been made to the area since 1992. These have comprised half-day trips, during which passengers were transported to shore by helicopter and then able to view station areas, lakes, bird colonies and other features around eastern Broknes while on foot. An increase in tourism Antarctica-wide has the potential over time to promote continued tourist visits to the Larsemann Hills, and the proposed establishment of a compacted snow airstrip near the site of the previous skiway may facilitate increased numbers of visits and visits of greater duration, including the potential for land-based (overnight) tourism.

1.2.4 Associated human impacts

The initial period of intensive human activity between 1986 and 1989 and the subsequent conduct of science and support operations in the area have resulted in notable localised alteration of the environment, concentrated on eastern Broknes. The construction of station buildings, associated facilities and access routes on eastern Broknes has caused physical degradation of the ice-free surface. Breakdown of rocks and exposure of the permafrost layer through repeated vehicle use has caused surface erosion and altered drainage patterns. Chemical contamination of some lakes and soils has occurred through the accidental spillage of hydrocarbons, and the disposal of wastewater on the ground surface. Several introduced floral species have been detected (and removed), and there is evidence of ingestion of human-derived food by wildlife. There is also some evidence on western Broknes of wind-blown litter and surface disturbance through repeated pedestrian access. Stornes, and the minor peninsulas and near shore islands, have been infrequently visited and are less disturbed.

1.2.5 Future activities

Continuing human activity in the Larsemann Hills is promoted by the coastal location, ice-free landscape, the potential for further scientific research, and the potential for tourist visits. Commitment to ongoing use by the Parties currently active in the area is evident both in the planned and current redevelopment of station facilities and transport routes between the facilities, and plans for future science programs. The proposed establishment of a compacted snow airstrip on the plateau south of Broknes for both inter-continental and intra-continental flights may give rise to increased activity, particularly in support of other East Antarctic locations.

1.3 Period of designation

The ASMA is designated for an indefinite period. The Management Plan is to be reviewed at least every 5 years.

2. Values of the Area

The Prydz Bay region contains a number of rock outcrops and offshore islands, which represent a significant fraction of the ice-free component of the East Antarctic coastline. Comprising an ice-free area of approximately 40 km^2, the Larsemann Hills represent the southernmost coastal "oasis" (69°30'S) in this geographic sector, and the second largest after the Vestfold Hills (~410 km^2), 110 km to the north-east. Such coastal oases are particularly rare in Antarctica. As such, the Larsemann Hills represents a significant biogeographical location, and exhibits associated environmental, scientific and logistical values.

2.1 Environmental and scientific values

Much of the scientific research in the Larsemann Hills depends on the natural environment being in a relatively undisturbed state, and for this reason the protection of scientific values will to a large extent contribute to the understanding and protection of the abundant environmental values of the Area.

With their geology significantly different from that of other outcrops in the Prydz Bay region, the Larsemann Hills provide one of few geological windows into the history of the Antarctic continent. Widespread exposed geological and geomorphological features provide a valuable insight into landscape formation, and the history of the polar ice-sheet and sea level. Many of these features are particularly vulnerable to physical disturbances.

Broknes is one of very few coastal areas of Antarctica that remained partially ice-free through the last glaciation, and sediments deposited there contain continuous biological and palaeoclimate records dating back c. 130 000 years.

The Larsemann Hills contain more than 150 lakes. Although some of the most scientifically important lakes are on eastern Broknes, the lakes of the Larsemann Hills are collectively recognised as the Area's most important ecological feature. The lakes are particularly valuable for their relatively simple natural ecosystems. However, they are susceptible to physical, chemical and biological modification within their catchment boundaries. A catchment-based approach to management of human activities is therefore appropriate to protect scientific values.

The comparatively benign microclimate and the occurrence of freshwater in summer provide a relatively hospitable environment able to support Antarctic life forms. Three species of breeding seabird are present (Snow petrels, Wilson's storm petrels and South polar skuas), and Weddell seals haul out close to shore to breed and moult. Mosses, lichens and cyanobacterial mats are widely distributed, and found in high concentrations in some locations. The accessibility of these biological sites from the station areas on eastern Broknes makes them a valuable and vulnerable characteristic of the Area.

Due to the short and well-documented history of human activity concentrated in a relatively small area, the Larsemann Hills also presents an excellent opportunity for human impacts studies.

2.2 Logistical values

The Larsemann Hills is an important logistical support base for access to the southern Prydz Bay region and the Antarctic interior. Australia and China have conducted substantial inland traverses supported by facilities in the Larsemann Hills. Russia plans to relocate the support base for the resupply of Vostok from Mirny to the Larsemann Hills, and is undertaking works at Progress involving the construction of a new living/laboratory building to accommodate up to 30 people, bulk fuel tanks and a garage/workshop. In the 2004/05 summer Russia started the airborne resupply of Vostok using aircraft based at Progress runway. The existence of a compacted snow airstrip in the area, capable of facilitating both inter-continental and intra-continental flights, also presents the region as a major hub for the access and support of other East Antarctic operations.

China is also to upgrade Zhongshan in order to make it suitable for supporting long term scientific monitoring and inland operations of the Chinese Antarctic Expeditions. A project of infrastructure improving has been launched, which mainly includes refitting of the old buildings and facilities, the construction of a new garage/workshop, a new administrative and communications centre, new scientific research quarters, new laboratories, new observatory fields, a new pier, a new road to the pier, and a new heliport.

Romania plans to establish research and biological laboratory space within Law-Racovita. India plans to establish a permanent research station in the Larsemann Hills.

There have previously been several instances of logistical cooperation between Australia, China, Russia and Romania, involving the transfer of personnel, fuel, supplies and equipment, and this Management Plan promotes such initiatives.

2.3 Wilderness and aesthetic values

Stornes, the minor peninsulas and near shore islands have seldom been visited and many show little sign of past or current human presence. The aesthetic value of the rugged ice-free hills interspersed by lakes and fjords, with a backdrop of the Dålk Glacier, near shore islands, icebergs or the plateau is noteworthy.

3. Aims and objectives

The Larsemann Hills are designated as an ASMA in order to protect the environment by promoting coordination and cooperation by Parties in the planning and conduct of all human activities in the Area.

With the adoption of this Management Plan, the Treaty Parties commit to:

- providing guidance on the appropriate conduct of activities to all visitors (including personnel involved in national research programs, transitory national program visitors and participants in non-governmental activities);
- minimising cumulative and other environmental impacts by encouraging communication and a consistent, cooperative approach to environmental protection in the conduct of research and support activities;
- minimising physical disturbance, chemical contamination and biological impacts, primarily through appropriately managing vehicle usage;
- preventing contamination of the environment through the implementation of comprehensive waste management practices and the appropriate handling and storage of harmful substances;
- maintaining the wilderness and aesthetic values of the Area;
- safeguarding the ability to conduct scientific research by not compromising the scientific values of the Area; and
- improving the understanding of natural processes in the Area, including through the conduct of cooperative monitoring and recording programs.

4. Description of the Area

4.1 Geography and Area boundary

The ASMA comprises the ice-free area and near-shore islands collectively known as the Larsemann Hills (see Map A), and the adjacent plateau. The ASMA includes the land:

beginning at 69°23′20″S, 76°31′0″E east of the southern tip of Dalkoy and from there, north to 69°22′20″S, 76°30′50″E north of Dalkoy

north-west to 69°20′40″S, 76°21′30″E
north of Striped Island

north-west to 69°20′20″S, 76°14′20″E
north-east of Betts Island

south-west to 69°20′40″S, 76°10′30″E
north-west of Betts Island

south-west to 69°21′50″S, 76°2′10″E
north-west of Osmar Island

south-west to 69°22′30″S, 75°58′30″E
west of Osmar Island

south-west to 69°24′40″S, 75°56′0″E
west of Mills Island

south-east to 69°26′40″S, 75°58′50″E
south of Xiangsi Dao

south-east to 69°28′10″S, 76°1′50″E
south-west of McCarthy Point

south-east to coastline at 69°28′40″S, 76°3′20″E

north-east to 69°27′32″S, 76°17′55″E
south of the Russian airstrip site

south-east to 69°25′10″S, 76°24′10″E
on the western side of the Dålk Glacier

north-east to 69°24′40″S, 76°30′20″E
on the eastern side of the Dålk Glacier

north-east returning to 69°23′20″S, 76°31′0″E.

The intention is however to manage, in accordance with this management plan, the conduct of all substantial human activity associated with the Larsemann Hills.

No artificial boundary markers are in place.

4.2 Climate

A major feature of the climate of the Larsemann Hills is the existence of persistent, strong katabatic winds that blow from the north-east most summer days. Daytime air temperatures from December to February frequently exceed 4˚C and can exceed 10˚C, with the mean monthly temperature a little above 0˚C. Mean monthly winter temperatures are between –15˚C and –18˚C. Pack ice is extensive inshore throughout summer, and the fjords and bays are rarely ice-free. Precipitation occurs as snow and is unlikely to exceed 250 mm water equivalent annually. Snow cover is generally deeper and more persistent on Stornes than Broknes, due to north-easterly prevailing winds and the perennial sea ice held in by the islands offshore from Stornes.

4.3 Natural features

4.3.1 Bedrock geology

Bedrock exposures in the Larsemann Hills are composed of supracrustal volcanogenic and sedimentary rocks metamorphosed under granulite facies conditions (800–860˚C, 6–7 kbar at peak) during the early Palaeozoic "Pan-African" event (~500-550 Ma). Peak metamorphic conditions were followed by decompression. The rocks were subjected to extensive melting and several deformational episodes, and have been intruded by several generations of pegmatites and granites. The supracrustal rocks are underlain by, and possibly derived from, a Proterozoic orthopyroxene-bearing orthogneiss basement. The Larsemann Hills (and neighbouring Bolingen Islands and Brattstrand Bluffs) differ from other parts of Prydz Bay, mainly due to the absence of mafic dykes and large charnockite bodies.

4.3.2 Geomorphology

The elongated form of large-scale topographic features of the Larsemann Hills results from compositional layering, folds and faults (lineaments) in the metamorphic bedrock. The landscape is dissected by large, structurally controlled, steep sided fjords and valleys rarely exceeding 100 m in depth on land; the maximum is 3 km in length (Barry Jones Bay). The maximum elevation above mean sea level is 162 m (Blundell Peak).

The coastline is generally bedrock, and beaches occur only at the heads of fjords or in isolated sheltered bays. There are several examples of sequences of ice-dammed lakes and associated gorges and alluvial fans. The offshore islands are likely to be roches moutonnees, isolated by the current sea level.

Numerous geomorphological features are found within the area. Landforms produced by wind are common, though ice and salt wedging clearly play a considerable role in grain detachment with wind primarily acting as a transporting agent. Periglacial landforms are also widespread, but not particularly abundant or well developed.

True soils are virtually absent due to a lack chemical and biological soil-forming processes. Surficial deposits are widespread but confined to lower areas and include snowpatch gravels, wind deposited materials, talus and fluvially deposited materials. Very thin soils (less than 10 cm) are also found in association with scattered moss beds and discontinuous lichen. A permafrost layer exists 20–70 cm below the surface in areas.

On north-eastern Stornes at approximately 69°31′48″S, 76°07′E there is an outcrop of post-depositionally placed marine Pliocene (4.5–3.8 Ma) sediment. These sediments, with a maximum thickness of 40 cm, occupy a narrow bench approximately 55 m above sea level and have yielded abundant well preserved foraminifera, less well preserved diatoms and molluscs.

On Broknes, areas that have remained ice-free through the Last Glacial Maximum contain sediment deposits (in lakes) that record climate, biological and ecological changes spanning the last glacial cycle.

4.3.3 Lakes

The Larsemann Hills contains more than 150 lakes ranging in salinity from freshwater to slightly saline, and in size from shallow ponds to large ice-deepened basins, although most are small (5000–30 000 m^2) and shallow (2–5 m). The surfaces of all the lakes freeze during winter, and most thaw for up to 2 months in summer, allowing them to be well-mixed by the regular katabatic winds. Most lakes are fed by snow melt and some have entrance and exit streams that flow persistently during the summer, and provide habitat for crustaceans, diatoms and rotifers; such streams are particularly evident on Stornes.

Small catchment areas and the near pristine waters make the Larsemann Hills lakes particularly susceptible to impacts resulting from human activities. Research has shown that several lakes on eastern Broknes in the immediate vicinity of the station areas and interlinking road network have experienced modified water chemistries, and inputs of nutrients, meltwater and sediment. Whilst these lakes clearly exhibit human impacts, the majority of the lakes on Broknes, and those elsewhere in the Area appear largely unmodified.

The lakes on east Broknes have the longest sediment record of any surface lakes in Antarctica. It appears that the ice sheet did not advance beyond Lake Nella and did not scour Progress Lake so these and lakes towards the north end of the peninsula are particularly valuable to the science community.

4.3.4 Lake and stream biota

Most of the phytoplankton comprises autotrophic nanoflagellates, though dinoflagellates occur in many lakes, and a desmid belonging to the genus *Cosmarium* is a major component of at least one lake. Heterotrophic nanoflagellates are more common than autotrophic nanoflagellates, though exhibiting low species diversity (only three or four species in most lakes), and particularly abundant in shallow lakes (*Parphysomonas* is very common). *Ciliates* are found in low numbers, with *Strombidium* the most common species, and a species of Holyophyra also found in most lakes. Rotifers occur sporadically in a number of lakes and the cladoceran *Daphniopsis studeri* is widespread, but found in low numbers.

The most obvious biotic feature observed in almost all the lakes are extensive blue-green cyanobacterial mats, which have accumulated since ice retreat, in places being up to 130 000 years old. These cyanobacterial mats are found to exceptional thicknesses of up to 1.5 m, not normally observed in other Antarctic freshwater systems, and are also widely distributed in streams and wet seepage areas.

4.3.5 Seabirds

Three species of seabird breed within the Larsemann Hills (South polar skuas, Snow petrels and Wilson’s storm petrels). Approximate numbers and locations of breeding pairs are documented for Broknes, and particularly eastern Broknes, but their distribution throughout the remainder of the area is uncertain.

South polar skuas (*Catharacta maccormicki*) are present between mid-late October and early April, with approximately 17 breeding pairs nesting on Broknes and similar numbers of non-breeding birds.

Snow petrel (*Pagodroma nivea*) and Wilson’s storm petrel (*Oceanites oceanicus*) nests are found in sheltered bedrock fragments, crevices, boulder slopes and rock falls, and are generally occupied from October until February. Approximately 850–900 pairs of Snow petrel and 40–50 pairs of Wilson’s storm petrel are found on Broknes, with concentrations of Snow petrels at Base Ridge and on rocky outcrops adjacent to the Dålk Glacier in the east and the plateau in the south.

Despite the apparent suitable exposed nesting habitat, no Adelie penguin (*Pygoscelis adeliae*) breeding colonies are found at the Larsemann Hills, possibly due to the persistence of sea ice past the hatching period. However birds visit from colonies on nearby island groups between the Svenner Islands and Bolingen Islands, during summer to moult. Emperor penguins (*Aptenodytes forsteri*) also occasionally visit from the Amanda Bay rookery 30 km to the north-east.

4.3.6 Seals

Weddell seals (*Leptonychotes weddelli*) are numerous on the Larsemann Hills coast, using the sea ice in the area to pup from October, and to moult from late December until March. Little is currently known about locations and numbers, although pupping has been observed on the sea ice adjacent to small islands north-east of eastern Broknes, and groups of moulting seals have been observed hauled out near the Broknes shore adjacent to the stations and in tide cracks in the fjords to the west. Aerial surveys during the moulting period have observed greater than 1000 seals, with multiple large groups (50–100 seals) hauled out in Thala Fjord and on rafted ice immediately to the west of Stornes, and numerous smaller groups amongst offshore islands and ice to the north- east of Broknes. Crabeater seals (*Lobodon carcinophagus*) and Leopard seals (*Hydrurga leptonyx*) are also occasional visitors.

4.3.7 Terrestrial micro fauna

Little research has been conducted with regard to terrestrial invertebrates in the Larsemann Hills. Five genera of terrestrial tardigrade (*Hypsibius, Minibiotus, Diphascon, Milnesium* and *Pseudechiniscus*), which include six species, are known to be present in localities associated with vegetation. The lakes and streams provide a series of habitats that contain a rich and varied fauna very typical of the Antarctic region. Seventeen species of rotifer, three tardigrades, two arthropods, protozoans, a platyhelminth and nematodes have been reported. The cladoceran *Daphniopsis studeri*, one of few species of freshwater crustacea known to occur in the lakes of continental Antarctica, has been identified in most Larsemann Hills lakes and represents the largest animal in these systems.

4.3.8 Terrestrial vegetation

Sampling of the coastal areas from the Vestfold Hills to the Larsemann Hills indicate that the flora of the Ingrid Christensen Coast is relatively uniform, and restricted to a similar distribution of bryophytes, lichens and terrestrial algae. Although few collections have been undertaken, it is believed that the nature of the basement rock, the relatively recent exposure from the ice cap, and the prevailing wind direction in the greater Prydz Bay area contribute to the fact that less than 1% of the Larsemann Hills has vegetative cover. Five introduced vascular species have been observed in the vicinity of station buildings, indicating that the environment will support introduced species.

Most terrestrial life, including mosses, lichens and accompanying invertebrates are found inland from the coast. Nevertheless, large moss beds are known to occur in sheltered sites on the larger islands (particularly Kolløy and Sigdøy), associated with Adelie penguin moulting sites, and nunataks in the southwest. There are seven positively identified moss species in the region: *Bryum pseudotriquetum*, which is most abundant, *Grimmia antarctici, Grimmia lawiana, Ceratodon pupureus, Sarconeurum glaciale, Bryum algens* and *Bryum argentum*.

The bryophyte flora also comprises one species of liverwort *Cephaloziella exiliflora*, which is found on an unnamed outcrop south of Stornes and known from only four other Antarctic localities. Lichen coverage is considerable on north-eastern Stornes and Law Ridge on Broknes and the lichen flora of the region comprises at least 25 positively identified species. Although no systematic studies have been undertaken in the area, similar work conducted in nearby locations on the Ingrid Christensen Coast suggest that it would not be unreasonable to expect the Larsemann Hills to exhibit close to 200 non-marine algal taxa, and 100–120 fungal taxa.

4.4 Human impacts

Past and ongoing human activities in the Larsemann Hills are concentrated on eastern Broknes where three stations are in close proximity to each other.

Areas outside Broknes exhibit very little evidence of human impact, with survey/photo control marks comprising the only obvious introduced features. Maintaining this well-preserved state is a major priority for management of the Larsemann Hills.

4.5 Access to the Area

4.5.1 Land access

In total, 15 km of unsealed roads, formed of local material, have been established on eastern Broknes. A principal road, 6.7 km in length, runs from Zhongshan in the north, through the centre of eastern Broknes, linking each of the stations and providing access to the continental plateau in the south. This road closely follows the most appropriate route with regard to avoiding lake catchments and steep slopes. There are four particularly steeps sections: a ridge approximately 0.5 km south of Zhongshan; a series of steep slopes between Progress II and Law-Racovita; the section of road which traverses the slope to the west of Lake Sibthorpe; and the ascent to the plateau near the Dålk Glacier. At present a survey is being conducted to identify a better route between Law- Racovita and Progress. The alternative of flattening the slope is also being investigated. The final kilometre of the route before entering the plateau proper is marked by marker canes every 50–100 m. There are also vehicle routes within the immediate station areas of Zhongshan and Progress II and a short access route connecting Law- Racovita to the main road. Vehicle access over ice-free surfaces within the Area is to be restricted only to roads, and particular care must be taken when traversing the noted steep sections.

Sea ice travel within the Area is possible, with ice persisting in the fjords and between the shore and numerous near-shore islands until late in the summer season. Ice conditions are variable at the eastern and western margins of the Area due to the presence of glaciers, and sea ice travel must take account of these conditions. In winter, sea ice access to the Zhonghan and Progress II is also feasible via the beach west of Zhongshan (69°22′30″S, 76°21′33″E) or the beach adjacent to Progress II (69°22′44″S, 76°23′36″E), depending on highly variable ice conditions. From the sea ice, it may then be possible to access the main road south of the steep section south of Progress II via either the easternmost bay of Nella Fjord (69°22′58″S, 76°22′44″E) or via Seal Cove (69°23′6″S, 76°23′49″E).

The Area can be approached on the plateau ice from Davis in the north-east (approximately 330 km) and Mawson in the west following the Lambert Glacier traverse route (approximately 2200 km). This comprises a caned route, which turns north from a marker at 69°55′23″S, 76°29′49″E then follows series of canes and drum beacons north to connect with the major access route on eastern Broknes.

4.5.2 Sea access

No established shipping anchorages or barge landings are designated for the Area due to the variable sea ice conditions present to the north-east of eastern Broknes. Vessels usually anchor approximately 5 nautical miles offshore, depending on ice conditions. Three main sites have been used in previous years:

- the bay ~250 m NNE of Zhongshan at 69°22′12″S, 76°22′15″E has been most frequently used in the past, and consists of a ~15 m opening between rock outcrops, and a large flat area on shore for vehicle operations;
- the beach adjacent to Progress II (69°22′44″S, 76°23′53″E); and
- the beach west of Zhongshan opening into Nella Fjord (69°22′30″S, 76°21′25″E).

Access from ships to the eastern shore of Broknes by small boat is difficult and sometimes impossible due to ice debris up to hundreds of metres off shore, blown by the prevailing north-easterly winds. Helicopters are therefore the only reliable means by which persons and supplies can be transported ashore quickly.

4.5.3 Air access

Designated helicopter landing and refuelling sites located at Zhongshan, Progress II, Law-Racovita and Progress I are to be used preferentially for general helicopter operations.

The Zhongshan helicopter-landing site (69o22′44″S, 76o21′32″E) consists of a circular concrete pad of 15 m diameter showing a painted map of Antarctica, and is located approximately 40 m west of the main administration / mess building (Map D). There are other possible (unconsolidated) landing sites nearby, although loose surface rocks and gravel make the use of the pad preferable. Landings are usually made travelling towards the main building from the direction of the lake, due to the north-east prevailing winds.

The usual helicopter-landing site at Progress II (69o22′40″S, 76o24′10″E) consists of a flat area (~20 x 20 m) of bare ground cleared of large rocks, and is adjacent to a large depot of 200 L fuel drums, approximately 250 m north of the largest building in the station area (Map E). The complex under construction will include a concrete helicopter pad.

The Law-Racovita helicopter-landing site (69°23′20″S, 76°22′55″E) is a flat area located approximately 60 m east of the base. Helicopters would normally land facing into the north-east prevailing winds.

There is no defined helicopter-landing site at Progress I, but Australian helicopters usually land adjacent to the fuel depot (69°24′S, 76°24′10″E).

Small ski/wheeled fixed-wing aircraft operations have previously been conducted infrequently in the region and may be possible on the sea ice adjacent to the stations, though ice conditions vary annually, and the proximity to wildlife colonies make such operations on the plateau preferable. Landings have been conducted near the site of the previous Russian runway, and proposed compacted snow airstrip at 69o25′59″S, 76o10′25″E Prevailing winds from the north-east and a slight rise in the surface suggest that landing and taking off towards the north- east is preferable. Flight paths should be selected to avoid wildlife.

4.5.4 Pedestrian access

Pedestrian access within the Area is not restricted, but is to be conducted in accordance with the accompanying Environmental Code of Conduct (see Appendix 1). Where established routes are apparent for frequently visited locations, these routes should be utilised to minimise physical disturbance of the land surface and to prevent further track formation. Where surface modification is not apparent, the most direct route between points should be taken, with consideration given to avoiding repetitive use of the same route and avoiding vegetation and other sensitive features.

4.6 Location of structures in or near the Area

There are currently two permanent year-round research stations (Zhongshan and Progress II) and one seasonal research facility (Law-Racovita) in the Area (Map C).

4.6.1 Zhongshan (People's Republic of China) General

Zhongshan is located on the north-eastern tip of eastern Broknes at 69°22′24″S, 76°22′40″E at approximately 11 m above sea level. The station was established in the 1988/89 summer season and has operated continuously since, to facilitate the conduct of year-round scientific research activity by the Chinese Antarctic program.

Station infrastructure

Station populations are approximately 60 personnel in summer and 20–25 in winter, with a maximum capacity to accommodate 76. The station consists of five main and several smaller buildings (Map D). Vehicle access to Zhongshan is via the main road from the plateau, and a network of routes link the main buildings within the station area. A concrete helicopter-landing pad is located west of the main station building, at 69°22′22″S, 76°22′8″E (see Section 4.5.3).

Power, fuel delivery and storage

Electrical power is provided by diesel generators. Fuel is transferred from the ship by barge or pipeline, depending on sea ice conditions, and stored in bulk tanks at the southern end of the station area. Between 200– 300 cubic metres of fuel are delivered to the station each year.

Water

Water for generator cooling and shower facilities is drawn from a large tarn immediately west of the station area, and potable water is drawn from a smaller adjacent snowmelt-fed tarn in summer and obtained by melting ice or snow in winter. Wastewater is discharged to the ocean after passing through a series of gravity-driven settlement tanks.

Waste management

Combustible wastes are separated and burnt in a high temperature, diesel-fuelled incinerator. The quantity of combustible wastes produced requires an incinerator burn every three to four days on average, and incinerator ash is collected and stored for return to China. Non-combustible wastes are sorted into waste categories and stored south of the power house for removal by ship at the next opportunity.

Vehicles

Vehicles are used in the immediate station area and to transport materials to other sites on eastern Broknes via the main road. Maintenance of vehicles, generators and instruments is undertaken in the powerhouse or vehicle workshop. All waste oil is returned to China.

Resupply

Resupply is generally undertaken once a year in summer. Cargo is brought to shore using either barges, or sleds towed behind traverse vehicles.

Communications

Verbal communication with China is largely by short-wave radio and INMARSAT A, B and C systems equipped for sending and receiving telephone calls, faxes, emails and scientific data. HF radio is used for communications in the Prydz Bay area and VHF radio is used for local communications. A radio-telephone link also provides contact with Davis (and via Davis to anywhere in the world), and this is used for conveying meteorological data on a daily basis.

Science

Science programs conducted from Zhongshan are largely of a station-based nature and include: meteorology, ozone monitoring, upper atmosphere physics, auroral observations, geomagnetic observations (some in cooperation with the Australian Antarctic Program), gravimetric observations, seismology, NOAA polar orbiting satellite image processing, atmospheric chemistry, remote sensing, GPS measurement and human physiology.

Activities away from the immediate station area during seasons with summer research programs include environmental evaluation and monitoring of snow-ice, soil, seawater, freshwater, moss, lichen, wildlife, geology, glaciology and sea ice ecosystems. Inland traverses have also been undertaken to conduct geology, geodesy, glaciology and meteorite studies.

4.6.2 Progress II (Russia) General

Progress II is located on eastern Broknes, approximately 1 km south of Zhongshan, at 69°21′57″S, 76°20′59″E. The station was established in 1988 on a plateau 300 m from the western shoreline of Dålk Bay, to allow greater ease of ship-based resupply and a more sheltered location than the location of Progress I (adjacent to the ice plateau). Progress II was occupied sporadically and shut down during the 1993/94 summer, but reopened in the 1997/98 summer season for operation as a year-round research facility.

Station infrastructure

The station accommodates a population of approximately 15 people year round, but occupation has been sporadic since 1989, with a maximum population over summer of 58. The station consists of a two-storey living/office building and 12 older huts (Map E). Vehicle access to Progress II is via the main road from the plateau, and a network of routes links the main buildings within the station area. A helicopter-landing site is located north-west of the main station building, at 69°22′40″S, 76°24′10″E (see Section 4.5.3).

The station is being rebuilt within the existing station boundaries. At the time of its planned completion in 2012, the station's facilities will include a helicopter pad, living/laboratory building providing accommodation for 30 people, a garage/workshop/diesel power station, and fuel storage.

The renovated buildings will be equipped with waste treatment facilities.

The existing routes will mostly be used to access the site. Following completion of the rebuilding program the old buildings and facilities are to be demolished and removed from the Antarctic Treaty area.

Power, fuel delivery and storage

Electrical power is provided by three diesel generators. The generators are supplied with fuel from two tanks adjacent to the power station, which are filled by wheeled tank from bulk tanks on the shore between Progress II and Zhongshan. Gas is used for cooking, and electric heaters are used to heat the buildings.

Water

Drinking water is drawn from a small lake to the north-west of the station area in summer, and from Progress Lake near the plateau in winter. Water from either lake is transported to the station in a water tank, and stored in a large tank adjacent to the mess building. In past years some fresh water has also been obtained by melting sea ice and small bergs near the station. Washing water is drawn from Stepped Lake during summer. A water condition plant has been installed, providing for the use of the lake's slightly brackish water.

Waste management

Small, non-combustible wastes are separated and compacted for removal. Kitchen wastes and combustibles are burnt in a high temperature incinerator. Sewage water from the main building is treated by an electro-chemical unit and discharged into the bay. The smaller old buildings do not have sewage treatment units; human wastes and kitchen scraps from these are stored in drums for return to Russia.

Larger wastes are stored in 200 L drums on the beach adjacent to the station, for return to Russia.

Vehicles

Vehicles are used in the proximity of the station for collecting water and transferring fuel and wastes, and to transport personnel and equipment to Progress I and to the plateau. Some vehicles are stationed at Progress I and a small outpost to the south, for use in compacted snow runway operations. Several large unused vehicles are also stored west of the main Progress II station area.

Resupply

Resupply is conducted by ship-shore helicopter operations following the summer season (April – May). Thick ice conditions are preferred, to also allow cargo to be deployed onto vehicles and driven directly to shore on the sea ice.

Communications

HF communications are used to contact other Russian stations. VHF communications are used for local aircraft, ship and field operations. INMARSAT B and C and Iridium systems are used to contact Russia and occasionally, other Russian stations.

Science

Progress II is primarily intended as a support base for inland geological and glaciological operations.

4.6.3 Law-Racovita (Australia – Romania) General

Law-Racovita is located towards the southern end of eastern Broknes, approximately 1 km south of Progress II and 2 km south of Zhongshan at 69°23′16″S, 76°22′47″E. The Base was established in the 1986/87 summer season.

Station infrastructure

Law-Racovita consists of one prefabricated multi-purpose building, five fibre-glass huts and a small ablutions shed. All wastes generated are drummed and removed. Plans are being made to upgrade the station's infrastructure, and to relocate it to the Facilities Zone, by 2010.

Power, fuel delivery and storage

A small petrol generator is used to provide electrical power and operated only when required to charge batteries etc. A small solar panel mounted on the roof of the main hut charges batteries to power the HF and VHF radios. Gas is used for cooking and heating the main hut.

Water

Drinking and washing water is generally obtained during summer by collecting and melting snow from a nearby snow bank. Drinking water is also collected from a small tarn adjacent to the section of road connecting Law-Racovita with the main route between north-eastern Broknes and the plateau.

Logistics

Four-wheeled motorbikes are occasionally stationed at Law-Racovita for the support of science programs during summer. Use of these vehicles is strictly restricted to the designated access routes.

Law-Racovita may be supported opportunistically from Davis (by helicopter), stations in the immediate area, or from ships resupplying any of these facilities.

Communications

Law-Racovita is equipped with VHF radios.

Science

Summer research projects have included studies of the glacial history of the area, geology, geomorphology, hydrology, limnology and biology, plus human impacts studies including the contamination and eutrophication of lakes and soils, and introduced species.

4.6.4 Compacted snow runway site and associated facilities (Russia)

The proposed site of a runway approximately 5 km south of Progress II and running SW-NE at 69°25′43″S, 76°20′36″E to 69°26′51″S, 76°17′18″E is accessed by the ice-free plateau access route and the beginning of the inland traverse route. Two field huts are presently located on the southernmost rock outcrop adjacent to the route, approximately 2 km north of the runway site at 69°24′39″S, 76°20′15″E.

4.6.5 Minor structures Progress I (Russia)

Progress I (69°24′S, 76°24′E) supported a wintering population of 16 in 1987 and 1988 and was partially dismantled and removed in 1991/92. One functional building remains at the site which is also used to store Russian airstrip construction equipment and fuel drums. Chinese traverse sleds, traverse vans, and a depot of fuel drums for traverse vehicles are stored in the immediate vicinity. Australia also maintains a depot of aviation fuel near Progress I (69°23′56″S, 76°24′37″E). A further Russian hut and airstrip construction vehicle storage area is located on the southernmost rock outcrop west of the caned vehicle route to the plateau, approximately 1 km past Progress I (69°24′43″S, 76°24′35″E).

Field hut (India)

Three fibreglass huts with basic provisions for emergency needs are currently sited on an un-named promontory at 69°24′S, 76°11′E. The huts were positioned by India in the 2004/05 and 2006/07 summers.

Monitoring sites

A long-term monitoring site, approximately 250 m north-east of Law-Racovita, was established in 1990 to measure the rate of surface lowering caused by wind abrasion and salt weathering. The site is situated on exposed coarse-grained yellow gneiss, and consists of 24 micro-erosion sites marked by painted yellow rings. Due to the nature of this study, the site should not be crossed on foot, as this will affect the measurements of natural erosion. The practice of using paint or other such permanent means of marking sites is discouraged, and collection of a GPS location is preferable.

A tide gauge, for measuring variation in the mean sea level, is located in the easternmost bay of Nella Fjord, 41.8 m from a known benchmark on shore (69°23′2″S, 76°22′19″E).

Monuments

A rock cairn laid on 8 February 1958 to mark the first Australian National Antarctic Research Expeditions (ANARE) visit to the Larsemann Hills, is located at the highest point on Knuckey Island (69°23′12″S, 76°3′55″E), the largest of a group of three islands lying approximately 1.1 km north-west of Stornes. The cairn contains a note, stored in a plastic sleeve within a glass jar, outlining the names of the landing party.

The gravesite of a Russian expeditioner who died in July 1998 is located on the hill overlooking the northern shore of Seal Cove at 69°22′58″S, 76°23′49″E. The site comprises a steel chest with affixed plaque, surrounded by a low metal railing. A headstone displaying an image of the expeditioner stands at the foot of the chest.

A small monument is located on the northern side of the hill at the northernmost tip of the eastern Broknes coast, north of Zhongshan. This site is a memorial to a previous Vice President of the Chinese Arctic and Antarctic Administration, and comprises a cement monument facing north towards Manning Island and containing a portion of the previous Vice President's ashes.

Other minor structures

A very small emergency food cache is contained within a plastic box at the summit of Blundell Peak on Stornes (69°6′14″S, 76°6′14″E), the highest peak in the Larsemann Hills.

4.7 Location of other protected areas

The only other protected area in the Prydz Bay region is ASPA 143: Marine Plain (68°3′36″S, 78°6′57″E), located on Mule Peninsula in the Vestfold Hills, approximately 110 km to the north-east. Historic Site and Monument (HSM) 6: Walkabout Rocks (68°21′57″S, 78°31′58″E) and HSM 72: Cairn on Tryne Islands (68°21′57″S, 78°24′E) are also located within the Vestfold Hills.

5. Zones within the Area

All activities within the Area are to comply with the provisions of the Protocol on Environmental Protection to the Antarctic Treaty and the appended Environmental Code of Conduct. In addition four zones are defined with restrictions on certain activities, as deemed necessary to meet the objectives for managing the Area.

5.1 Facilities Zone

The construction of station buildings and associated infrastructure on eastern Broknes has caused the greatest impact on the Larsemann Hills environment. However, these impacts have been largely restricted to the immediate station areas and connecting access routes. As the lakes are recognised as the most important ecological feature of the Area, and are susceptible to the impact of human activities undertaken within their catchment limits, a catchment-based approach is the most appropriate means of managing activities in the Area. The existing permanent stations are well situated to limit the spread of their environmental effects, due to their isolation from the rest of the Area, with most station infrastructure located in drainage basins that discharge into the sea.

To ensure that this situation is maintained, a Facilities Zone is defined within the ASMA boundary, encompassing the majority of eastern Broknes. The boundary of the Facilities Zone is defined by the Dålk Glacier in the east, the sea in the north, the western margin of impacted catchments in the west, and the ice plateau including the airstrip and access route in the south. The installation of infrastructure within the ASMA will generally be restricted to already impacted areas in the Facilities Zone. Additional activity within the ASMA involving the building of new infrastructure elsewhere may be considered based on adequate scientific and/or logistic justification.

5.2 Helicopter Zone

Helicopter operations have the potential to cause disturbance to breeding and moulting wildlife. To minimise such disturbance, it is recommended that helicopters operating in the Area take into account the presence of wildlife and maintain maximum possible separation distances. Pilots are to avoid flying and landing upwind of lakes and vegetated areas.

5.3 Magnetic Quiet Zone

Several magnetometers are operated at Zhongshan. A circular zone of 80 m radius is defined surrounding the induction magnetometer sensors located in the gully north of the station at 69°22′12″S, 76°22′8″E, and a further zone to a radius of 80 m from the magnetometer array located west of the water supply lakes and centred at 69°22′22″S, 76°21′46″E. All ferrous materials are to be excluded from these zones to avoid contamination of magnetic field measurements. Permission to enter the Magnetic Quiet Zone must be obtained from the scientist in charge of the experiment.

5.4 Restricted Zone – Stornes

Designation of Stornes as a Restricted Zone recognises the desirability of protecting this infrequently visited and consequently minimally impacted peninsula, including as a reference site for possible future comparison with Broknes.

Stornes is also geologically and mineralogically unique for the extensive development of a diverse suite of borosilicate and phosphate minerals, five and nine species, respectively. The relatively rare borosilicates prismatine and grandidierite are found abundantly in spectacular crystals and segregations over a wide area, while the ferromagnesian fluorphosphate wagnerite forms spectacular nodules locally and microscopic grains regionally. Stornes is the type locality for four new minerals. The aluminium borosilicate boralsilite was described in 1998 and subsequently found at several localities on the peninsula in 2003; to date it is known only from one other locality worldwide. Three new phosphate minerals were discovered in samples collected in 2003; description of these minerals is underway. The borosilicate and phosphate assemblages are considered scientifically significant both in their variety and origin. A major question being addressed in ongoing research is what geologic processes concentrated boron and phosphorus to such an extent.

The sediments on north-eastern Stornes at approximately 69°25′S 76°0′E contain abundant well preserved foraminifera, diatoms and molluscs. This location represents one of only two recorded sites in East Antarctica displaying sediment from this time interval. The sediments are thin and friable and thus require protection from human disturbance. Recent attempts to accurately locate and delimit the site have however been prevented by substantial snow cover.

Preparatory work on Stornes' possible designation as an Antarctic Specially Protected Area is underway.

6. Management activities

Communication between Parties, between on-ground personnel, and between on-ground personnel and national offices will be the key to the successful implementation of management measures in the Larsemann Hills; Parties with research programs in the area commit to ensuring appropriate communication at both a national program and on-ground level. Annual discussions to review the implementation of the management plan will be held during annual Treaty-related meetings.

The relevant station and field base leaders will also meet on an annual basis (logistics permitting) and maintain verbal communications throughout the year on aspects relevant to the management of the Larsemann Hills.

6.1 Logistics, including facilities

- Any further track and infrastructure development in ice-free areas will be restricted to that part of eastern Broknes already modified by human activities and delimited by the Facilities Zone (see Section 5.1), unless a location outside the Zone is justified for adequate scientific and/or logistical reasons. This restriction shall not apply to facilities to be set up for ensuring the safety of field workers.

- Environment impact assessment will proceed as required by Article 8 of the Protocol before constructing or modifying structures, and the Parties proposing to conduct such activities will inform other Parties with active research programs in the Area.
- The cooperative use of infrastructure will be promoted in preference to the construction of new facilities.
- The impacts of man-made structures on wilderness and aesthetics values will be considered and minimised by restricting new structures to already impacted areas wherever possible, and by locating structures so as to minimise their visibility from surrounding areas. Research will be continued to further develop GIS-based models to assist in the evaluation of such impacts prior to construction activities.
- Fuel storage areas will be bunded and located outside lake catchment boundaries wherever possible.
- The use of vehicles will be minimised and essential vehicle use restricted to designated ice-free routes, sea ice and plateau ice.
- Vehicle routes that do not serve the aims of this management plan will be closed with rehabilitation of the impacted area undertaken wherever possible.
- The planning and conduct of vehicle use will take into account the wildlife distances identified in the Environmental Code of Conduct.
- Options for cooperation in the transfer of personnel, supplies, and fuel will be explored.
- As a minimum, waste disposal and management activities will comply with the provisions laid down in Annex II to the Protocol.
- Wastes and disused equipment will be removed from the Antarctic Treaty Area at the earliest opportunity.
- The Parties with active research programs in the Area will jointly develop contingency plans for incidents with potential to adversely impact on the environment.
- Regular and opportunistic collection of wind-dispersed litter will be undertaken.
- All equipment left in the field will be periodically reviewed for potential removal and its interim protection from wind dispersal and the like will be assessed.
- The rehabilitation of modified and disused sites will be investigated and progressed as appropriate.

6.2 Introduced species and wildlife disturbance

- As a minimum, activities will comply with the provisions relating to introduced species and conservation of flora and fauna laid down in Annex II to the Protocol.
- The Parties with active research programs in the Area will jointly develop quarantine policies and procedures for the Area.
- The need to maintain appropriate separation distances from wildlife will be taken into account in the planning and conduct of activities in the Area.

6.3 Data management

- The Parties with active research programs in the Area will jointly develop, and provide input to, a database for recording relevant management information and metadata records to assist the planning and coordination of activities.
- Efforts will be made to increase knowledge of the environmental values of the Area, and the impacts of human activities upon those values, and to apply this knowledge to the environmental management of the Area.

6.4 Science

- Cooperation with, and coordination of, scientific research will be undertaken wherever possible.

6.5 Monitoring

- The Parties with active research programs in the Area will jointly undertake monitoring activities to evaluate the effectiveness of this Management Plan.

6.6 Monuments

- Activities will be managed to ensure the preservation of existing monuments where such action is considered desirable.
- The placement of further cairns or monuments outside the Facilities Zone is prohibited.

6.7 Exchange of information

- To enhance cooperation and the coordination of activities in the Area, avoid duplication of activities, and facilitate the consideration of cumulative impacts, Parties active in the area will:
- distribute to other such Parties details of activities that may have a bearing on the operation of this management plan (that is, proposals to withdraw from or establish new research activities, proposals to construct new facilities, information obtained regarding non-governmental visits etc.); and
- provide reports to the CEP on the implementation and maintenance of this management plan.
- Other Parties proposing to conduct activities in the region, including non-governmental groups, will inform at least one of the Parties active in the ASMA of their intentions – in the spirit of the aims and objectives of this management plan.

Appendix 1. Environmental Code of Conduct

The actions of individuals contribute significantly to protecting the Antarctic environment. This Code of Conduct is intended to provide general guidelines to help minimise environmental impacts when in the Larsemann Hills, particularly for activities undertaken away from main station areas.

General principles

- The Antarctic environment is highly susceptible to the impacts of human activities, and as a general rule has much less natural ability to recover from disturbance than the environments of other continents; consider this when undertaking activities in the field.
- Everything taken into the field must be removed. This includes human wastes and also means avoiding the use or dispersal of foreign materials that are difficult to collect and remove. Strip down excess packaging before going off-station, to minimise waste taken into the field.
- The collection or disturbance of any biological or geological specimen or man-made artefact may only be undertaken with prior approval and, if required, in accordance with a permit.
- Wherever possible, accurately record the contact person, location (preferably by GPS) and usage details of all field activities (such as sample sites, field camps, depots, oil spills, markers, equipment etc.) for transfer to the management database.
- This Environmental Code of Conduct is intended as a guide for field activities, but cannot be expected to cover every situation – you should always consider your responsibilities and seek to minimise your impact on all aspects of the environment.

Travel

- Some biological communities and geological formations are especially fragile, even when concealed by snow; be alert and avoid such features when travelling to and between field locations.
- Vehicle and helicopter usage should be restricted to essential tasks to minimise: atmospheric emissions; track formation, physical disturbance of the land surface or biological communities; wildlife disturbance; and the potential for fuel spills.
- When vehicle use is essential, access should be restricted to sea ice, plateau areas and designated ice-free routes. Facilities should be accessed using existing routes.
- Vehicles and other equipment should be fully fuelled on station before departure, to reduce the need for refuelling in the field.
- Avoid refuelling or changing oil in windy conditions or in areas that might direct accidental spillage into lakes, vegetation or other sensitive areas, and always use fuel cans with nozzles/funnels.
- When travelling on foot, use established tracks and designated crossing points wherever possible.
- Avoiding making new tracks. Where established tracks do not exist, take the most direct route that avoids vegetated areas and delicate geological formations such as screes, sediments, streambeds and lake margins.

Wildlife

- Do not feed wildlife.
- Distances from wildlife at which disturbance may be expected to occur are provided in the table following. When moving on foot around wildlife, keep quiet, move slowly, and stay low to the ground – increase your distance if disturbance is evident.

Field camps

- Existing accommodation should be used where possible.
- Where necessary, campsites should be located as far away as practicable from lake shores, streambeds, vegetated sites and wildlife, to avoid contamination and/or disturbance.
- Ensure that equipment and stores are properly secured at all times to prevent foraging by wildlife and dispersion by high winds.
- Collect all wastes produced at field camps, including human wastes and grey water, for return to station and subsequent treatment or disposal.
- Solar or wind powered generators should be utilised wherever possible to minimise fuel usage.

Fieldwork

- All clothing and equipment must be meticulously cleaned before being brought to Antarctica and before moving between sampling locations, to prevent contamination, cross-contamination and the introduction and spread of foreign organisms.
- Do not build cairns, and minimise the use of other objects to mark sites; such markers should be removed on completion of the related task.
- When permitted to collect samples, adhere to the sample size specified in your permit and take samples from the least conspicuous location possible.
- Always use a drop sheet when sampling soils and backfill soil pits to prevent wind erosion and dispersal of deeper sediments.
- Take great care when handling chemicals and fuels, and ensure you have appropriate materials with you to catch and absorb spills.
- Minimise the use of liquid water and chemicals that could contaminate the isotopic and chemical record within lake or glacier ice.
- Scrupulously clean all sampling equipment to avoid cross-contamination between lakes.
- To prevent lake contamination, or toxic effects on the biota at the surface, avoid reintroducing large volumes of water obtained from lower in the water column; excess water or sediment should be returned to station for appropriate disposal or treatment.
- Ensure that sampling equipment is securely tethered, and leave nothing frozen into the ice that may cause later contamination.
- Do not wash, swim or dive in lakes; these activities contaminate the water body and physically disturb the water column, delicate microbial communities, and sediments.

Note: The guidelines laid down in this Environmental Code of Conduct shall not apply in cases of emergency. All activities in the Larsemann Hills must comply with the Antarctic Specially Managed Area (ASMA) management plan for the area. As required by Article 8 of the Protocol, all activities must undergo an environmental impact assessment prior to the activity being undertaken.

Distances at which disturbance may be expected to occur when approaching wildlife on foot

Species	Distance
Giant petrels and albatrosses, breeding / nesting	100 m
Emperor penguins (in colonies, huddling, moulting, with eggs or with chicks)	50 m
All other penguins (in colonies, moulting, with eggs or chicks)	30 m
Prions, petrels, skuas, on nests Seals with pups and seal pups on their own	20 m
Non breeding penguins and adult seals	5 m

Distance at which disturbance may be expected to occur when approaching wildlife using small vehicles (e.g. quads and skidoos)

Species	Distance
All wildlife	150 m

Distance at which disturbance may be expected to occur when approaching wildlife using tracked vehicles

Species	Distance
All wildlife	250 m

Distances at which disturbance may be expected to occur when approaching wildlife using aircraft

Birds	**Vertical** Single-engine helicopters 2500 ft (~ 750 m) Twin-engine helicopters 5000 ft (~1500 m)
	Horizontal ½ nm (~930 m)
Seals	**Vertical and horizontal** Single-engine helicopters 2500 ft (~ 750 m)
	Twin-engine helicopters 5000 ft (~1500 m)
	Twin-engine, fixed-wing aircraft 2500 ft (~750 m)

Appendix 2: National program contact details

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Appendix 3: Larsemann Hills references and select bibliography

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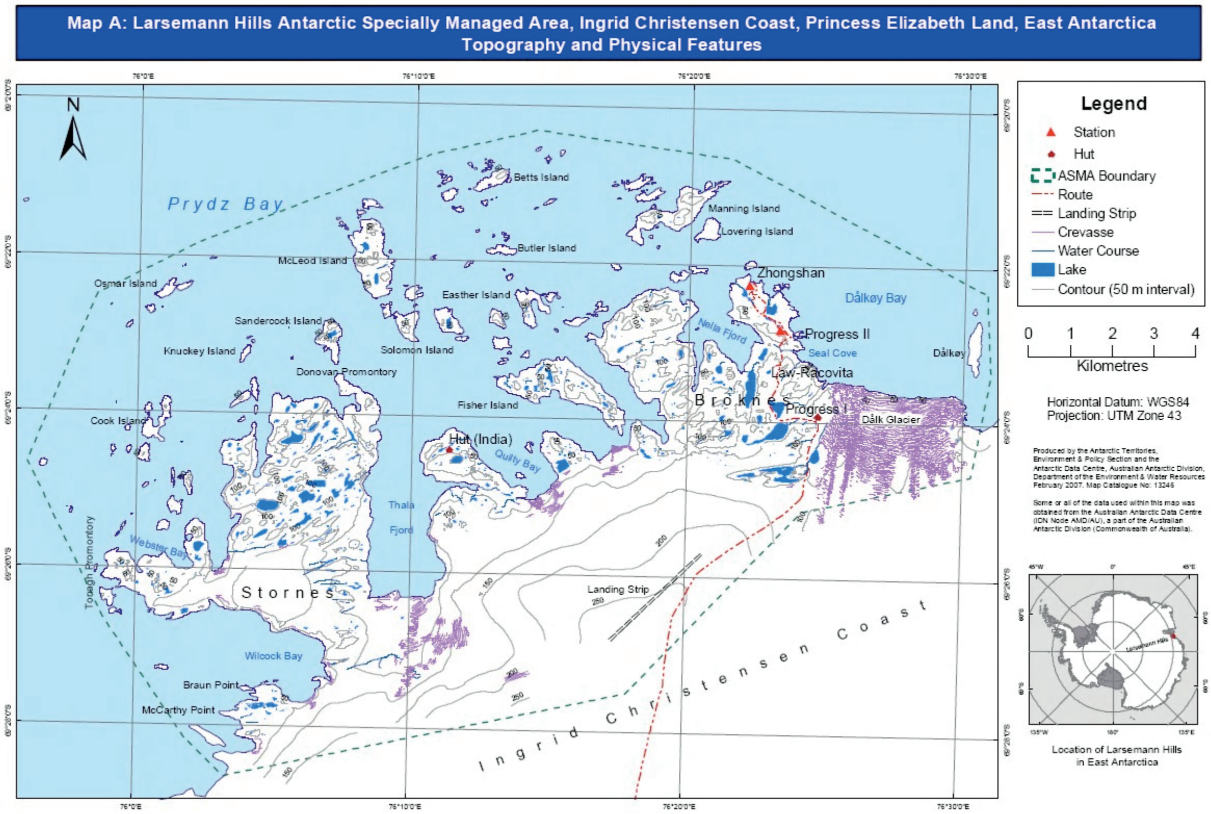
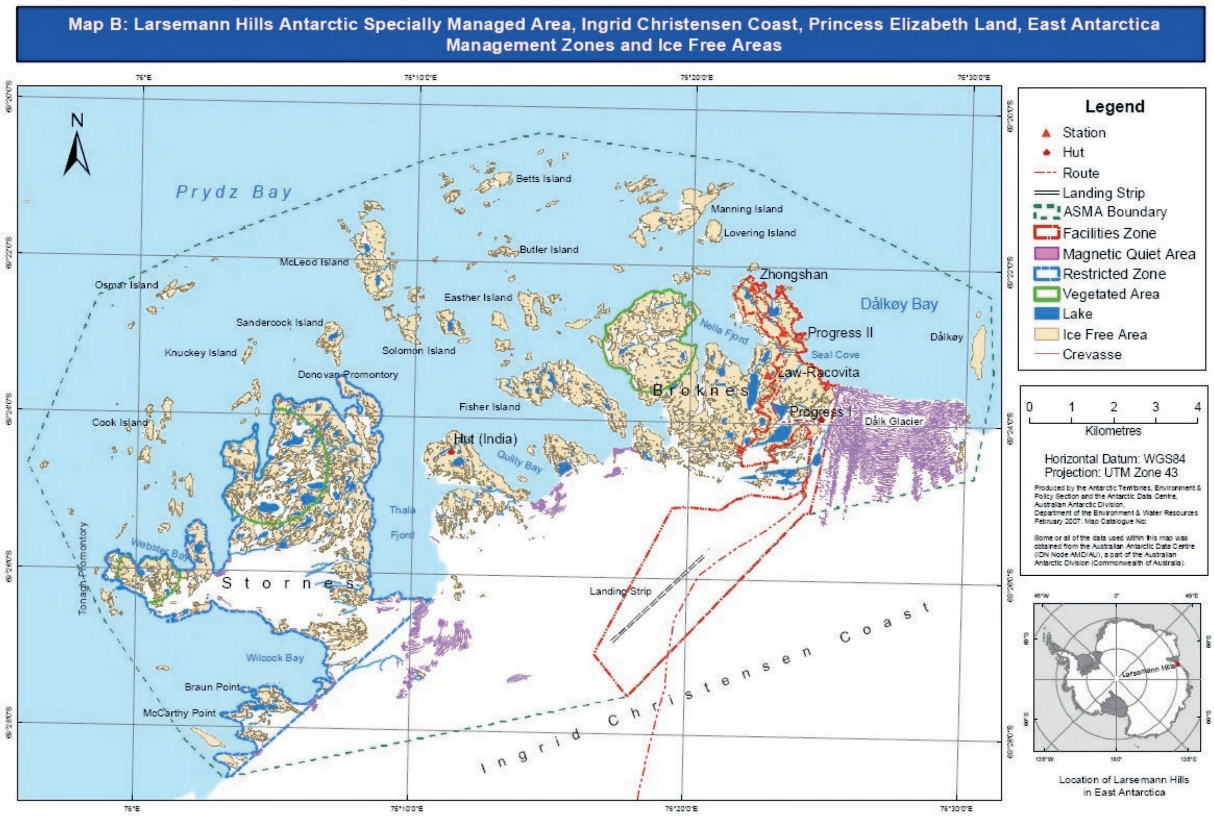
Appendix 4: Larsemann Hills maps

Map A. Topography and physical features

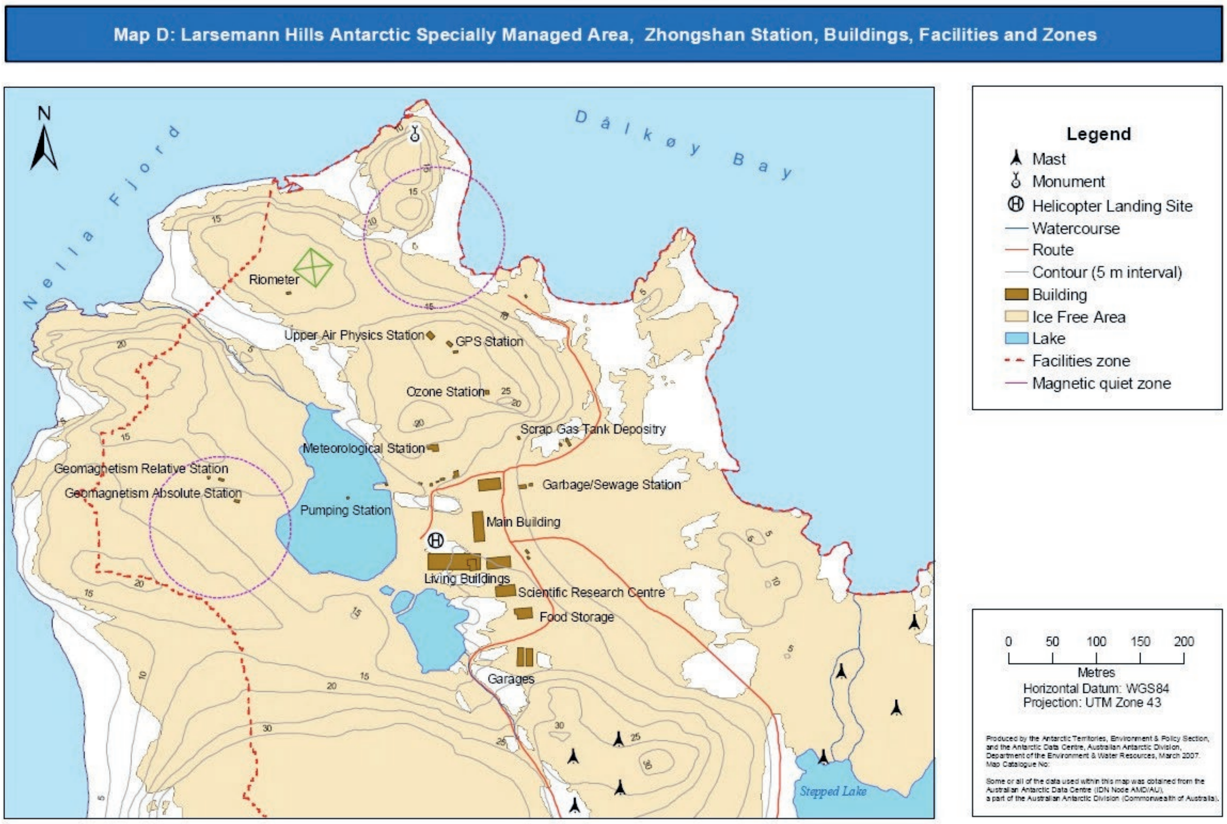


Map B. Management zones and ice free areas

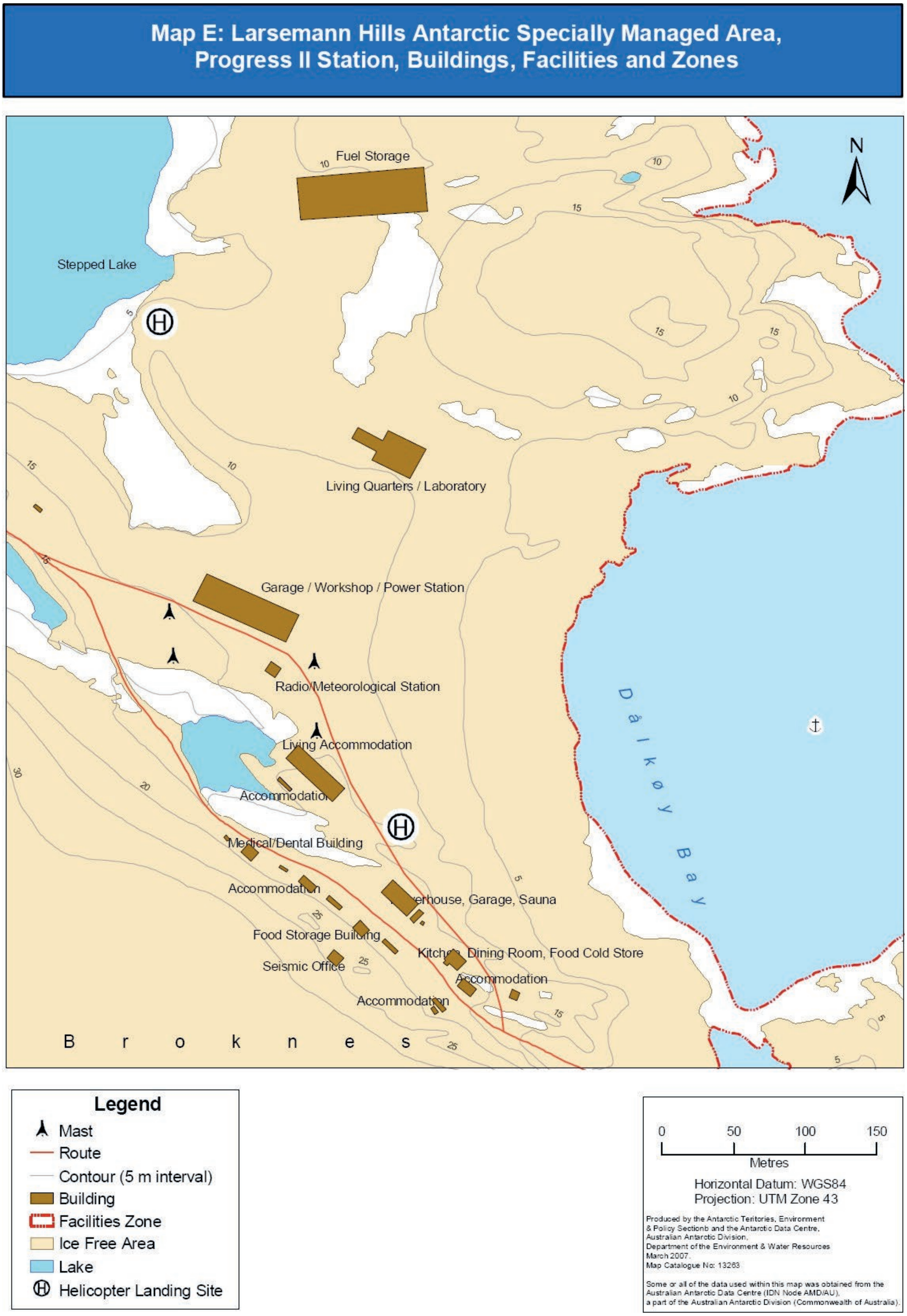


Map C. Detail of northern part of facilities zone

Map D. Zhongshan – buildings, facilities and zones



Map E. Progress II – buildings, facilities and zones



Detailed maps of the region are available via the Australian Antarctic Data Centre website at: *http://aadc-maps.aad.gov.au/aadc/mapcat/search_mapcat.cfm*

(Map References # 13130 and 13135)