

Management Plan For Antarctic Specially Protected Area No. 116 NEW COLLEGE VALLEY, CAUGHLEY BEACH, CAPE BIRD, ROSS ISLAND

1. Description of values to be protected

In 1985, two areas at Cape Bird, Ross Island were designated as SSSI No. 10, Caughley Beach (Recommendation XIII-8 (1985)) and SPA No. 20, New College Valley (Recommendation XIII-12 (1985)), following proposals by New Zealand that these areas should be protected because they contained some of the richest stands of moss and associated microflora and fauna in the Ross Sea region of Antarctica. This is the only area on Ross Island where protection is specifically given to plant assemblages and associated ecosystems.

At that time, SPA No. 20 was enclosed within SSSI No. 10, in order to provide more stringent access conditions to that part of the Area. In 2000, SSSI No. 10 was incorporated with SPA No. 20 by Measure 1 (2000), with the former area covered by SPA No. 20 becoming a Restricted Zone within the revised SPA No. 20. The boundaries of the Area were revised from the boundaries in the original recommendations, in view of improved mapping and to follow more closely the ridges enclosing the catchment of New College Valley. Caughley Beach itself was adjacent to, but never a part of, the original Area, and for this reason the entire Area was renamed as New College Valley, which was within both of the original sites.

The Area was redesignated by Decision 1 (2002) as Antarctic Specially Protected Area (ASPA) No. 116 and a revised Management Plan was adopted through Measure 1 (2006).

The boundaries of the Area closely follow the ridges enclosing the catchment of New College Valley and cover approximately 0.33 km². Moss in this Area is restricted to localised areas of water-flushed ground, with cushions and carpets up to 20 m² in area. A diverse range of algal species also inhabit streams in the Area, and springtails, mites and nematodes are plentiful on water surfaces and underneath rocks. The absence of lichens makes the species assemblage in this Area unique on Ross Island.

The susceptibility of mosses to disturbance by trampling, sampling, pollution or introductions of non-native species is such that the Area requires long-term special protection. Designation of this Area is intended to ensure examples of this habitat type are adequately protected from visitors and overuse from scientific investigations. The ecosystem at this site remains of exceptional scientific value for ecological investigations and the Restricted Zone is valuable as a reference site for future comparative studies.

2. Aims and objectives

Management of New College Valley, Caughley Beach, Cape Bird aims to:

- avoid degradation of, or substantial risk to, the values of the Area by preventing unnecessary human disturbance to the Area;

- preserve a part of the natural ecosystem of the Area as a reference area for the purpose of future comparative studies;
- allow scientific research on the ecosystem, in particular on mosses, algae and invertebrates in the Area, while ensuring protection from over-sampling;
- allow other scientific research in the Area provided it is for compelling reasons which cannot be served elsewhere;
- prevent or minimise the introduction to the Area of alien plants, animals and microbes;
- allow visits for management purposes in support of the aims of the Management Plan.

3. Management activities

The following management activities are to be undertaken to protect the values of the Area:

- Copies of this Management Plan, including maps of the Area, shall be made available at all adjacent operational research/field stations.
- Rock cairns or signs illustrating the location and boundaries of the Area, with clear statements of entry restrictions, shall be placed at appropriate locations on the boundary of the Area and the Restricted Zone to help avoid inadvertent entry.
- Markers, signs or structures erected within the Area for scientific or management purposes shall be secured and maintained in good condition, and removed when no longer required.
- Visits shall be made as necessary (preferably at least once every five years) to assess whether the Area continues to serve the purposes for which it was designated and to ensure management and maintenance measures are adequate.
- National Antarctic Programmes operating in the Area shall consult together with a view to ensuring the above management activities are implemented.

4. Period of designation

Designated for an indefinite period.

5. Maps

Map A: New College Valley, Caughley Beach, Cape Bird, Ross Island, Regional Topographic Map. Map specifications: Projection - Lambert conformal conic. Standard parallels - 1st 76° 40' 00" S; 2nd 79° 20' 00" S. Central Meridian - 166° 30' 00" E. Latitude of Origin - 78° 01' 16.211" S. Spheroid - WGS84.

Map B: New College Valley, Caughley Beach, Cape Bird, Ross Island, Vegetation Coverage Map. Map specification: Projection - Lambert conformal conic. Standard parallels – 1st - 76.6° S; 2nd -79.3° S. Spheroid - WGS84. Map includes vegetation coverage and streams.

6. Description of the Area

6(i) Geographical coordinates, boundary markers and natural features

Cape Bird is at the northwest extremity of Mount Bird (1,800 m), an inactive volcanic cone which is probably the oldest on Ross Island. New College Valley is located south of Cape Bird on ice-free slopes above Caughley Beach, and lies between two Adélie penguin colonies known as the Cape Bird Northern and Middle Rookeries (Map A). The Area, comprising veneered glacial moraines at the fore of the Cape Bird Ice Cap, consists of seaward dipping olivine-augite basalts with scoriaceous tops erupted from the main Mount Bird cone.

The northwest corner of the north boundary of the Area is approximately 100 m south of the Cape Bird hut (New Zealand) and is marked by an ASPA sign post ($77^{\circ} 13.128'S$, $166^{\circ} 26.147'E$) (Map B). The north boundary of the Area extends upslope and eastward toward a prominent terminal moraine ridge, approximately 20 m from the Cape Bird Ice Cap and is marked with a rock cairn ($77^{\circ} 13.158'S$, $166^{\circ} 26.702'E$).

The eastern boundary follows the terminal moraine ridge from the rock cairn ($77^{\circ} 13.158'S$, $166^{\circ} 26.702'E$) southeast until the ridge disappears where it joins the Cape Bird Ice Cap. The boundary continues southeast following the glacier edge to the southern boundary.

The southern boundary is a straight line crossing the broad southern flank of New College Valley, and is marked with rock cairns at the south-western corner of the Area ($77^{\circ} 13.471'S$, $166^{\circ} 25.832'E$) and the south-eastern corner of the area on the hilltop 100 m from the Cape Bird Ice Cap glacier edge ($77^{\circ} 13.571'S$, $166^{\circ} 27.122'E$).

The western boundary of the Area follows the top of the coastal cliffs of Caughley Beach from the south-western corner rock cairn ($77^{\circ} 13.471'S$, $166^{\circ} 25.832'E$) for a distance of 650 m to the northwest corner of the Area ($77^{\circ} 13.128'S$, $166^{\circ} 26.147'E$) where the ASPA signpost is located.

Based on the Environmental Domain Analysis for Antarctica (Resolution 3 (2008)), New College Valley, Caughley Beach is located within Environment S *McMurdo South Victoria Land geologic*.

Northwest-facing New College Valley drains meltwater from the Cape Bird Ice Cap during the summer. Streams in the Area are fed by melt from persistent summer snow drifts and have eroded their own shallow gullies and channels. The ground is largely covered by stones and boulders of volcanic origin which have been reworked by glacial action.

The Area contains the most extensive ephemeral stream course distributions of the moss *Hennediella heimii* on Ross Island. Surveys have shown that this moss, together with much lower occurrences of two other species – *Bryum subrotundifolium* and *Bryum pseudotriquetrum* – are confined almost entirely to the stream courses across the steep till and scoria covered slopes (Map B). The mosses are generally associated with algal growths, namely rich, red-brown oscillatorian felts and occasional reddish-black growths of *Nostoc commune*. The Area includes the full course of three stream systems that contain significant growths of algae, together with the mosses.

The Area supports a terrestrial invertebrate community including populations of springtails *Gomphiocephalus hodgsonii* (Collembola: Hypogastruridae), mites *Nanorchestes antarcticus*

and *Stereotydeus mollis* (Acari: Prostigmata) and nematodes (*Panagrolaimus davidi*, *Plectus antarcticus*, *Plectus frigophilus*, *Scottinema lindsayae* and *Eudorylaimus antarcticus*) with the presence of rotifers, tardigrades, and ciliate and flagellate protozoa noted. The distribution of terrestrial invertebrates at this site is related to the abiotic environment with most arthropod species being associated with macroscopic vegetation or soil algal biomass level, although this relationship does not describe the distribution of all taxa.

Skuas (*Catharacta maccormicki*) frequently rest on Caughley Beach and overfly, land and nest within the Area. Adélie penguins (*Pygoscelis adeliae*) from the nearby rookeries do not nest in the Area, but have been observed occasionally to traverse across New College Valley.

6(ii) Special zones within the Area

An area of New College Valley is designated as a Restricted Zone in order to preserve part of the Area as a reference site for future comparative studies, while the remainder of the Area (which is similar in biology, features and character) is more generally available for research programmes and sample collection. The Restricted Zone encompasses ice-free slopes within New College Valley above Caughley Beach some of which are north-facing with snow drifts which provide a ready supply of melt water to foster moss and algal growth.

The northwest corner (77° 13.164'S, 166° 26.073'E) of the Restricted Zone is 60 m to the south and across a small gully from the northwest corner of the Area. The north boundary of the Restricted Zone extends 500 m upslope from the northwest corner to a cairn (77° 13.261'S, 166° 26.619'E), then following a faint but increasingly prominent ridge southeast to a point in the upper catchment of New College Valley marked by a cairn approximately 60 m from the ice terminus of the Cape Bird Ice Cap (77° 13.368'S, 166° 26.976'E). The Restricted Zone boundary extends 110 m southwest across the valley to a cairn marking the southeast corner of the Restricted Zone (77° 13.435'S, 166° 26.865'E). The south boundary of the Restricted Zone extends in a straight line from this cairn (77° 13.435'S, 166° 26.865'E) 440 m northwest down a broad and relatively featureless slope to the southwest corner of the Area (77° 13.328'S, 166° 26.006'E). A cairn is placed on the southwest boundary of the Restricted Zone to mark the lower position of the south boundary (77° 13.226'S, 166° 25.983'E).

Access to the Restricted Zone is allowed only for compelling scientific and management purposes that cannot be served by visits elsewhere in the Area.

6(iii) Location of structures within and adjacent to the Area

Structures known to exist within the Area include a United States Navy Astrofix marker, cairns marking the boundaries of the Area and the Restricted Zone, a signpost situated at the northwest corner of the Area and an approximately one meter square wooden frame marking the site of an experimental oil spill from 1982.

A field hut (New Zealand), stores hut and toilet are located north of the northwest corner of the Area (Map B).

6(iv) Location of other protected areas in the vicinity

The nearest protected areas are:

- Lewis Bay, Mount Erebus, Ross Island (ASPA No. 156), approximately 25 km SE;
- Tramway Ridge, Mount Erebus, Ross Island (ASPA No. 130) 30 km SSE;
- Cape Crozier, Ross Island (ASPA No. 124) 75 km SE;

- Cape Royds, Ross Island (ASPA No. 121 and No. 157) and Cape Evans, Ross Island (ASPA No. 155) 35 km and 45 km south on Ross Island respectively; and
- Beaufort Island, McMurdo Sound, Ross Sea (ASPA No. 105) 40 km to the north.

7. Terms and conditions for entry Permits

Entry into the Area is prohibited except in accordance with a Permit issued by an appropriate national authority. Conditions for issuing a Permit to enter the Area are that:

- outside of the Restricted Zone, it is issued only for scientific study of the ecosystem, or for compelling scientific reasons that cannot be served elsewhere, or for essential management purposes consistent with the Management Plan objectives such as inspection or review;
- access to the Restricted Zone is allowed only for compelling scientific or management reasons that cannot be served elsewhere in the Area;
- the actions permitted are not likely to jeopardise the ecological or scientific values of the Area or other permitted activities;
- any management activities are in support of the objectives of the Management Plan;
- the actions permitted are in accordance with the Management Plan;
- the Permit, or a copy, shall be carried within the Area;
- a visit report shall be supplied to the authority named in the Permit;
- the Permit shall be issued for a stated period.

7(i) Access to and movement within or over the Area

Helicopters are prohibited from landing within the Area. Two helicopter landing sites are located outside the Area. Between October to February, the preferred landing site is below the cliffs on Caughley Beach, 100 m west of the west boundary of the Area (Maps A and B). Between March and September, an alternative helicopter landing site is located adjacent to the Cape Bird field hut (New Zealand), above Caughley Beach (Map B).

Between October and February the preferred flight path is an approach from the south upslope from Middle Rookery (Map A). Under certain wind conditions, flights north of the helicopter pad may be necessary, and in this case should follow the recommended aircraft approach and departure routes, and be in accordance with the 'Guidelines for the Operation of Aircraft Near Concentrations of Bird in Antarctica' (Resolution 2, 2004) to the maximum extent possible. See Map A for the recommended aircraft approach routes into and out of Cape Bird.

Overflight of the Area lower than 50 m (~150 ft) above ground level is prohibited. Hovering over the Area is not permitted lower than 100 m (~300 ft) above ground level. Use of helicopter smoke grenades within the Area is prohibited.

Vehicles are prohibited within the Area and all movement within the Area should be on foot. Access into the Area should preferably follow the track from the Cape Bird Hut (New Zealand). Visitors should avoid areas of visible vegetation and care should be exercised walking in areas of moist ground, particularly the stream course beds, where foot traffic can easily damage sensitive soils, plant and algal communities, and degrade water quality. Visitors should avoid walking on such areas by walking on ice or rocky ground. Pedestrian

traffic should be kept to the minimum necessary consistent with the objectives of any permitted activities and every reasonable effort should be made to minimise effects.

Access to regions south of the Area from the Cape Bird Hut should be made by a route below the cliffs along Caughley Beach.

7(ii) Activities which may be conducted in the Area

- Compelling scientific research which cannot be undertaken elsewhere and which will not jeopardise the ecosystem or values of the Area or interfere with existing scientific studies;
- Essential management activities, including monitoring and inspection.

7(iii) Installation, modification or removal of structures

No structures are to be erected within the Area, or scientific equipment installed, except for compelling scientific or management reasons, as specified in a Permit. All markers, structures or scientific equipment installed in the Area must be authorised by Permit and clearly identified by country, name of the principal investigator or agency, year of installation and date of expected removal. All such items should be free of organisms, propagules (e.g. seeds, eggs) and non-sterile soil, and be made of materials that pose minimal risk of contamination of the Area. Removal of specific structures or equipment for which the Permit has expired shall be a condition of the Permit.

7(iv) Location of field camps

Camping within the Area is prohibited. A field hut (New Zealand), stores hut and toilet are located north of the northwest corner of the Area (Map B).

7(v) Restrictions on materials and organisms which may be brought into the Area

No living animals, plant material or microorganisms shall be deliberately introduced into the Area and precautions listed in 7(ix) shall be taken against accidental introductions. No poultry products shall be brought into the Area. No herbicides or pesticides shall be brought into the Area. Any other chemicals, including radio-nuclides or stable isotopes, which may be introduced for scientific or management purposes specified in the Permit, shall be removed from the Area at or before the conclusion of the activity for which the Permit was granted. Fuel or other chemicals shall not be stored in the Area, unless required for essential purposes connected with the activity for which the Permit has been granted, and must be contained within an emergency cache authorized by an appropriate authority. All materials introduced shall be for a stated period only, shall be removed at or before the conclusion of that stated period, and shall be stored and handled so that risk of their introduction into the environment is minimised.

7(vi) Taking or harmful interference with native flora or fauna

Taking of, or harmful interference with native flora or fauna is prohibited, except in accordance with a separate Permit issued in accordance with Annex II of the Protocol on Environmental Protection to the Antarctic Treaty. Where taking or harmful interference with animals is involved this should, as a minimum standard, be in accordance with the SCAR Code of Conduct for the Use of Animals for Scientific Purposes in Antarctica.

7(vii) The collection or removal of materials not imported by the Permit holder

Material may be collected or removed from the Area only in accordance with a permit and should be limited to the minimum necessary to meet scientific or management needs.

Similarly, sampling is to be carried out using techniques which minimise disturbance to the Area, as well as duplication. Material of human origin likely to compromise the values of the Area, which was not brought into the Area by the Permit holder or otherwise authorised and which is not an historical artefact or abandoned relic, may be removed from any part of the Area, including the Restricted Zone, unless the environmental impact of removal is likely to be greater than leaving the material *in situ*. Where the environmental impact of removal is likely to be greater than leaving the material *in situ*, the appropriate national authority must be notified and approval obtained.

7(viii) Disposal of waste

All wastes, including all human wastes, shall be removed from the Area.

7(ix) Measures that may be necessary to continue to meet the aims and objectives of the Management Plan

Permits may be granted to enter the Area to:

- carry out biological monitoring and Area inspection activities, which may involve the collection of a small number of samples or data for analysis or review;
- erect or maintain signposts, structures or scientific equipment; or
- carry out management activities.

Any specific sites of long-term monitoring shall be appropriately marked on site and on maps of the Area. A GPS position should be obtained for sites of long-term monitoring and scientific sampling for lodgement with the Antarctic Master Directory system through the appropriate national authority. If appropriate, metadata should also be provided for the Antarctic Master Directory system through the appropriate national authority.

To help maintain the ecological and scientific values of the isolation and relatively low level of human impact at the Area, visitors shall take special precautions against introductions. Of particular concern are microbial or vegetation introductions sourced from soils at other Antarctic sites, including stations, or from regions outside Antarctica. To minimise the risk of introductions, visitors shall thoroughly clean footwear and any equipment to be used in the area particularly sampling equipment and markers before entering the Area.

7(x) Requirements for reports

The principal permit holder for each visit to the Area shall submit a report to the appropriate national authority as soon as practicable, and no later than six months after the visit has been completed. Such visit reports should include, as applicable, the information identified in the recommended visit report form [contained in Appendix 4 of the Guide to the Preparation of Management Plans for Antarctic Specially Protected Areas appended to Resolution 2 (1998)] [available from the website of the Secretariat of the Antarctic Treaty www.ats.aq].

If appropriate, the national authority should also forward a copy of the visit report to the Party that proposed the Management Plan, to assist in managing the Area and reviewing the Management Plan. Parties should maintain a record of activities and report them in the Annual Exchange of Information. Parties should, wherever possible, deposit originals or copies of such original visit reports in a publicly accessible archive to maintain a record of usage, for the purposes of any review of the management plan and in organising the scientific use of the Area.

8. Bibliography

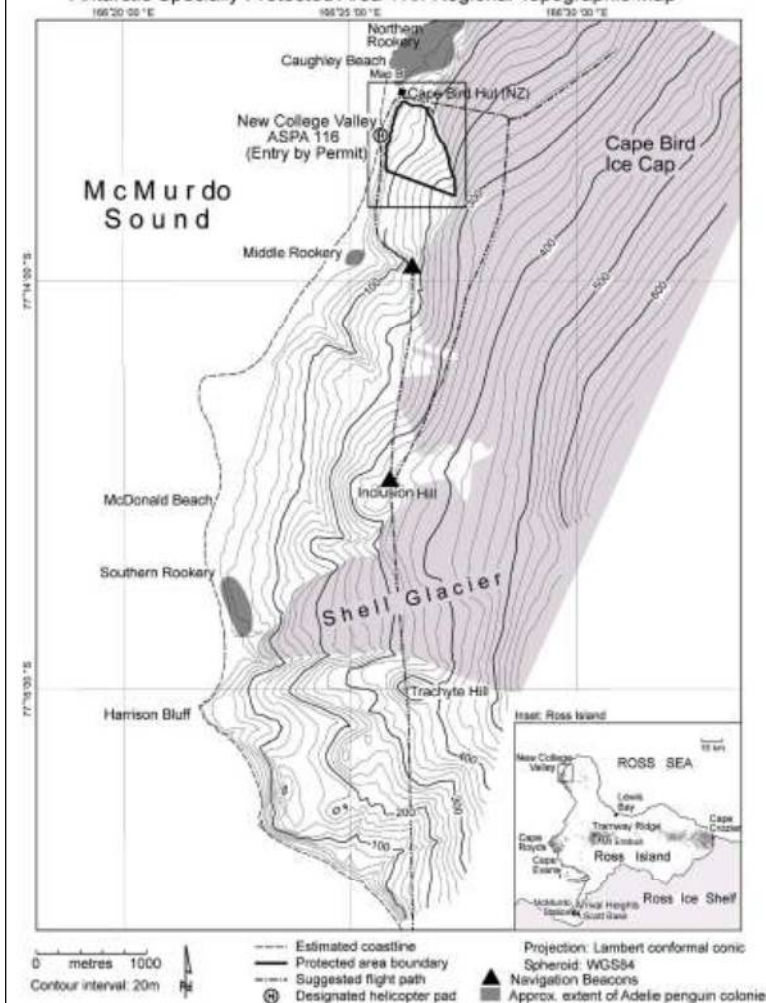
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Map A - New College Valley, Caughley Beach, Cape Bird, Ross Island
 Antarctic Specially Protected Area 116: Regional Topographic Map



**Map B - New College Valley, Caughley Beach, Cape Bird, Ross Island
Antarctic Specially Protected Area 116: Vegetation Coverage Map**



Management Plan for Antarctic Specially Protected Area No. 120

POINTE-GÉOLOGIE ARCHIPELAGO, TERRE ADÉLIE

Jean Rostand, Le Mauguen (former Alexis Carrel), Lamarck and Claude Bernard Islands, The Good Doctor's Nunatak and breeding site of Emperor Penguins

1. Description of values to be protected

In 1995, four islands, a nunatak and a breeding ground for emperor penguins were classified as an Antarctic Specially Protected Area (Measure 3 (1995), ATCM XIX, Seoul) because they were a representative example of terrestrial Antarctic ecosystems from a biological, geological and aesthetics perspective. A species of marine mammal, the Weddell seal (*Leptonychotes weddelli*) and various species of birds breed in the area: emperor penguin (*Aptenodytes forsteri*); Antarctic skua (*Catharacta maccormicki*); Adélie penguins (*Pygoscelis adeliae*); Wilson's petrel (*Oceanites oceanicus*); giant petrel (*Macronectes giganteus*); snow petrel (*Pagodroma nivea*), cape petrel (*Daption capense*).

Well-marked hills display asymmetrical transverse profiles with gently dipping northern slopes compared to the steeper southern ones. The terrain is affected by numerous cracks and fractures leading to very rough surfaces. The basement rocks consist mainly of sillimanite, cordierite and garnet-rich gneisses which are intruded by abundant dikes of pink anatexites. The lowest parts of the islands are covered by morainic boulders with a heterogeneous granulometry (from a few cm to more than a m across).

Long-term research and monitoring programs of birds and marine mammals have been going on for a long time already (since 1952 or 1964 according to the species), currently supported by the French Polar Institute Paul Émile Victor (IPEV) and the French National Centre for Scientific Research (CNRS). This has enabled the implementation of a population database which is particularly useful in view of the long timescale of the observations. It is maintained and used by the Centre d'Etudes Biologiques de Chize (CEBC-CNRS). Within this context, human scientific presence in the protected area is currently estimated at four people for a few hours, three times a month between the 1st November and the 15th February, and, inside the emperor penguin colony itself, at two people for a few hours between the 1st April and the 1st November.

Among the approximately thirty emperor penguin breeding sites on record, this is the only one located adjacent to a permanent station. It is therefore a providential spot to study this species and its environment.

2. Aims and objectives

Management of the Cape Géologie Archipelago Specially Protected Area aims at:

- preventing disturbance in the area due to the proximity of the Dumont d'Urville Station;
- avoiding any major changes to the structure and composition of flora and fauna and the association of different species of vertebrates harbored in the area, which is one of the most representative for both faunistic and scientific interest on Adélie Coast;
- permitting scientific research in the field of marine and terrestrial biology, i.e., ethology, ecology, physiology and biochemistry, demographic monitoring of marine birds and mammals, and environmental impact assessment of surrounding human activities;

- permitting scientific or technological research programmes in areas other than those previously mentioned (e.g. geology) or management programmes, with particular attention to the scheduling of visits in order to minimise the impacts on the flora and fauna.
- controlling the logistic operations related to the activities of the nearby Dumont d'Urville station, which may require temporary access to the ASPA.

3. Management activities

The following management activities will be undertaken to protect the values of the Area:

The present management plan is kept under periodical review to ensure that the values of the ASPA are monitored. Any activity carried out in the area undergoes an environmental impact assessment before being undertaken.

All members of staff staying at or in transit at the Dumont d'Urville base will be duly informed of the existence of the ASPA, of its geographical boundaries, of the entry restrictions in place and of the current management plan. To ensure this, a sign displaying a map of the area and listing the restrictions and relevant management measures shall be displayed prominently at the Dumont d'Urville station.

Copies of this management plan shall also be available in each of the four Treaty languages at the Dumont d'Urville station.

Information related to each incursion into the ASPA, namely a minima: activity undertaken or reason for presence, number of people involved, duration of stay, is recorded by the head of the Dumont d'Urville station.

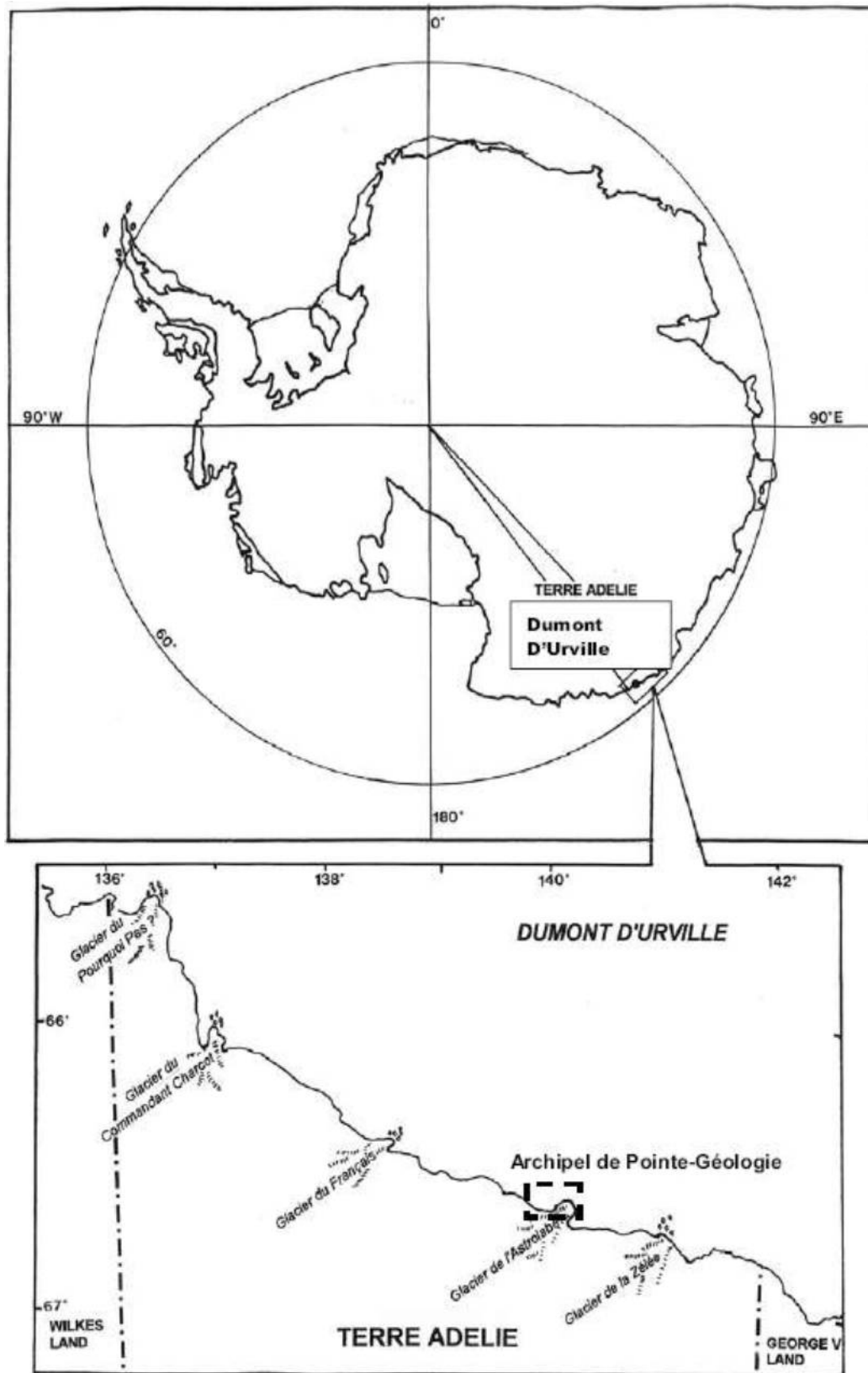
4. Period of Designation

The Area is designated as an Antarctic Specially Protected Area (ASPA) for an indefinite period.

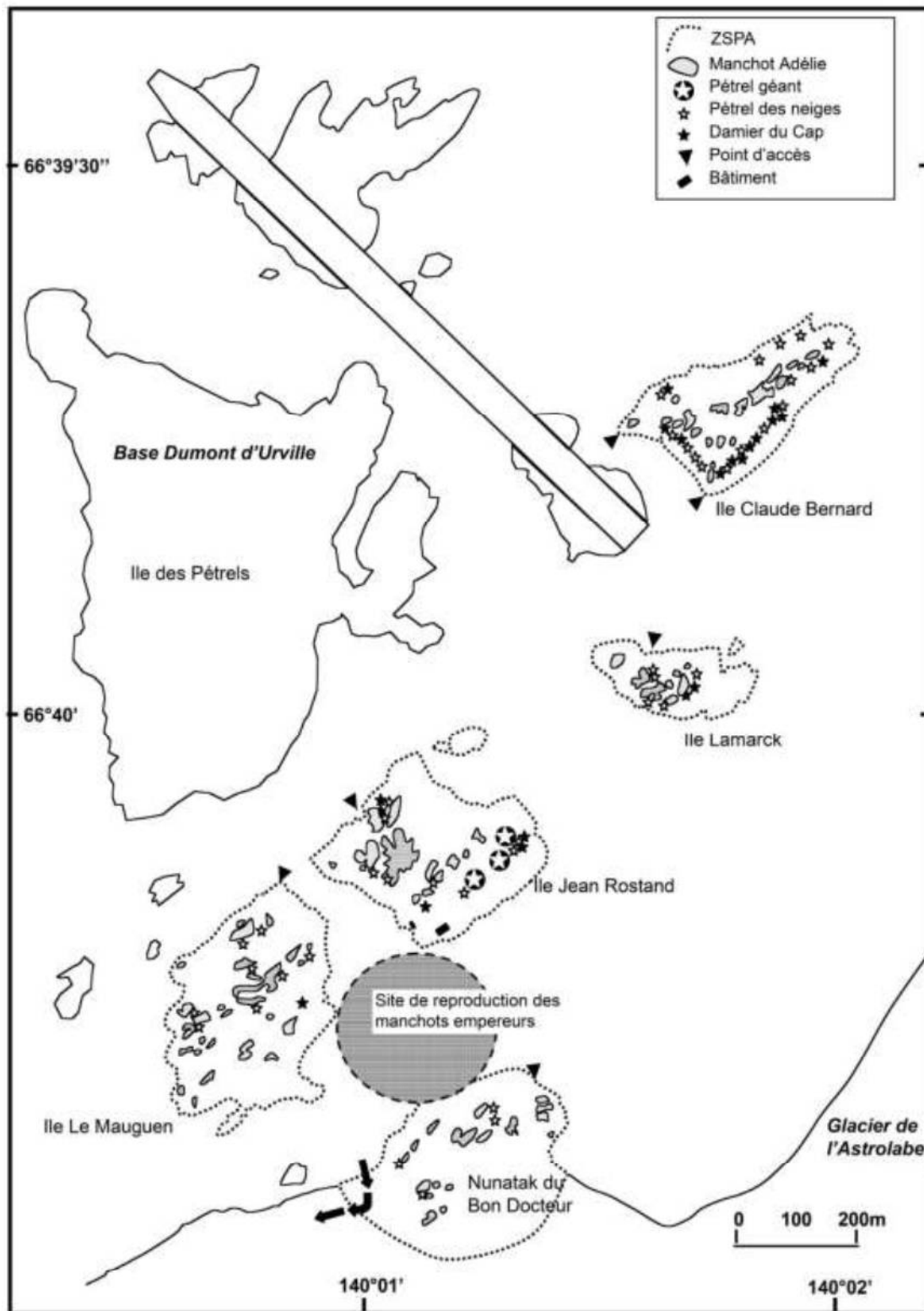
5. Maps

Map 1 shows the geographical location of Terre Adélie in the Antarctic and the location of the Cape Geology Archipelago on the Terre Adélie coast.

On Map 2 of the Cape Geology Archipelago, the dotted line indicates the boundary of the ASPA within the archipelago.



Map 1 - Location of the Cape Geology Archipelago, Terre Adélie (Antarctica).



Map 2 - Location of bird colonies (except skua territories and Wilson's petrels nests) within the Cape Geology Archipelago ASPA. The dotted lines show the ASPA boundary. Possible access of land vehicles to the continent via the Good Doctor's Nunatak is shown by means of arrows.

6. Description of the Area and Identification of Sectors

6(i) Geographic coordinates, boundary markers and natural features

The ASPA 120 is located along the Terre Adélie coast, in the heart of the Cape Geology Archipelago, coastal area of Adélie Coast (140° - 140°02'E ; 66°39'30'' à 66°40'30'' S). It comprises the following territories:

- Jean Rostand Island,
- Le Mauguen (formerly Alexis Carrel) Island,
- Lamarck Island,
- Claude Bernard Island,
- the 'Bon Docteur' Nunatak,
- and the Emperor penguins breeding grounds, on the pack ice which surrounds the islands in winter.

As a whole, the surface of the rock outcrops does not exceed 2 km². The highest points are distributed along North-East-South-West ridges (C. Bernard Island: 47.6 m; J.Rostand Island 36.39 m; Le Mauguen (formerly Alexis Carrel) Island: 28.24 m Nunatak: 28.50 m).

During the summer, the pack ice between the islands disappears, and only the Southern flanks of the islands are still covered by firs. The area is then clearly limited by natural markers (island outlines and rocky outcrops).

No tracks or roads exist in the area.

6(ii) Identification of restricted or prohibited zones

Access to any part of the area is prohibited unless authorized by a permit.

Entry restrictions to different sites within the ASPA are determined according to the distribution of bird species (Table 1), the timing of their presence on breeding grounds (Table 2) and their specific sensitivity (Table 3). Location of breeding colonies is shown on the map. Birds are mainly present during the austral summer, except for the emperor penguins, which breed in winter.

Among the bird species present on the Cape Geology Archipelago, the emperor penguin and the southern giant petrel only breed inside the ASPA. Since the ASPA was established in 1995, the populations of those two species are now stable or slightly increasing (Table 3). However, long-term forecasts suggest that the high protection status should be maintained through the current management plan.

The case of Rostand Island

The establishment of the Dumont d'Urville station has resulted in a drastic decrease of the populations of emperor penguins and southern giant petrels in the Cape Geology Archipelago. The breeding colony on Petrel Island disappeared completely during the first years when the base was being set up in close proximity to this colony (building extensions, intensification of helicopter flights, installation and replacement of fuel storage tanks). Currently, 100% of the population breeds inside the ASPA, in the South-Eastern part of Rostand Island. The birds are present in an area defined by the NE-SW ridge going through the 33.10 metre and the 36.39 metre marks North West of the colony, marked on the floor with stakes. Access to this breeding area is strictly prohibited, except to ornithologists holding a Permit allowing access once a year when southern giant petrel chicks are being banded. Access to the rest of Rostand Island is authorised throughout the year to Permit Holders.

The case of the emperor penguin colony

The significant decrease of emperor penguins by the end of the 1970s seems to have been due to long weather anomalies between 1976 and 1982 causing a significant decrease in the surface area of the pack ice. For the last fifteen years, the emperor penguin breeding population has been slightly increasing in parallel with an increase in pack ice surface area in the Terre Adélie sector. No one, except Permit Holders, is allowed to approach or to disturb the emperor penguin colony in any manner during the period when they are present at the breeding grounds, from March to mid-December when the chicks fledge. It is recommended that the minimum distance between authorised observers and the colony should be 20 m.

The emperor penguin colony is not always at the same site and moves about on the pack ice during winter. The protection zone for these animals is therefore defined by the sites where birds are present (colony or groups of individuals), with an additional 40 m buffer zone.

6(iii) Location of structures in the Area

Prévost hut and a shelter are located on Rostand Island. There are no other buildings anywhere else in the Area.

There is no other protected area within 50 km of the Pointe-Géologie ASPA No. 120.

Table 1. Number of seabird breeding pairs within ASPA No. 120 (count done during the 2010/2011 breeding cycle). The population breeding within the ASPA compared to that of the Cape Geology (PG) population as a whole is also mentioned (Source: unpublished data CEBC-CNRS on the breeding cycle 2010/2011 except for Wilson's storm petrels, data Micol & Jouventin 2001¹)

Site	Emperor penguin	Adélie penguin	South Polar skua	Snow petrel	Cape petrel	Wilson's storm petrel	Southern giant petrel
C. Bernard	--	3360	7	214	238	178	--
Lamarck	--	1160	1	38	36	45	--
J. Rostand	--	3994	7	61	46	35	15-18
Le Mauguen (formerly Alexis Carrel)	--	3478	15	21	2	72	
Nunatak	---	1831	1	5	--	41	--
Winter pack ice between islands	2838	--	--	--	--	--	--
ASPA TOTAL	2838	13823	31	369	322	371	15-18
PG TOTAL	2838	32746	67	1066	516	1200	15-18
% ASPA/PG	100	42	46	32	62	31	100

¹ Micol T. et Jouventin P 2001, Long-term population trends in seven Antarctic seabirds at Pointe Géologie (Terre Adélie) *Polar Biology* **24** :175-185.

Table 2. Presence of birds on breeding grounds

	Emperor penguin	Adelie penguin	South Polar skua	Snow petrel	Cape petrel	Wilson's storm petrel	Southern giant petrel
First arrival	March	October	October	September	October	November	July
First egg laying	May	November	November	November	November	December	October
Last departure	Mid-December	March	March	March	March	March	April

Table 3. Sensitivity to disturbance caused by human beings and changes in populations of the Cape Geology Archipelago (Sources : unpublished data CEBC-CNRS, Thomas 1986², and Micol & Jouventin 2001 for data on Wilson's storm petrel)

	Emperor penguin	Adelie penguin	South Polar skua	Snow petrel	Cape petrel	Wilson's storm petrel *	Southern giant petrel
Sensitivity ²	High	Medium	Medium	Medium	High	High	High
Trend 1952-1984	Diminishing	Stable	Stable	?	?	?	Diminishing
Trend 1984-2000	Stable	Increasing	Increasing	Stable	Stable	?	Stable
Trend 2000-2011	Slightly increasing	Increasing	Increasing	Increasing	Stable	?	Stable
Trend 1952-2011	Diminishing	Increasing	Increasing	Stable	Stable	?	Diminishing

7. Permit Conditions

- Entry into the Area is subject to obtaining a Permit issued by an appropriate national authority.
- Permits may be granted to carry out various scientific research, site monitoring or inspection activities, or one-off logistical operations. For each single entry, permits will authorize the scope of the tasks to be undertaken, their time-span and the maximum number of people commissioned to enter the Area (Permit Holders and any accompanying persons who may be needed for professional or safety reasons).

7(i) Access to and movement within the Area

- No helicopters or terrestrial vehicles are authorized within the Area. No overflights over the Area, either by helicopters or other aircraft are authorized. Access to the Area is only permitted by foot or by light watercraft (in summer).
- The transit traffic of land vehicles between the Dumont d'Urville station, on Petrel Island, and the Cap Prudhomme station on the continent, will normally take place in winter, following a straight line across the pack ice. During the very rare occasions when sea-ice conditions do not allow these transits to be made safely, a route along the western edge of the □ Bon Docteur □ Nunatak □ can be permitted exceptionally, as indicated on Map 2. The vehicles will then follow the distance instructions regarding emperor penguins as mentioned in Section 6(ii).

² Thomas T., 1986 L'effectif des oiseaux nicheurs de l'archipel de Pointe Géologie (Terre Adélie) et son évolution au cours des trente dernières années. *L'oiseau RFO* **56** :349-368.

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- The movement of authorised persons within the Area shall, in any case, be limited, in order to avoid unnecessary disturbance to birds, and to ensure that breeding areas or their access are not damaged or endangered.

7(ii) Activities which are or may be conducted within the Area, including restrictions on time and place

- Compelling scientific activities which cannot be conducted elsewhere.
- Essential management and logistical activities
- Educational and scientific outreach activities (filming, photography, sound recording...)

7(iii) Installation, modification or removal of structures

- No structures are to be erected or scientific equipment installed in the Area except for compelling scientific reasons or management activities as authorized by an appropriate national authority.
- The possible modification or dismantling of installations currently on Rostand Island can only proceed after authorisation.

7(iv) Location of field camps

Only safety tents should be erected when security reasons so require it provided all precautions have been taken in order to avoid damaging or disturbing the fauna.

7(v) Restriction on materials and organisms which may be brought into the Area

- According to the provisions set forth in Annex II to the Madrid Protocol, no living animals or plant materials, poultry products, including dried eggs, shall be introduced into the Area.
- No chemicals shall be brought into the Area, except chemicals which may be introduced for a compelling scientific purpose as specified in the Permit. Any chemical introduced shall be removed from the Area at or before the conclusion of the activity for which the Permit was granted.
- Fuel, food and other materials are not to be stored in the Area, unless required for compelling purposes connected with the activity for which the Permit has been granted. Such materials are to be removed when no longer required. Permanent storage is not permitted.

7(vi) The taking of or harmful interference with flora and fauna

- Taking of or harmful interference with native flora and fauna is prohibited except in accordance with a specific Permit. In the case of authorised taking or interference, the requirements of article 3 of Annex II of the Protocol will be used as the minimum standard.

7 (vii) The collection or removal of anything not brought into the Area by the Permit Holder

- Collection or removal of anything not brought into the Area by a Permit Holder is prohibited unless specifically mentioned in the Permit.
- Debris of man-made origin may be removed from the Area and dead or pathological specimens of fauna or flora cannot be removed unless explicitly mentioned in the Permit.

7(viii) Disposal of waste

- All waste produced must be removed from the Area after each visit.

7(ix) Measures that may be necessary to ensure that the aims and objectives of the Management Plan can continue to be met

- Visits to the Area shall be restricted to scientific, logistic and management objectives only.

7(x) Requirements for reports of visits to the Area

Parties should ensure that the principal Holder of each Permit issued submits to the appropriate authority a report describing the activities undertaken. Such reports, which must be submitted within a maximum of six months following a visit to the Area, should include, as appropriate, the information identified in the Visit Report form suggested by SCAR.

Parties should maintain a record of such activities and, in the Annual Exchange of Information, should provide summary descriptions of activities conducted by persons subject to their jurisdiction, in sufficient detail to allow evaluation of the effectiveness of the Management Plan. Parties should, wherever possible, deposit original or copies of such original reports in a publicly accessible archive to maintain a record of usage, to be taken into consideration both when reviewing the Management Plan and when organizing the scientific manipulation of the Area.

Management Plan for Antarctic Specially Protected Area No. 122

ARRIVAL HEIGHTS, HUT POINT PENINSULA, ROSS ISLAND

Introduction

The Arrival Heights Antarctic Specially Protected Area (ASPA) is situated near the south-western extremity of Hut Point Peninsula, Ross Island, at 77° 49' 41.2" S, 166° 40' 2.8" E, with an approximate area 0.73 km². The primary reason for designation of the Area is its value as an electromagnetically 'quiet' site for the study of the upper atmosphere and its close proximity to logistical support. The Area is used for a number of other scientific studies, including trace gas monitoring, auroral and geomagnetic studies and air quality surveys. As an example, the longevity and quality of the numerous atmospheric datasets makes the Area of high scientific value. Since its designation in 1975, numerous projects have been located in or near the Area with a potential to degrade the electromagnetically quiet conditions at Arrival Heights. The interference generated by these activities appears to have an acceptably low impact on scientific experiments, although a detailed review of the level of interference is currently being undertaken. The continued use of the Area is favored by its geographical characteristics, its proximity to logistical support and high costs associated with relocation. The Area was proposed by the United States of America and adopted through Recommendation VIII-4 [1975, Site of Special Scientific Interest (SSSI) No. 2]; date of expiry was extended through Recommendations X-6 (1979), XII-5 (1983), XIII-7 (1985), and XIV-4 (1987) and Resolution 3 (1996). The Area was renamed and renumbered through Decision 1 (2002); a revised management plan was provided through Measure 2 (2004). The degradation of electromagnetically 'quiet' conditions within the Area was recognized by SCAR Recommendation XXIII-6 (1994). Minor corrections to the boundaries of the Area have been made to ensure consistency between the text and the updated and more accurate maps provided in the current management plan.

1. Description of values to be protected

An area at Arrival Heights was originally designated in Recommendation VIII-4 (1975, SSSI No. 2), after a proposal by the United States of America on the grounds that it was "an electromagnetic and natural 'quiet site' offering ideal conditions for the installation of sensitive instruments for recording minute signals associated with upper atmosphere programs." For example, electromagnetic recordings have been carried out at Arrival Heights as part of long term scientific studies, yielding data of outstanding quality because of the unique characteristics of the geographic location with respect to the geomagnetic field combined with relatively low levels of electromagnetic interference. The electromagnetically quiet conditions and the longevity of data collection at Arrival Heights make the data obtained of particularly high scientific value.

In recent years, however, increases in science and support operations associated with Scott Base and McMurdo Station have raised the levels of locally generated electromagnetic noise at Arrival Heights and it has been recognized that the electromagnetically 'quiet' conditions have to some degree been degraded by these activities, as identified in SCAR Recommendation XXIII-6 (1994).

Scientific research within the Area appears to operate within an acceptably low level of electromagnetic interference (EMI) from other activities in the vicinity and the aims and objectives set out in the management plan for Arrival Heights therefore remain relevant. However, recent site visits and deployment of new instruments have shown that there is some elevated very-low frequency (VLF) noise in the 50 Hz – 12 kHz range from sources located outside of the Area (most likely wind turbines installed ~1 km from the Area). There is also evidence of increased VLF noise in the 12 - 50 KHz frequency range, which probably arises inside of the Area from, for example, the electrical power grid configuration and grounding, and the proliferation of units such as uninterruptable power supplies (UPS). The US and NZ scientific communities that run projects at Arrival Heights are currently undertaking a detailed analysis of the possible causes of EMI with the goal of providing practical recommendations for mitigating potential effects.

Notwithstanding these observations, the original geographical characteristics of the site, such as its elevated position and thus broad viewing horizon, the volcanic crater morphology, and the close proximity to the full logistic support of nearby McMurdo Station (US) 1.5 km south and Scott Base (NZ) 2.7 km SE, continue to render the Area valuable for upper atmospheric studies and boundary layer air sampling studies. Moreover, there are scientific, financial and practical constraints associated with any proposed relocation of the Area and the associated facilities. Thus, the current preferred option for management is to minimize sources of EMI to the maximum extent practicable, and to monitor these levels routinely so that any significant threat to the values of the site can be identified and addressed as appropriate.

Since original designation the site has been used for several other scientific programs that benefit from the restrictions on access in place within the Area. In particular, the broad viewing horizon and relative isolation from activities (e.g.

vehicle movements, engine exhausts) has been valuable for measurement of trace gases, particularly ozone, spectroscopic and air particulate investigations, pollution surveys, and auroral and geomagnetic studies. In addition, the protected status of Arrival Heights has also had the effect of limiting the extent and magnitude of physical disturbance within the Area. As a result, soils and landscape features are much less disturbed than is the case in the surrounding areas of Hut Point where station developments have taken place. In particular, sand-wedge polygons are far more extensive than elsewhere in the Hut Point vicinity, covering an area of approximately 0.5 km². The relatively undisturbed nature of the environment at Arrival Heights makes the Area valuable for comparative studies of impacts associated with station developments, and valuable as a reference against which to consider changes. These additional values are also important reasons for special protection at Arrival Heights.

The Area continues to be of high scientific value for a variety of high quality and long-term atmospheric data sets that have been collected at this site. Despite the acknowledged potential for interference from local and surrounding sources, the long-term data series, the accessibility of the site for year-round observations, its geographical characteristics, and the high cost of relocation, warrant that the site receive ongoing and strengthened protection. The vulnerability of this research to disturbance through chemical and noise pollution, in particular electromagnetic interference, is such that this Area requires continued special protection.

2. Aims and objectives

Management at Arrival Heights aims to:

- avoid degradation of, or substantial risk to, the values of the Area by preventing unnecessary human disturbance to the Area;
- allow scientific research in the Area, in particular atmospheric research, while ensuring protection from incompatible uses and uncontrolled equipment installation that may jeopardize such research;
- minimize the possibility of generation of excessive electromagnetic noise interference within the Area through regulating the types, quantity and use of equipment that can be installed and operated in the Area;
- encourage the consideration of the values of the Area in the management of surrounding activities and land uses, in particular to monitor the levels, and encourage the minimization of sources of electromagnetic radiation that may potentially compromise the values of the Area;
- allow access for maintenance, upgrade and management of communications and scientific equipment located within the Area;
- allow visits for management purposes in support of the aims of the management plan; and
- allow visits for education or public awareness purposes associated with the scientific studies being conducted in the Area that cannot be fulfilled elsewhere.

3. Management activities

The following management activities are to be undertaken to protect the values of the Area:

- Signs showing the location and boundaries of the Area with clear statements of entry restrictions shall be placed at appropriate locations at the boundaries of the Area to help avoid inadvertent entry.
- Signs showing the location of the Area (stating the special restrictions that apply) shall be displayed prominently, and a copy of this management plan shall be kept available, in the principal research hut facilities within the Area and at McMurdo Station and Scott Base.
- Markers, signs or structures erected within or near the boundary of the Area for scientific or management purposes shall be secured and maintained in good condition, and removed when no longer necessary.
- Visits shall be made as necessary (no less than once every five years) to assess whether the Area continues to serve the purposes for which it was designated and to ensure management and maintenance measures are adequate.
- Electromagnetic noise surveys shall be undertaken within the Area bi-annually to detect equipment faults and to monitor levels of interference that may have potential to compromise the values of the Area unacceptably, for the purposes of identification and mitigation of their sources.
- Potentially disruptive activities that are planned to be conducted outside of but close to the Area, such as blasting or drilling, or the operation of transmitters or other equipment with the potential to cause significant electromagnetic interference within the Area, should be notified in advance to the appropriate representative(s) of national authorities operating in the region, with a view to coordinating activities and / or undertaking mitigating actions in order to avoid or minimize disruption to scientific programs.
- National Antarctic Programs operating in the region shall appoint an Activity Coordinator who will be responsible for inter-program consultation regarding all activities within the Area.

- National Antarctic Programs operating in the region shall consult together with a view to ensuring the conditions in this management plan are implemented, and take appropriate measures to detect and enforce compliance where the conditions are not being followed.

4. Period of designation

Designated for an indefinite period.

5. Maps and photographs

Map 1: Arrival Heights, ASPA No. 122 in relation to Hut Point Peninsula, showing the location of nearby stations (McMurdo Station, US; and Scott Base, NZ), installations (SuperDARN, satellite receptors and wind turbines) and routes (roads and recreational trails). Projection Lambert Conformal Conic: Standard parallels: 1st 77° 40' S; 2nd 78° 00' S; Central Meridian: 166° 45' E; Latitude of Origin: 77° 50' S; Spheroid WGS84; Datum McMurdo Sound Geodetic Control Network. Data sources: Topography: contours (10 m interval) derived from digital orthophoto and DEM from aerial imagery (Nov 1993); Permanent ice extent digitized from orthorectified Quickbird satellite image (15 Oct 05) (Imagery © 2005 Digital Globe, provided through the NGA Commercial Imagery Program); Infrastructure: station layout CAD data USAP (Feb 09 / Mar 11), ERA (Nov 09) and USAP (Jan 11) field survey; Recreational trails PGC field survey (Jan 09 / Jan 11).

Inset 1: The location of Ross Island in the Ross Sea. **Inset 2:** The location of Map 1 on Ross Island and key topographic features.

Map 2: Arrival Heights, ASPA No. 122 topographic map, showing protected area boundaries, site facilities, nearby installations (SuperDARN, satellite receptors) and routes (access roads and recreational trails). Projection details and data sources are the same as for Map 1.

6. Description of the Area

6(i) Geographical coordinates, boundary markers and natural features

Boundaries and coordinates

Arrival Heights (77° 49' 41.2" S, 166° 40' 2.8" E; Area: 0.73 km²) is a small range of low hills located near the southwestern extremity of Hut Point Peninsula, Ross Island. Hut Point Peninsula is composed of a series of volcanic craters extending from Mount Erebus, two of which, namely First Crater and Second Crater, respectively form part of the southern and northern boundaries of the Area. The Area is predominantly ice-free and elevations range from 150 m to a maximum of 280 m at Second Crater. Arrival Heights is located approximately 1.5 km north of McMurdo Station and 2.7 km northwest of Scott Base. The Area has a broad viewing horizon and is comparatively isolated from activities at McMurdo Station and Scott Base, with the majority of McMurdo Station being hidden from view.

The southeastern boundary corner of the Area is defined by Trig T510 No.2, the center of which is located at 77° 50' 08.4" S, 166° 40' 16.4" E at an elevation of 157.3 m. Trig T510 No.2 replaced, and is 0.7 m from, the former boundary survey marker (T510) which no longer exists. The replacement T510 No.2 marker is an iron rod (painted orange) installed into the ground approximately 7.3 m west of the access road to Arrival Heights, and is surrounded by a small circle of rocks. The boundary of the Area extends from Trig T510 No.2 in a straight line 656.0 m northwest over First Crater to a point located at 77° 49' 53.8" S, 166° 39' 03.9" E at 150 m elevation. The boundary thence follows the 150 m contour northward for 1186 m to a point (77° 49' 18.6" S, 166° 39' 56.1" E) due west of the northern rim of Second Crater. The boundary thence extends 398 m due east to Second Crater, and around the crater rim to a US Hydrographic Survey marker (a stamped brass disk) which is installed near ground level at 77° 49' 23.4" S, 166° 40' 59.0" E and 282 m elevation, forming the northeastern boundary of the Area. The boundary thence extends from the US Hydrographic Survey marker southward for 1423 m in a straight line directly to Trig T510 No.2.

Geology, geomorphology and soils

Hut Point Peninsula is 20 km long and is formed by a line of craters that extend south from the flanks of Mt. Erebus (Kyle 1981). The basaltic rocks of Hut Point Peninsula constitute part of the Erebus volcanic province and the dominant rock types are alkali basaltic lavas and pyroclastics, with small amounts of phonolite and occasional outcrops of intermediate lavas (Kyle 1981). Aeromagnetic data and magnetic models indicate that the magnetic volcanic rocks underlying Hut Point Peninsula are likely to be <2 km in thickness (Behrendt *et al.* 1996) and dating studies suggest that the majority of basaltic rocks are younger than ~ 750 ka (Tauxe *et al.* 2004).

The soils at Arrival Heights consist mostly of volcanic scoria deposited from the eruptions of Mount Erebus, with particle size ranging from silt to boulders. The thickness of surface deposits ranges from a few centimetres to tens of metres, with permafrost underlying the active layer (Stefano, 1992). Surface material at Arrival Heights also includes magma flows from Mount Erebus, which have been weathered and reworked over time. Sand-wedge polygons cover an

area of approximately 0.5 km² at Arrival Heights and, because physical disturbance has been limited by the protected status of the Area, are far more extensive than elsewhere in the southern Hut Point Peninsula vicinity (Klein *et al.* 2004).

Climate

Arrival Heights is exposed to frequent strong winds and conditions are generally colder and windier than at nearby McMurdo Station and Scott Base (Mazzera *et al.* 2001). During the period February 1999 to April 2009, the maximum temperature recorded within the Area was 7.1°C (30 Dec 2001) and the minimum was -49.8°C (21 July 2004). During this period, December was the warmest month, with mean monthly air temperatures of -5.1°C, and August was the coolest month, averaging -28.8°C (data sourced from National Institute of Water and Atmospheric Research, New Zealand, <http://www.niwa.cri.nz>, 21 May 2009).

The mean annual wind speed recorded at Arrival Heights between 1999 and 2009 was 6.96 ms⁻¹, with June and September being the windiest months (data sourced from National Institute of Water and Atmospheric Research, New Zealand, <http://www.niwa.cri.nz>, 21 May 2009). The highest recorded gust at Arrival Heights between 1999-2011 was 51 m/s (~184 km/h) on 16 May 2004. The prevailing wind direction at Arrival Heights is north-easterly, as southern air masses are deflected by the surrounding topography (Sinclair 1988). Hut Point Peninsula lies at the confluence of three dissimilar air masses, predisposing the area to rapid onset of severe weather (Monaghan *et al.* 2005).

Scientific research

Numerous long-term scientific investigations are conducted at Arrival Heights, with the majority of research focusing on the earth's atmosphere and magnetosphere. Research areas include extremely low and very low radio frequencies, auroral events, geomagnetic storms, meteorological phenomena and variations in trace gas levels, particularly ozone. The Area has good access and logistical support from nearby McMurdo Station and Scott Base, which helps to facilitate research within the Area.

The extremely-low-frequency and very-low-frequency (ELF/VLF) data have been continuously collected at Arrival Heights since the austral summer of 1984-1985 (Fraser-Smith *et al.* 1991). The ELF/VLF noise data are unique in both length and continuity for the Antarctic and were recorded concurrently with ELF/VLF data at Stanford University, allowing for comparison between polar and mid-latitude time series. The lack of electromagnetic interference and remote location of Arrival Heights allow researchers to measure background ELF/VLF noise spectra and weak ELF signals, such as Schumann resonances, which are associated changes in the magnetosphere and ionosphere (Füllekrug & Fraser-Smith 1996). ELF/VLF and Schumann resonance data collected within the Area have been studied in relation to fluctuations in sun spots, solar particle precipitation events, and planetary-scale meteorological phenomenon (Anyamba *et al.* 2000; Schlegel & Füllekrug 1999; Fraser-Smith & Turtle 1993). Furthermore, ELF data have been used as a proxy measure of global cloud-to-ground lightning activity and thunderstorm activity (Füllekrug *et al.* 1999) and VLF data provide input to global networks which monitor lightning activity and conditions in the ionosphere (Clilverd *et al.* 2009; Rodger *et al.* 2009). High quality electromagnetic data from Arrival Heights has enabled determination of an upper limit for the photon rest mass of $\sim 10^{-52}$ kg (Füllekrug 2004) based on detection of minute global ionospheric reflection height measurements (Füllekrug *et al.* 2002), and it has also provided a critical link between lightning at mid- and tropical latitudes and surface temperature variations in moderate and tropical climates (Füllekrug & Fraser-Smith 1997). Recent research has developed novel measurement technologies with a sensitivity of $\mu\text{V/m}$ over the broad frequency range from ~ 4 Hz to ~ 400 kHz (Füllekrug 2010), which has promising scientific potential requiring conditions of electromagnetic quiescence such as are present at Arrival Heights.

The southerly location of Arrival Heights results in several weeks of total darkness during the austral winter, allowing low intensity auroral events and dayside emissions to be observed (Wright *et al.* 1998). Data recorded at Arrival Heights have been used to track the motion of polar cap arcs, a form of polar aurora, and results have been related to solar wind and interplanetary magnetic field conditions. Auroral observations made at Arrival Heights by researchers for the University of Washington have also been used to calculate the velocity and temperature of high altitude winds by analyzing the Doppler shift of auroral light emissions. In addition to auroral research, optical data collected within the Area have been used to monitor the response of the thermosphere to geomagnetic storms (Hernandez & Roble 2003) and medium frequency radar has been used to measure middle atmospheric (70-100 km) wind velocities (McDonald *et al.* 2007).

A range of trace gas species are measured at Arrival Heights, including ozone, bromine, methane, nitrogen oxides, hydrogen chloride and carbon monoxide, with records commencing as early as 1982 (Connor *et al.* 2005). Arrival Heights represents a key site in the Network of the Detection of Atmospheric Composition (NDACC), with data being used to monitor changes in the stratosphere, including long-term evolution of the ozone layer and changes in overall atmospheric composition. Ozone levels have been recorded at Arrival Heights since 1988 and are used to monitor both long-term and seasonal variations in ozone (Oltmans *et al.* 2008; Nichol *et al.* 1991), as well as in estimations of Antarctic ozone loss (Kuttippurath *et al.* 2010). In addition to longer-term trends, sudden and substantial ozone depletion events have been recorded during spring-time at Arrival Heights, which occur over a period of hours and thought to result from the release of bromine compounds from sea salt (Riedel *et al.* 2006; Hay *et al.* 2007). Tropospheric bromine levels have been continuously recorded since 1995 within the Area and have been studied in

relation to ozone depletion, stratospheric warming and changes in the polar vortex, as well as being used in validation of satellite measurements (Schofield *et al.* 2006). Nitrogen oxide (NO₂) data collected at Arrival Heights have also been used to investigate variations in ozone levels and results show substantial variations in NO₂ at daily to interannual timescales, potentially resulting from changes in atmospheric circulation, temperature and chemical forcing (Struthers *et al.* 2004, Wood *et al.*, 2004). In addition, ground-based Fourier transform spectroscopy has been used at Arrival Heights to monitor atmospheric carbonyl sulfide levels and to record HCL fluxes from Mount Erebus (Deutscher *et al.* 2006; Keys *et al.* 1998).

Vegetation

Lichens at Arrival Heights were surveyed in 1957 by C.W. Dodge and G.E. Baker, with species recorded including: *Buellia alboradians*, *B. frigida*, *B. grisea*, *B. pernigra*, *Caloplaca citrine*, *Candelariella flava*, *Lecanora expectans*, *L. fuscobrunnea*, *Lecidella siplei*, *Parmelia griseola*, *P. leucoblephara* and *Physcia caesia*. Moss species recorded at Arrival Heights include *Sarconeurum glaciale* and *Syntrichia sarconeurum* (BAS Plant Database, 2009), with *S. glaciale* documented within drainage channels and disused vehicle tracks (Skotnicki *et al.* 1999).

Human activities and impact

The Arrival Heights facilities are used year-round by personnel from McMurdo Station (US) and Scott Base (NZ). In addition to two laboratory buildings, numerous antenna arrays, aerials, communications equipment, and scientific instruments are located throughout the Area, along with associated cabling.

The scientific instruments used for atmospheric research in the Area are sensitive to electromagnetic noise and interference, with potential local noise sources including VLF radio transmissions, powerlines, vehicle emission systems and also laboratory equipment. Noise sources generated outside of the Area that may also affect electromagnetic conditions at Arrival Heights include radio communications, entertainment broadcast systems, ship, aircraft, or satellite radio transmissions, or aircraft surveillance radars. A site visit report from 2006 suggested that levels of interference at that time were acceptably low, despite activities operating out of McMurdo Station and Scott Base. In order to provide some degree of protection from local radio transmissions and station noise, some of the VLF antennas at Arrival Heights are located within Second Crater.

Unauthorised access to the Area, both by vehicle and on foot, is thought to have resulted in damage to cabling and scientific instruments, although the extent of damage and impact upon scientific results is unknown. A camera was installed at the USAP building in early 2010 to monitor traffic entering the Area via the road leading to the laboratories.

Recent installations within and close to the Area include an FE-Boltzmann LiDAR in the New Zealand Arrival Heights Research Laboratory in 2010, the Super Dual Auroral RADAR Network (SuperDARN) Antenna Array (2009-10) and two satellite earth station receptors (Map 2). The SuperDARN Antenna Array transmits at low frequencies (8 – 20 MHz), with the main transmission direction to the southwest of the Area, and its location was selected in part to minimize interference with experiments at Arrival Heights. Two satellite earth station receptors (Joint Polar Satellite System (JPSS) and MG2) are located nearby. One of the receptors has the ability to transmit (frequency range 2025 – 2120 Hz) and measures have been taken to ensure that any irradiation of the Area is minimal.

Three wind turbines were constructed approximately 1.5 km east of the Area and close to Crater Hill during austral summer 2009-10 (Map 1). EMI emissions from the turbines should comply with accepted standards for electrical machinery and utilities. However, EMI originating from the new wind turbines has been detected in very low frequency datasets at Arrival Heights, with potential sources of EMI including turbine transformers, generators and power lines.

A detailed analysis of EMI is currently being carried out, with particular attention being paid to determining possible impacts arising from operation of the nearby wind turbines and the LiDAR and power systems installed in laboratories within the Area. Results are anticipated in late 2011.

Air quality monitoring has been regularly carried out at Arrival Heights since 1992 and recent studies suggest that air quality has been reduced, most likely due to emissions originating from McMurdo or Scott Base (Mazzera *et al.* 2001), for example from construction and vehicle operations. Investigations found that air quality samples contained higher concentrations of pollution derived species (EC, SO₂, Pb, Zn) and PM₁₀ (particles with aerodynamic diameters less than 10 µm) aerosols than other coastal and Antarctic sites.

6(ii) Access to the Area

Access to the Area may be made over land by vehicle or on foot. The access road to the Area enters at the south-east and extends to the research laboratories. Several vehicle trails are present within the Area and run from the Satellite Earth Station in First Crater to the foot of Second Crater. Pedestrian access may be made from the access road.

Access by air and overflight of the Area are prohibited, except when specifically authorized by permit, in which case the appropriate authority supporting research programs within the Area must be notified prior to entry.

6(iii) Restricted and managed zones within the Area

None.

6(iv) Structures within and near the Area

Both the New Zealand and United States programs have research and living facilities within the Area. New Zealand opened a new research laboratory at Arrival Heights on 20 January 2007, replacing an old building which has been removed from the Area. The US maintains one laboratory within the Area. A range of antenna arrays and aerials designed to meet scientific needs are located throughout the Area (Map 2), and a new VLF antenna was installed at Arrival Heights during December 2008. A Satellite Earth Station (SES) is located several meters inside the boundary of the Area on First Crater (Map 2).

The SuperDARN Antenna Array is located approximately 270 m SW of the Area, while two satellite earth station receivers are installed approximately 150 m SW of the Area (Map 2).

6(v) Location of other protected areas within close proximity of the Area

The nearest protected areas to Arrival Heights are on Ross Island: Cape Evans (ASPA No. 155) is the closest at 22 km north; Backdoor Bay (ASPA No. 157) is 32 km north, Cape Royds (ASPA No. 121) is 35 km NNW; Tramway Ridge (ASPA No. 130) near the summit of Mt. Erebus is 40 km north; Lewis Bay (ASPA No. 156) the site of the 1979 DC-10 passenger aircraft crash is 50 km NE; New College Valley (ASPA No. 116) is 65 km north at Cape Bird; and Cape Crozier (ASPA No. 124) is 70 km to the NE. NW White Island (ASPA No. 137) is 35 km to the south across the Ross Ice Shelf. Antarctic Specially Managed Area No. 2 McMurdo Dry Valleys is located approximately 50 km to the west of the Area.

7. Permit conditions

Entry into the Area is prohibited except in accordance with a permit issued by an appropriate national authority. Conditions for issuing a permit to enter the Area are that:

- it is issued only for scientific study of the atmosphere and magnetosphere, or for other scientific purposes that cannot be served elsewhere; or
- it is issued for operation, management and maintenance of science support facilities (including safe operations), on the condition that movement within the Area be restricted to that necessary to access those facilities; or
- it is issued for educational or public awareness activities that cannot be fulfilled elsewhere and which are associated with the scientific studies being conducted in the Area, on the condition that visitors are accompanied by permitted personnel responsible for the facilities visited; or
- it is issued for essential management purposes consistent with plan objectives such as inspection or review;
- the actions permitted will not jeopardize the scientific or educational values of the Area;
- any management activities are in support of the objectives of the Management Plan;
- the actions permitted are in accordance with the Management Plan;
- the Permit, or a copy, shall be carried within the Area;
- a visit report shall be supplied to the authority or authorities named in the Permit;
- permits shall be valid for a stated period.

7(i) Access to and movement within the Area

Access to the Area is permitted by vehicle and on foot. Landing of aircraft and overflight within the Area is prohibited unless specifically authorized by permit. Prior written notification must be given to the appropriate authority or authorities supporting scientific research being conducted in the Area at the time of the proposed aircraft activity. The location and timing of the aircraft activity should be coordinated as appropriate in order to avoid or minimize disruption to scientific programs.

Vehicle and pedestrian traffic should be kept to the minimum necessary to fulfil the objectives of permitted activities and every reasonable effort should be made to minimize potential impacts on scientific research: e.g. personnel entering the Area by vehicle should coordinate travel so vehicle use is kept to a minimum.

Vehicles shall keep to the established vehicle tracks as shown on Map 2, unless specifically authorized by permit otherwise. Pedestrians should also keep to established tracks wherever possible. Care should be taken to avoid cables and other instruments when moving around the Area, as they are susceptible to damage from both foot and vehicle traffic. During hours of darkness, vehicle headlights should be switched off when approaching the facilities, in order to prevent damage to light-sensitive instruments within the Area.

7(ii) Activities that are or may be conducted in the Area, including restrictions on time or place

Activities that may be conducted within the Area include:

- scientific research that will not jeopardize the scientific values of the Area;
- essential management activities, including the installation of new facilities to support scientific research;
- Activities with educational aims (such as documentary reporting (photographic, audio or written) or the production of educational resources or services) that cannot be served elsewhere;
- use of hand-held and vehicle radios by visitors entering the Area is allowed; however, their use should be minimized and shall be restricted to communications for scientific, management or safety purposes;
- surveys of electromagnetic noise to help ensure that scientific research is not significantly compromised.

7(iii) Installation, modification or removal of structures

- No structures are to be erected within the Area except as specified in a permit.
- All structures, scientific equipment or markers installed within the Area, outside of research hut facilities, must be authorized by permit and clearly identified by country, name of the principal investigator and year of installation. Removal of such structures, equipment or markers upon expiration of the permit shall be the responsibility of the authority which granted the original permit, and shall be a condition of the permit.
-
- Installation (including site selection), maintenance, modification or removal of structures shall be undertaken in a manner that minimizes environmental disturbance and installations should not jeopardize the values of the Area, particularly the electromagnetically 'quiet' conditions. Installations should be made of materials that pose minimal risk of environmental contamination of the Area. The time period for removal of equipment shall be specified in the permit.
- No new Radio Frequency (RF) transmitting equipment other than low power transceivers for essential local communications may be installed within the Area. Electromagnetic radiation produced by equipment introduced to the Area shall not have significant adverse effects on any on-going investigations unless specifically authorized. Precautions shall be taken to ensure that electrical equipment used within the Area is adequately shielded to keep electromagnetic noise to a minimum.
- Installation or modification of structures or equipment within the Area is subject to an assessment of the likely impacts of the proposed installations or modifications on the values of the Area, as required according to national procedures. Details of proposals and the accompanying assessment of impacts shall, in addition to any other procedures that may be required by appropriate authorities, be submitted by investigators to the activity coordinator for their national program, who will exchange documents received with other activity coordinators for the Area. Activity coordinators will assess the proposals in consultation with national program managers and relevant investigators for the potential impacts on the scientific or natural environmental values of the Area. Activity coordinators shall confer with each other and make recommendations (to proceed as proposed, to proceed with revisions, to trial for further assessment, or not to proceed) to their national program within 60 days of receiving a proposal. National programs shall be responsible for notifying investigators whether or not they may proceed with their proposals and under what conditions.
- The planning, installation or modification of nearby structures or equipment outside the Area that emit EMR should take into account their potential to affect the values of the Area.

7(iv) Location of field camps

Camping within the Area is prohibited. Overnight visits are permitted in buildings equipped for such purposes.

7(v) Restrictions on materials and organisms that can be brought into the Area

There are no specific restrictions on materials and organisms that can be brought into the Area.

7(vi) Taking or harmful interference with native flora or fauna

Taking or harmful interference with native flora and fauna is prohibited, except in accordance with a separate permit issued by the appropriate national authority specifically for that purpose under Article 3 of Annex II to the Protocol.

7(vii) Collection or removal of anything not brought into the Area by the permit holder

- Material may be collected or removed from the Area only in accordance with a permit and should be limited to the minimum necessary to meet scientific or management needs.
- Material of human origin likely to compromise the values of the Area, which was not brought into the Area by the permit holder or otherwise authorized, may be removed from any part of the Area unless the

impact of removal is likely to be greater than leaving the material *in situ*. If this is the case the appropriate authority should be notified.

- The appropriate national authority should be notified of any items removed from the Area that were not introduced by the permit holder.

7(viii) Disposal of waste

All wastes, including human wastes, shall be removed from the Area.

7(ix) Measures that are necessary to ensure that the aims and objectives of the management plan can continue to be met

- 1) Permits may be granted to enter the Area to carry out scientific monitoring and site inspection activities, which may involve the collection of data for analysis or review, or for protective measures.
- 2) Any specific sites of long-term monitoring shall be appropriately marked.
- 3) Electromagnetic bands of particular scientific interest and that warrant special protection from interference should be identified by parties active within the Area. As far as practically possible, the generation of electromagnetic noise should be limited to frequencies outside of these bands.
- 4) The intentional generation of electromagnetic noise within the Area is prohibited, apart from within agreed frequency bands and power levels or in accordance with a permit.

7(x) Requirements for reports

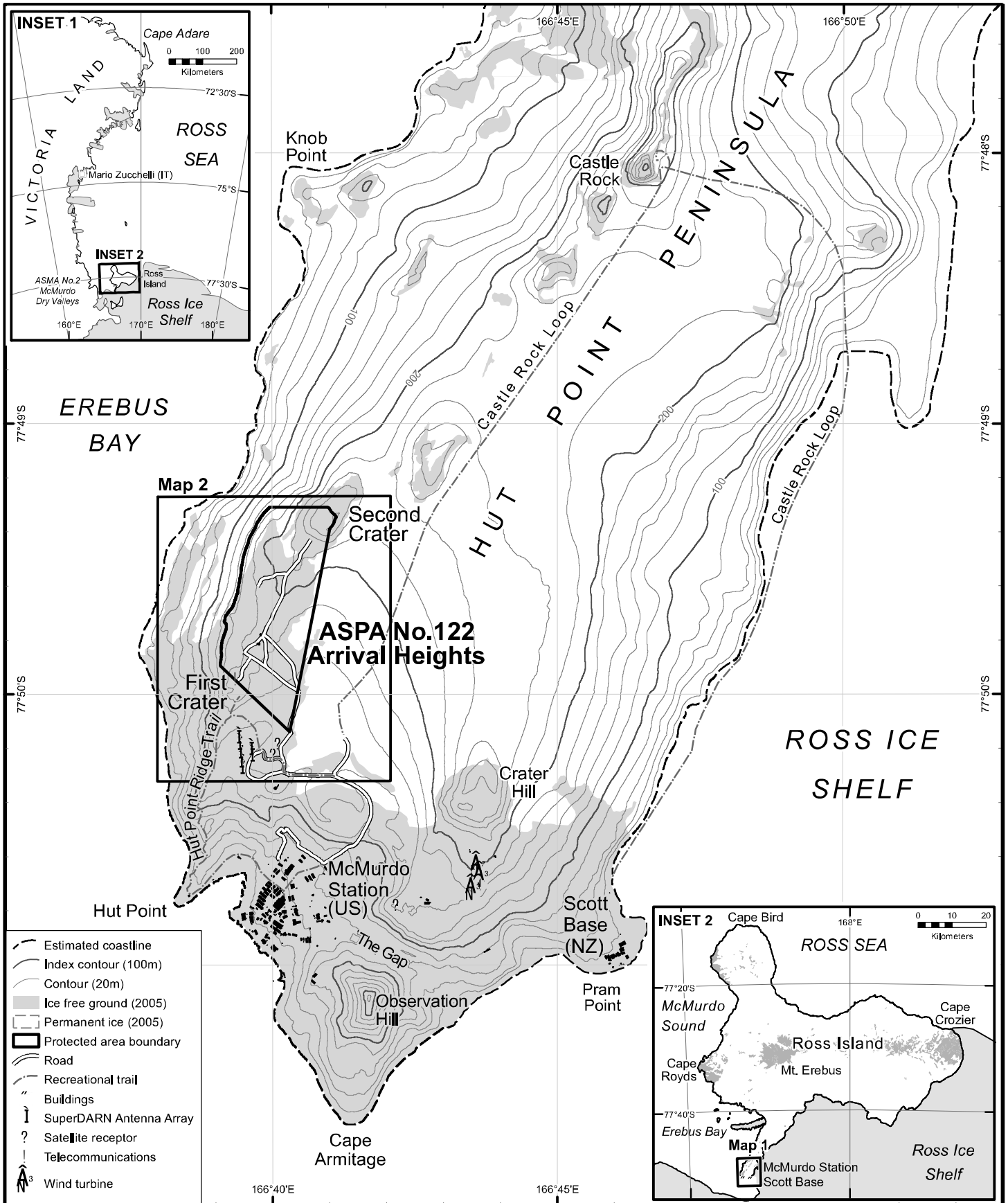
- Parties should ensure that the principal holder for each permit issued submits to the appropriate authority a report describing the activities undertaken. Such reports should include, as appropriate, the information identified in the Visit Report Form contained in Appendix 4 of Resolution 2 (1998)(CEP I).
- Parties should maintain a record of such activities and, in the annual Exchange of Information, should provide summary descriptions of activities conducted by persons subject to their jurisdiction, which should be in sufficient detail to allow evaluation of the effectiveness of the Management Plan. Parties should, wherever possible, deposit originals or copies of such original reports in a publicly accessible archive to maintain a record of usage, to be used both for review of the management plan and in organizing the scientific use of the Area.
- The appropriate authority should be notified of any activities / measures undertaken, and / or of any materials released and not removed, that were not included in the authorized permit. All spills shall be reported to the appropriate authority.

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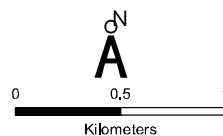
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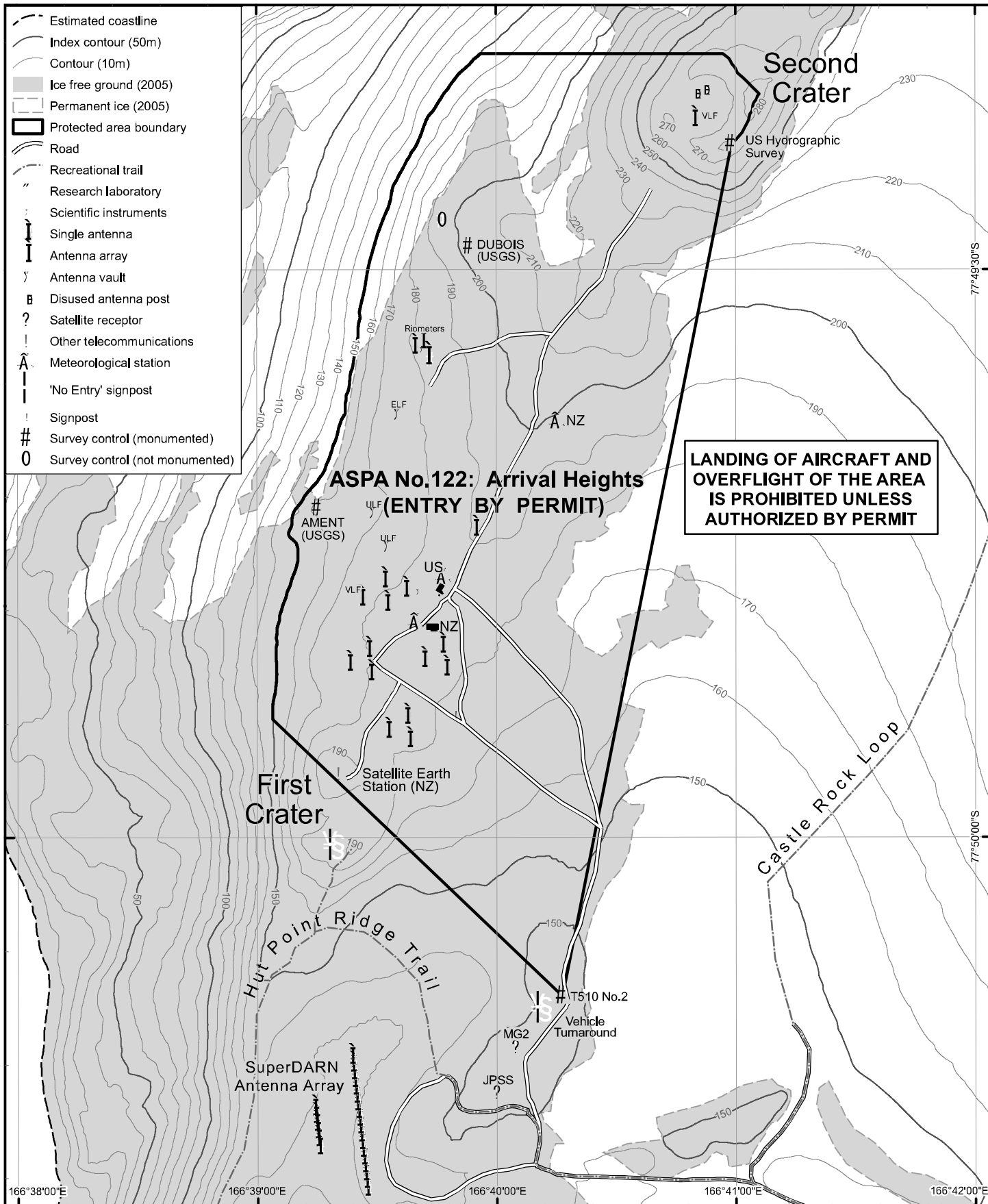
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Projection: Lambert Conformal Conic
 CM 166°45'; SP1 -77°40'; SP2 -78°00'; LO -77°50';
 Spheroid: WGS84; Data sources: Contours: Derived from
 2m DEM, contour interval 20m; Buildings: RPSC survey (Feb 09);
 Features: Derived from USAP (Feb 2009) & ERA (Nov 2009)
 field surveys; Recreational trails: PGC field survey 2009;
 Permanent ice extent: Digitised from Quickbird orthophoto (15 Oct 05)
 (Imagery © 2005 Digital Globe; NGA Commercial Imagery Program);
 ASPA boundary based on Management Plan (2011).

ASPANo. 122 - Arrival Heights
Map 1: Regional overview





Projection: Lambert Conformal Conic
 CM 166°45'; SP1 -77°40'; SP2 -78°00'; LO -77°50';
 Spheroid: WGS84; Data sources: Contours: Derived from
 2m DEM, contour interval 10m; Features: Derived from
 USAP (Feb 2009) & ERA (Nov 2009) field surveys;
 Recreational trails: PGC field survey 2009; Permanent ice
 digitised from orthorectified Quickbird image (15 Oct 05)
 (Imagery © Digital Globe; NGA Commercial Imagery Program);
 ASPA boundary based on Management Plan (2011).

ASP A No. 122 - Arrival Heights Map 2: ASPA Boundary & topography

Note: Overground cables are present throughout
 Arrival Heights and are not shown on this map.
 Care should be taken to avoid disturbing these cables.

