Australian Government

Department of Agriculture, Water and the Environment
Australian Antarctic Division

ENVIRONMENTAL IMPACT ASSESSMENT – AUSTRALIAN ANTARCTIC PROGRAM AVIATION OPERATIONS 2020-2025
draft released for public comment

This document should be cited as: Commonwealth of Australia (2020). *Environmental Impact Assessment – Australian Antarctic Program Aviation Operations 2020-2025 – draft released for public comment.* Australian Antarctic Division, Kingston.

Cover photos from L to R: groomed runway surface, Globemaster C17 at Wilkins Aerodrome, fuel drum stockpile at Davis, Airbus landing at Wilkins Aerodrome

Prepared by:
Dr Sandra Potter

on behalf of:

Mr Robb Clifton
Operations Manager
Australian Antarctic Division
Kingston 7050
Australia

Contents

Overview 7

1. Background 9

1.1 Australian Antarctic Program aviation 9
1.2 Previous assessments of aviation activities 10
1.3 Scope of this environmental impact assessment 11
1.4 Consultation and decision outcomes 12

2. Details of the proposed activity and its need 13

2.1 Introduction 13
2.2 Inter-continental flights 13
2.3 Air-drop operations 14
2.4 Air-to-air refuelling operations 14
2.5 Operation of Wilkins Aerodrome 15
2.6 Intra-continental fixed-wing operations 17
2.7 Operation of ski landing areas 18
2.8 Helicopter operations 18
2.9 Fuel storage and use 19
2.10 Aviation activities at other sites 20
2.11 Unmanned aerial systems 20
2.12 Facility decommissioning 21

3. Alternatives 22

3.1 Introduction 22
3.2 Discontinue international flights and rely on shipping 22
3.3 Discontinue domestic fixed-wing operations 22
3.4 Discontinue helicopter operations 23
3.5 Vary the scale and layout of Wilkins' infrastructure 23
3.6 Use other sites and landing surfaces 23
3.7 'Do nothing' 24

4. Existing environment 25

4.1 Introduction 25
4.2 Physical characteristics 25
4.3 Biodiversity 27
4.4 Human environment 30
4.5 Heritage values 31
4.6 Wilderness, aesthetic and intrinsic values 32

5. Potential environmental impacts 33

5.1 Introduction 33
5.2 Spatial extent and intensity 33
5.3 Impacts on air quality through emissions 34
5.4 Impacts on water, snow and ice quality/processes through emissions to the atmosphere 34
5.5 Impacts on water, snow and ice quality/processes through other releases and activities 35
5.6 Impacts on biota through habitat alteration 36
5.7 Impacts on wildlife through noise disturbance and visual stimuli 36
5.8 Impacts on wildlife through direct strikes or entanglement 38
5.9 Disease introduction risks 37
5.10 Impacts associated with introductions and species transfers 37
5.11 Impacts on geology and vegetation 39
5.12 Impacts on research and scientific values 39
5.13 Impacts on wilderness and aesthetic values 40
5.14 Impacts on heritage values 42
5.15 Second order and cumulative impacts 42

6. Mitigation measures 43

6.1 Introduction 43
6.2 General measures 43
6.3 Actions to minimise the impacts of aircraft on wildlife 44
6.4 Actions to minimise the impacts of unmanned aviation operations 45
6.5 Actions to minimise the unintentional import of species and other biological matter via international flights 46
6.6 Actions to minimise the transfer of species and other biological matter via domestic flights 47
6.7 Actions to minimise disease risks 47
6.8 Actions to minimise the risk and impacts of fuel spillage 47
6.9 Actions to minimise the risks specific to bulk fuel storage 47
6.10 Actions to minimise risks and impacts specific to depots and drummed fuel stocks 47
6.11 Additional actions to minimise risks and impacts associated with sling-loading 48
6.12 Additional actions to minimise risks and impacts specific to air-drops 49
6.13 Actions to protect heritage 51
6.14 Other actions to protect the environment 51

7. Monitoring 52

7.1 Background 52

7.2 Previous aviation-related monitoring 52

7.3 Current and future monitoring 53

8. Methods, data and references 54

8.1 Introduction 53

8.2 Review of past activities 54

8.3 Specialist input 54

8.4 Reference material 55

8.5 Uncertainties 55

Appendixes

1. Compliance with required content of initial environmental evaluations 57
2. Environmental impact assessment summary 58
3. *EPBC Act* 1999 referral decision 61
4. Infrastructure and plant and equipment at Wilkins Aerodrome 62
5. Possible landing sites 64
6. Environmental domains 65
7. Biogeographic regions and their biodiversity 67
8. East Antarctic vertebrate fauna 69
9. Wildlife concentration map list 72
10. Main wildlife breeding locations in aviation operational area 73
11. Protected areas within East Antarctica 74
12. Important Bird Areas within East Antarctica 75
13. Aesthetic values, East Antarctica 77
14. Content of environmental briefings 81
15. Procedure for ushering penguins from ski landing areas 82
16. State of the Environment reporting (monitoring) themes 83
17. Environmental risks and control measures for use of poultry meat and eggs at Wilkins 84
18. Environmental risk 85
19. Review of 2015-20 aviation activities 86
20. Bibliography 93

Definitions, abbreviations and acronyms 100

Environmental impact assessment – Australian Antarctic Program Aviation Operations 2020 – 2025 constitutes an evaluation of the potential environmental impacts of continuing Australian Antarctic Program aviation operations at levels similar to current operations.[1] It has been prepared consistent with the requirements of Australia's domestic legislation implementing the Protocol on Environmental Protection to the Antarctic Treaty, namely the *Antarctic Treaty (Environment Protection) Act* 1980 and associated regulations. It provides information that the regulations specify must be included in assessments known as 'initial environmental evaluations' (see Appendix 1).

Background information on aviation in support of Australia's Antarctic program is provided in Section 1. Details on the nature of and rationale for the proposed activity are provided in Section 2; possible alternatives in Section 3; the affected region's environment, including its biological, geological, scientific, aesthetic and wilderness significance, in Section 4; the activity's inherent and potential environmental impacts in Sections 5, 6 and 7; and an overview of the scope that exists to reduce or eliminate the impacts, in Section 8.

A non-technical summary is provided at Appendix 2.

The assessment concludes that while the environmental impacts of Australian aviation operations in Antarctica are cumulative, they will remain tenable if the mitigation measures outlined in this document are adopted. On this basis, the Australian Antarctic Division of the Department of Agriculture, Water and the Environment, as proponent, believes that the activity may be authorised to proceed.

[1] Note however that in May 2018 the Australian Government announced its intention to construct a paved runway in the Vestfold Hills, near Davis in Princess Elizabeth Land. The development of the Davis aerodrome and the conduct of operations to this facility are the subject of a separate environmental impact assessment and approval process that is currently underway. The anticipated timeframes for construction (with flights commencing around 2040) mean that this option would not be available for aviation operations between 2020 and 2025.

1. Background

1.1 Australian Antarctic Program aviation

Australia's Antarctic program is managed on behalf of the Australian Government by the Australian Antarctic Division (AAD) of the Department of Agriculture, Water and the Environment. The AAD is tasked with advancing Australia's strategic, scientific, environmental and economic interests in the Antarctic by protecting, administering and researching the region. To this end, Australia maintains three research stations on the coast of East Antarctica – Casey in Wilkes Land, Davis in Princess Elizabeth Land, and Mawson in Mac.Robertson Land.

Australia's use of aircraft in Antarctica is neither new nor revolutionary. Vought-Sikorsky, Kingfisher, Auster, de Havilland, Dakota, Beaver, Pilatus Porter, Hercules, CASA, single and twin-engine helicopters and other aircraft have played a role in undertaking or supporting programs since the first Australian National Antarctic Research Expedition in 1947. Aviation's uses have included:

- conducting medical evacuations
- resupplying stations and field parties
- supporting scientific and other programs away from stations
- positioning and rotating personnel
- facilitating international scientific collaboration
- assisting ships' navigation through sea ice

In its present configuration, the aviation support of Australia's Antarctic program is summer and East Antarctic-centric and typically involves:

- flights between Australia and Antarctica using a privately-operated Airbus A319 ER, Australian Defence Force C-17A Globemaster III ('C17s'), and occasionally, Hercules C130J
- operation of an aviation hub/terminus, Wilkins Aerodrome ('Wilkins'), inland from Casey
- occasional Hercules LC-130H aircraft flights between the United States' McMurdo station and, mostly, Wilkins and the Casey and Davis ski landing areas (SLAs) inland
- occasional air-drops
- intra-continental flights between SLAs and other sites using De Havilland DHC-6 Twin Otter and/or Basler BT-67 aircraft
- intra-continental flights and operations over water and sea ice using Eurocopter AS350 B3 helicopters
- maintaining facilities (buildings, automatic weather stations, runway markers and the like) needed to support aviation operations in Antarctica
- preparing SLAs, and grooming ice between stations and landing areas to support vehicular traffic
- fuel storage and handling

Australia's Antarctic program is otherwise supported using shipping.

1.2 Previous assessments of aviation activities

The Protocol on Environmental Protection to the Antarctic Treaty, signed by Australia in 1991 and entering into force in 1998, creates a legally binding framework for the protection of the Antarctic environment. Article 3(1) of the Protocol stipulates that:

> the protection of the Antarctic environment and dependent and associated ecosystems and the intrinsic value of Antarctica, including its wilderness and aesthetic values and its value as an area for the conduct of scientific research, in particular research essential to understanding the global environment, shall be fundamental considerations in the planning and conduct of all activities in the Antarctic Treaty area [and that]
>
> activities in the Antarctic Treaty area shall be planned and conducted on the basis of information sufficient to allow prior assessments of, and informed judgments about, their possible impacts on the Antarctic environment and dependent and associated ecosystems and on the value of Antarctica for the conduct of scientific research.

Environmental impact assessment (EIA) procedures are a required part of the planning process leading to decisions about logistic support and other activities (Article 8(3) of the Protocol).

The Protocol is implemented for Australia by the *Antarctic Treaty (Environment Protection) Act* 1980 (*ATEP Act*). The Act provides for three levels of environmental assessment – preliminary assessment (PA), initial environmental evaluation (IEE) and comprehensive environmental evaluation (CEE) – the latter two assessment requirements being linked to the likely extent of the impacts of an activity.

A PA of the AAD's anticipated aviation operations in the 2020-25 period was undertaken in July 2019 and led to the requirement to prepare an IEE[2] (this document).

Other aviation-related assessments undertaken to date have addressed plans to:

- trial Hobart-Casey flights by ski-equipped Hercules (1990)[3]
- enlarge the stations' helipads and use long-range (twin-engine) helicopters (1994 –)
- routinely conduct inter-continental flights (2005–15)[4]

---

[2] A determination that the activity was likely to have a minor or transitory impact on the environment was made by the Minister for the Environment's delegate on 27 September 2019.

[3] This activity was assessed under the *Environment Protection (Impact of Proposals) Act* 1974 and associated administrative procedures.

[4] An *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)* referral was also made (#2002/801 of 12 September 2002) on account of the potential for operations to interact with listed threatened species and communities (Sections 18 and 18A of the Act) and listed migratory species (Sections 20 and 20A); and obligations to protect the environment from Commonwealth actions (Section 28). On 14 October 2002 the then Minister for the Environment and Heritage deemed that the provisions of Part 3 of the Act were not controlling provisions provided the activity was undertaken in a particular manner, that is, in accordance with various conditions (see Appendix 3).

- vary the aircraft to be used for inter-continental flights from a Falcon 900EX to an Airbus A319, and to vary passenger numbers, flight frequency, runway construction processes, runway maintenance processes and aerodrome monitoring parameters (2007–)
- use CASA C-212 aircraft for intra-continental flights
- replace the CASA C-212s with Twin Otter DHC-6 and Basler BT-67 aircraft
- cache drums of aviation fuel at remote sites
- sling load fuel ship-shore in 1000 L intermediate bulk containers
- increase the volume of special Antarctic blend (SAB) fuel stored at Casey to support extending Wilkins' operating season
- continue inter-continental aviation operations beyond their first 10-year authorisation[5]
- undertake air-drops
- undertake geotechnical investigations and other field work in support of the selection of a runway site in the Vestfold Hills, near Davis
- build a paved runway in the Vestfold Hills[6]

1.3 Scope of this environmental impact assessment

This IEE-level assessment relates to Australian Antarctic Program (AAP) 2020-21 to 2025-26 season aviation operations south of 60°S. It considers ongoing:

- inter-continental flights using Airbus A319 (or similar wheeled jet aircraft), C-17A Globemaster III, and LC-130H and C130J Hercules
- flights within East Antarctica using Twin Otter DHC-6, Basler BT-67 or similar aircraft, and landings at prepared and unprepared sites
- aircraft ferry flights on entry into the Antarctic Treaty area
- intra-continental, local area and ship-shore helicopter operations
- operations at Wilkins Aerodrome
- deployments of portable buildings, automatic weather stations, runway markers, wind socks and the like needed to support aviation operations (at Wilkins and elsewhere)
- storage/caching of aviation fuel

---

[5] The IEE prepared for 2015-16 to 2019-20 season activities also consolidated the assessment of many of the activities previously assessed or occurring prior to the Protocol's entry into force (e.g. single-engine helicopter operations). The 2015-20 assessment – for which the authorisation expires 30 September 2020 – and the current assessment, are similar in scope.

[6] In May 2018 the Australian Government announced its intention to construct a paved runway in the Vestfold Hills, near Davis in Princess Elizabeth Land. On the basis of a PA submitted in October 2019 , the Minister's delegate determined that the AAD is required to prepare a CEE. This activity is also the subject of a referral (#2019/8594) under the *EPBC Act* (see AAD 2020b).

- unmanned aircraft use for scientific and operational purposes
- sling-loading operations
- Australian Defence Force and other air-drops

Activities that are out of scope include:

- ongoing geotechnical investigations and the construction of and operations to a paved runway in the Vestfold Hills
- flying operations outside the Antarctic Treaty area
- the construction of new helicopter facilities at Davis or in the broader Vestfold Hills region
- recreational uses of unmanned aviation systems
- the use of chemical and other dust suppressants
- the use of the Australian Government's aviation capability to support tourism
- non-government uses of the Australian Government's Antarctic aviation capability
- any landings on areas of sea ice by large fixed-wing aircraft

Matters of style, interpretation etc.

Location coordinates that are not provided may be obtained from the Australian Antarctic Data Centre.[7]

'Domestic flights' and 'intra-continental flights' are used inter-changeably, that is, flights within Antarctica. 'International flights' and 'inter-continental flights' refer to sorties between Antarctica and Australia and other places outside of the Antarctic Treaty area.

Definitions for terms that may not be commonly understood, and abbreviations and acronyms used in the text, are provided at the end of this document.

1.4 Consultation and decision outcomes

This document has been released for public consultation after which the relevant minister/ delegate will decide whether or not to authorise the activities proposed.

Parties who may be affected by the operations flagged include other national Antarctic programs, contractors, AAD staff and AAP participants.

Subject to the *Administrative Appeals Tribunal Act* 1975, a person or persons whose interests are affected by a decision may, within 28 days, make an application in writing for the reasons for the decision. An application for independent review of the decision may be made to the Administrative Appeals Tribunal by or on behalf of the person or persons whose interests are affected, either within 28 days of receipt of the decision, or within 28 days of the declaration if reasons for the decision are not sought.

[7] http://data.aad.gov.au/ or email aadcwebqueries@aad.gov.au.

2. Details of the proposed activity and its need

2.1 Introduction

The AAD proposes to continue using aviation to support the achievement of the Australian Government's *Australian Antarctic Strategy and 20 Year Action Plan* and goals of:

- maintaining the Antarctic Treaty system and enhancing Australia's influence within the system
- protecting the Antarctic environment
- understanding the role of Antarctica in the global climate system
- undertaking work of practical, economic and national significance

This assessment is premised on aviation operations in the next five years being undertaken at similar levels, over a similar geographic range and using the same or similar aircraft as those used to support Australia's Antarctic program in the last five years. The potential physical elements and operations involved are outlined below.

2.2 Inter-continental flights

It is proposed to continue undertaking flights to the Antarctic continent using the following or similar aircraft:

- Airbus A319 ER / ACJ 319 LR aircraft (33.8 m long, 11.7 m high, 34.1 m wingspan)
- C-17A Globemaster III (53 m long, 16.8 m high, 51.8 m wingspan)
- Hercules C130J (~29 m long, 11 m high, 40 m wingspan).

A319 flights are expected to:

- be scheduled between August and April and occur no more than 3 times/week and 20 times/ summer season
- be made at an altitude of ~39 000 feet, the aircraft beginning descent at ~65°S, tracking inland from ~117°E, and intersecting the coast at an elevation no lower than 20 000 feet
- operate over the Vanderford Glacier in accordance with Airservices Australia-prescribed waypoints
- burn ~20 t fuel/sortie
- generate ~0.9 kg HC, 4.5 kg CO and 4.2 kg NO_x each landing and take-off cycle

C17 flights are expected to:

- be scheduled between August and April and occur no more than 8 times/season
- other than for air-drops, be made at an altitude of ~39 000 feet, the aircraft beginning descent at ~65°S, tracking inland from ~117°E, and intersecting the coast at an elevation no lower than 20 000 feet

- operate over the Vanderford Glacier in accordance with Airservices Australia-prescribed waypoints
- burn ~80 t fuel/sortie
- generate ~1.36 kg SO_x, 2.3 kg HC, 25.64 kg CO, 40.1 kg NO_x and 2.11 kg particulates each landing and take-off cycle

C130J flights are expected to:

- be scheduled between August and April and occur no more than 8 times/season
- be made at an altitude of ~39 000 feet, the aircraft beginning descent at ~65°S, tracking inland from ~117°E, and intersecting the coast at an elevation no lower than 20 000 feet
- operate over the Vanderford Glacier in accordance with Airservices Australia-prescribed waypoints
- burn ~14 t fuel/sortie and uplift ~5000 L at Wilkins each sortie
- generate ~0.49 kg SO_x, 1.31 kg HC, 7.89 kg CO, 9.34 kg NO_x and 0.68 kg particulates each landing and take-off cycle

2.3 Air-drop operations

The AAD proposes to continue using air-drops to support station and field operations including search and rescue activities. Air-drops are expected to:

- be undertaken by Baslers or C17s, the latter supported, as needed, by air-to-air refuelling
- deposit up to 20 t of cargo/sortie
- involve multiple passes over designated drop zones

2.4 Air-to-air refuelling operations

Air-to-air refuelling operations may be undertaken using Australian Defence Force KC-30A multi-role tanker transports (a military variant of Airbus A330 airliners). The tankers (59 m long, 17.4 m high, wingspan 60.3 m) are expected to:

- carry < 100 t of fuel/flight
- refuel C17s as required
- be undertaken clear of cloud and at ~20 000 feet above mean sea level

2.5 Operation of Wilkins Aerodrome

The AAD proposes to continue operation of a Civil Aviation Safety Authority (CASA) certified runway on natural ablated glacial ice at ~740 m ASL, ~70 km SE of Casey.[8]

Wilkins' operations are expected to typically involve:

- a 65 ha physical footprint
- the arrival and departure of international and domestic flights, with aircraft on the ground for < 5 hours/landing, entailing:
    - visits or transits by < 45 passengers/flight (< 800 return passengers/season)
    - the ground handling of < 10 t of small and light items of cargo each Airbus flight and < 30 t cargo each C17 flight
- the semi-permanent presence of ~18 buildings and containers for the purposes of providing: on-site accommodation in the form of single rooms for ~9 personnel with overflow capacity for four;[9] combined messing, ablutions and recreation; an operations space; a gymnasium; power generation; workshop; vehicle garaging and repair capacity; and equipment storage (~200 m^3) – with indicative energy demands as follows:

Building	Peak energy requirement/hour	Operation (hours/day)
Accommodation van	21 kW	24
Mess van/kitchen	10-40 kW	24
Operations	20 kW	24
Workshop	10 kW	24
Site office	10 kW	24
Runway equipment van x 2	10 kW (5 kW each)	24
Generator van x 2	5-10 kW	24

- the storage of a range of environmentally hazardous materials including fuel – nominally up to 4 x 205 L drums of unleaded petrol, 28 000 L diesel (2 x 14 000 L units) and ~10 x 205 L drums aviation turbine kerosene (ATK)
- the consumption of 7000 –12 000 L diesel/week (i.e. SAB) associated with vehicle use and power generation, and up to 1000 L ULP/season
- the manufacture of ~15 000 L of water/week, from locally sourced snow
- the local discharge of ~12 000 L of waste-water/week (from the kitchen, laundry, showers and urinals),[10] and the generation of exhaust gas and acoustic emissions associated with incinerator toilet use, vehicle operations, power generation and aircraft movements
- for Wilkins' staff use – provision of an electric incinerator toilet to burn solids

[8] As Wilkins moves at a rate of ~12 m WSW each year, the runway is realigned approximately every 3 years.
[9] 40+ could take shelter in heated spaces in an emergency.
[10] Disposed of at at 66°40.430'S, 111°27.263'E or, if it becomes unsafe, another site within a 5 km radius.

- for personnel in transit – provision of a portable toilet facility on a sledge, the solids being transported to Casey for incineration
- the generation of ash, waste plastic, paper, wood, glass etc., and food waste (including poultry products), grease trap waste and workshop waste (oily rags, metals, waste oil, etc.)
- maintenance of a bamboo cane line marked route to Casey and Casey SLA over glacial ice and snow[11]
- the set-up of windsocks, markers, signage etc. needed for operational reasons
- regular vehicular traffic between Casey and Wilkins to:
    - resupply Wilkins with food and other stores and equipment, potentially involving sleds towed by heavy vehicles
    - resupply Wilkins with fuel (14 000 L/load) using a tracked fuel tanker/trailer towed by heavy vehicles
    - transfer cargo to and from flights using Hagglunds and tractors towing sleds
    - transfer passengers in conjunction with Airbus and other flights
    - transport solid waste from Wilkins to Casey
    - undertake maintenance work etc. at Wilkins
    - extend Wilkins-based personnel's recreational opportunities
- surface disturbance associated with the routine movement of snow to remove build-up downwind of infrastructure and to facilitate movement between buildings etc.
- surface disturbance associated with annual runway re-establishment and ongoing runway (3500 m x 45 m), runway edge (out to 150 m), approach (2100 m x 10 m) and apron (150 m x 100 m) maintenance involving heavy vehicles:
    - grading and/or blowing snow as required (potentially daily)
    - proof rolling[12]
    - surface tilling (generally weekly)[13]
- runway delineation using, for example:
    - lead in markers to the apron, every 300 m for 2 km
    - bamboo canes every 500 m along the 100 m runway strip edge
    - bamboo canes every 500 m along the 150 m runway strip edge
    - other markers (most likely polyvinyl chloride or polyester rectangles on two polycarbonate poles) every 100 m along the runway pavement edge
    - sledge-mounted precision approach path indicator (PAPI) and runway end lighting (RENL)

---

[11] Maintenance of the route may involve heavy vehicle-supported grading, 'dragging' or grooming, mostly undertaken in conjunction with trips to/from Casey for other purposes.
[12] Involves an 88 t trailer simulating 1.3 x the maximum take-off weight of the Airbus.
[13] Tilling the runway generally takes ~12 hours using one vehicle.

- the use of multiple vehicles including ~10 heavy vehicles operating on site for 300-1000 hours/season and ~6 light vehicles for 100-500 hours/season – indicative fuel consumption figures as follows:

Equipment	Average hours/ day each unit	Approximate fuel use/ hour
Case Quadtrac tractor	6	60-85 L/hour
Overassen snow blower	6	35-50 L/hour
Caterpillar 14H grader	2	26-32 L/hour
Caterpillar D7R bulldozer	3	20-30 L/hour
Caterpillar 996H loader 966	6	20-30 L/hour
Prinoth BR 350 snow groomer x 2	6-12	20-30 L/hour
Hagglunds	8	15-30 L/hour
Caterpillar 297 multi terrain loader / skid steer ('Bobcat')	3	10-20 L/hour

- construction/maintenance of a berm (~100 m long x 8 m high, x 6 m wide at its pinnacle) for the annual winter storage of infrastructure[14]
- refuelling aircraft as required

2.6 Intra-continental fixed-wing operations

It is proposed to continue intra-continental (domestic) operations using USAP Hercules LC-130H, Twin Otter DHC-6, Basler BT-67 or similar aircraft.

LC-130H flights are expected to:

- be made between stations and inland SLAs, <5 times/season
- carry 6 flight crew and no more than 40 passengers or 10 t of cargo/flight (or a combination thereof)
- be refuelled in Antarctica as required[15]
- generate ~0.49 kg SO_x, 1.31 kg HC, 7.89 kg CO, 9.34 kg NO_x and 0.68 kg particulates each landing and take-off cycle

Twin Otters and Baslers are expected to:

- ferry through the Antarctic Peninsula, South Pole (USA) and Dome C (France/Italy) or McMurdo (USA)
- undertake inter-station transfers and field deployments of personnel and cargo, potentially carrying 19 (Twin Otter) and 28 (Basler) passengers/flight[16]

---

[14] Needed to to alleviate drift build-up. The location is ~ 1500 m north of the runway.
[15] Expected uplift is ~4500 L.
[16] On short flights. Regulatory restrictions currently limit the number of passengers per Basler flight to 18.

- land on unprepared and groomed sites
- park overnight at Wilkins, SLAs or, on occasion, at sites further afield
- be refuelled in Antarctica as required

2.7 Operation of ski landing areas

The AAD proposes to continue operating SLAs on the sea ice or inland of Casey, Davis and Mawson, at each site potentially involving:

- servicing up to 75 domestic fixed-wing (principally Twin Otter and Basler) flights/season
- the inland set up of semi-permanent flight support facilities comparable with the current arrangements,[17] and their intermittent short-term occupation by, primarily, air–ground support officers
- operation of a generator using ~300 L fuel/day
- use of quads, skidoos, Hagglunds and heavy vehicles to move fuel and cargo sleds, consuming ~1500 L fuel/week[18]
- SLA preparation and maintenance using Prinoth snow groomers and tractors towing drag beams, or a quad or skidoo towing a beam or 'Mogul Master' to remove surface irregularities over a landing area of some 150 000 m[19]
- an ~30 ha physical footprint/site
- positioning automatic weather stations, runway markers, wind socks, emergency response sleds (fire extinguishers, spill kits etc.) as needed to provide for fixed-wing operations
- on-site drummed fuel storage (plateau sites only), and vehicle and aircraft refuelling
- supporting cargo, crew, passenger etc. helicopter flights between Davis and its plateau SLA

2.8 Helicopter operations

The AAD proposes to continue using helicopters to support Program activities. Potential airframes include single-engine models such as Eurocopter AS350 B3 ('Squirrels') and medium-lift twin-engine models such as Sikorsky S-92.

---

[17] As at January 2020, the Casey SLA has an operations building (144 m^3), and 4 x 20' units. The Davis SLA has 6 x 20' units providing for operations management, basic accommodation (for 4-6), power generation, equipment storage and undertaking minor vehicle and equipment repairs.

[18] This figure is typical but could vary substantially. In the 2014-15 season, preparations for a Hercules flight involved the use of ~1600 L fuel /day.

[19] 2200 m long and 60 m wide if used for LC-130 flights. The Casey SLA may also be prepared using a Prinoth snow groomer or other equipment based at Wilkins or Casey.

It is expected that:

- helicopters will be mostly ship or Davis-based
- no more than six aircraft will be used by the Program at any one time, and that their combined total flight time will not exceed 600 hours/season
- the majority of flying in the Davis area will be within the Vestfold Hills and west to the Rauer Islands and Larsemann Hills
- flying operations in the Mawson area will mostly be conducted during visits of ships and in support of scientific programs along the coast, inland in the Prince Charles Mountains and in the vicinity of the Framnes Mountains
- the resupply of Mawson by air will be conducted over a distance of < 110 nm with the following potential flight intensity for sling loads

  Two helicopters:
  - 2 nm ship to shore – 1 helicopter delivering / picking up a load every 2 minutes
  - 5 nm ship to shore – 1 helicopter delivering / picking up a load every 4 minutes
  - 10 nm ship to shore – 2 helicopters delivering / picking up a load every 16 minutes

  Four helicopters:
  - 10 nm ship to shore – 2 helicopters delivering / picking up a load every 7 minutes
  - 20 nm ship to shore – 2 helicopters delivering / picking up a load every 15 minutes
  - 40 nm ship to shore – 2 helicopters delivering / picking up a load every 30 minutes
- flying operations in the Casey region will be focussed within the Windmill Islands, from some 10 nm north of the station to around 20 nm south, and extending 10 nm west to the Frazier Islands, and around 100 nm inland, to the summit of Law Dome

2.9 Fuel storage and use

Station stocks and field caches of aviation fuel (ATK) are needed to support science and meet operational demands, the field caches being used to extend the range and payload of aircraft. Small volumes of drummed petrol (< 1000 L/field site) and or other fuel may also need to be handled.

It is proposed to continue:

- transporting and storing ATK in 205 L drums and other units of mostly <1000 L
- maintaining depots of drums in the vicinity of stations and at sites throughout East Antarctica
- mostly delivering fuel:
  - from ship to shore – in drums transported in 'half height' containers (~39/unit), or by helicopter sling-loads
  - between Casey and Wilkins – by surface vehicle, ~70 km over glacial ice and snow and occasionally by helicopter (mostly coinciding with a ship being at the station)
  - between Casey and Casey SLA – by surface vehicle, ~10 km over glacial ice and snow

- between Davis and the SLA on the plateau – by helicopter (~40 km across the Vestfold Hills), or using vehicles and sleds via the sea ice and fjords in winter
- from Mawson to a landing site ~20 km inland – by surface vehicle
- to other field sites using aircraft
- by vehicle to any sea-ice landing sites near Mawson, Davis and Casey on an 'as required' i.e. flight-by-flight basis

The maximum number of drums of fuel (principally ATK) to be held at or near Australia's facilities are expected to be as follows:

Name / location	Purpose	Likely max. # 205 L drums	Nature of storage location
Casey	main stock for operations in the region	2000	gravel, eastern end of the station
Casey SLA (plateau)	domestic flights	200	ice sheet
Wilkins	limited aviation ground equipment and emergency use	20	ice sheet
Davis SLA (plateau)	domestic flights	200	ice sheet
Davis	main stock for operations in the region	2000	gravel, near helipad
Mawson	main stock for operations in the region	200	rock/gravel

Holdings at remote sites are generally expected to be limited to < 50 drums however certain campaigns may necessitate the summer depoting of stocks of several hundred drums.

2.10 Aviation activities at other sites

The AAD proposes to continue using aircraft to operate on to ice shelves, sea ice, glaciers, low lying snow fields and the high plateau, and in the case of helicopters, also land on icebergs and in ice-free areas.

Potential landings sites are provided at Appendix 5. Other sites may be chosen for operational, safety, environmental or season/project-specific reasons.

Such flying operations may create a requirement to place automatic weather stations in the field. Existing and potential locations of instrumentation include Wilkins, Law Dome, Snyder Rocks, Haut Nunatak, Cape Poinsett, the Casey SLA, the Davis SLA and the Bunger Hills.

2.11 Unmanned aerial systems

The AAD proposes to continue using unmanned aerial systems, in particular where they provide opportunity to minimise the environmental impacts and/or costs associated with conventional aircraft. Potential activities include undertaking infrastructure, sea ice, ice cap thickness and magnetometer surveys; supporting glacial retreat monitoring; small scale meteorological studies; small scale ocean/sea ice/atmosphere interaction studies; mapping; collecting footage for public relations etc.; surveillance for illegal fishing; searches for missing persons; detection of crevasses; and ice reconnaissance in support of the safe and efficient navigation of ships.

airframe used will be dictated by the nature of the particular activity to be supported, and with reference to the likely impacts specific to that activity.

2.12 Facility decommissioning

The AAD proposes to relocate or decommission (remove) any aviation facilities that become redundant.

Site clean-up may involve the excavation and treatment of contaminated soil.

3. Alternatives

3.1 Introduction

The environmental and operational implications of a range of different aviation systems – or abandoning aviation – are outlined below. Any number of system permutations is however possible.

3.2 Discontinue international flights and rely on shipping

Discontinuing inter-continental aviation and relying on shipping would provide for the decommissioning of Wilkins. In that event the Wilkins area would eventually return to its original aesthetic (as distinct from the area's return to a contaminant-free or 'pristine' state).

On an operational level, discontinuing international flights and relying on shipping would reduce the AAD's:

- flexibility in deploying Program personnel to and from Antarctica
- ability to quickly repatriate scientific samples and to deliver and return other high priority cargo
- capacity to support airborne research en route to Antarctica
- capacity to undertake or support search and rescue activities and evacuate sick or injured personnel from Antarctica
- ability to collaborate with other national Antarctic programs
- ability to conduct airborne surveillance

3.3 Discontinue domestic fixed-wing operations

Discontinuing intra-continental aviation would reduce the level of emissions attached to AAP activities and reduce the risks associated with the local handling of large volume of aviation fuel. It would however negate or reduce the AAD's:

- flexibility in moving Program personnel between stations and into the field
- capacity to support airborne research
- capacity to retrieve sick or injured personnel from the field to stations (and in turn, to evacuate sick or injured personnel from Antarctica)
- capacity to undertake or support search and rescue activities
- ability to collaborate with other national Antarctic programs
- ability to support inland programs and conduct airborne surveillance

3.4 Discontinue helicopter operations

Discontinuing rotary-wing aviation and making greater use of ground vehicles and travel by foot (in the Davis area in particular) would lessen the risk of wildlife disturbance associated with low elevation coastal flights and reduce the environmental risks associated with transporting and storing large volumes of drummed fuel. Using surface travel rather than helicopters may however have an enduring impact on ice free areas and may negate or reduce the AAD's:

- ability to transfer personnel and cargo ship – shore
- ability to use its shipping resupply capability early and late in the season
- ability to service a SLA on the plateau behind Davis
- ability to move Program personnel into the field
- capacity to support airborne research
- capacity to undertake or support search and rescue activities and retrieve sick or injured personnel
- ability to collaborate with other national Antarctic programs

3.5 Vary the scale and layout of Wilkins' infrastructure

Expanding the facilities available at Wilkins would negate the need for transit passengers to travel to and overnight at Casey in the event that domestic connections are not immediately possible. This scenario would create a need to generate additional power for heating and water supply at Wilkins, and increase the volume of locally disposed untreated waste water. The resupply of an expanded Wilkins and the return of its solid waste etc. via Casey could also result in an increase in traffic between sites.

Reducing Wilkins' infrastructure footprint could have workplace health and safety implications for staff stationed there for long periods.

3.6 Use other sites and landing surfaces[20]

Scope potentially exists to use other aircraft, other sites as aviation hubs, and other landing surfaces for fixed-wing operation; more than 50 possible aviation systems have been identified based on different aircraft, hubs and landing site combinations. The potential environmental consequences and system disadvantages attached to these options variously include:

[20] As noted earlier, in May 2018 the Australian Government announced it intends to construct a paved runway in the Vestfold Hills, near Davis in Princess Elizabeth Land. The development of the Davis aerodrome and the conduct of operations to this facility are the subject of a separate environmental impact assessment and approval process. The anticipated timeframes for construction (with flights commencing around 2040) mean that this option would not be available for aviation operations between 2020 and 2025.

- an inability to give effect to the system change ahead of or within the next five seasons (in scenarios involving, for example, fuel pre-positioning, establishing new aviation hubs and/or long construction lead times)
- an expansion in Australia's Antarctic footprint (in scenarios involving building additional infrastructure)[21]
- the cumulative impacts on a rare habitat type (in scenarios involving new constructions or other activity in coastal ice-free areas where countries' impacts are already disproportionately concentrated[22])
- markedly greater scope for wildlife disturbance with implications for the breeding energetics of species (in scenarios involving establishing an aviation hub in one of the continent's wildlife-rich coastal areas)[23]
- the elevated biosecurity risks specific to some sites/activities (for example scenarios involving direct flights to ice-free areas in which there is a growing risk of introduced species being able to establish)[24]
- the requirement to store and handle more fuel in Antarctica[25]
- the particular challenges involved in managing fuel drums/storage – and any fuel clean-up requirements – at sites distant from stations[26]
- increases in system costs (for example in scenarios involving aircraft requiring new certifications)
- increased ground support demands (for example if additional sites are to be managed in a manner comparable with operations at Wilkins)
- reliance on others' operations and/or parties over whom the AAD may not have financial or legal control

Wilkins Aerodrome has been sited to achieve the best meteorological conditions for runway operations in that region. It is at an elevation that is sufficiently cold to allow for summer operation and in an area where snow does not naturally accumulate. It is also sited at a location where the prevailing winds align with the slope of the terrain, and where it is distant from concentrations of wildlife.

---

[21] Australia already has the third largest footprint of Antarctic nations (S. Brooks, pers. comm., 7 May 2019); 54% of 30 countries' combined infrastructure footprint is attributable to three countries (Brooks *et al*. 2019).
[22] 81% of buildings in Antarctica are within ice-free areas; 76% are in ice-free areas within 5 km of the coast, i.e. they are located within 0.06% of the continent (Brooks *et al.* 2019).
[23] AAD policy currently defines flying large fixed-wing aircraft within 1220 m of wildlife as causing disturbance. The Madrid Protocol (Annex II) defines flying aircraft in a manner that disturbs concentrations of wildlife as 'harmful disturbance.'
[24] e.g. Chown *et al.* (2012).
[25] It is an expectation that EIAs for new activities consider the nature and scale of any clean-up activity that will be subsequently required – see Committee for Environmental Protection (2014).
[26] The response to a 600 L spill in the Vestfold Hills in 2016 necessitated the airlift of >130 tonnes of contaminated soil to Davis for treatment (Klekociuk and Wienecke 2017).

Similarly, the siting of the SLAs currently used factor local area conditions and the expectation that the impacts of aviation on the environment should – and will be – no more than minor or transitory.

3.7 'Do nothing' (prediction of future environmental state in the absence of the proposed activity)

Intuitively, an increase in voyages and surface vehicle use to help compensate for the loss of, or simply a reduction in, aviation-based logistical capacity would focus activities and impacts on coastal areas where Antarctica's biodiversity is concentrated.

Closing Wilkins and discontinuing aircraft use may release resources that could be redirected to achieving improved environmental outcomes and compliance with the Madrid Protocol.[27]

Logistic support changes of this significance would however have negative and far-reaching implications for personnel safety and AAP delivery.

[27] Australia has an unfunded liability of some $136 million for the remediation of its abandoned Antarctic sites (Press 2014). Site clean-up is a requirement under the Madrid Protocol.

4. Existing environment

4.1 Introduction

The effective management of the values of the regions in which Australian program aircraft and facilities operate and exist is dependent on the values' identification, assessment and understanding. Notwithstanding more than fifty years of study, our knowledge of the continent is highly variable; biological survey and other data does not exist for some large geographical areas. It is nonetheless evident that Antarctica's environment is not homogeneous. This section provides an overview of the region and its values.

4.2 Physical characteristics

The Antarctic continent may be divided into different regions or 'environmental domains' based on physical (abiotic) attributes. Future Australian aviation operations are most likely to span the domains identified as:[28]

- *East Antarctic coastal geologic ('Environment D'):* Environment D is a small terrestrial environment focused along the coastline of the continent from Enderby to Queen Maud Lands. The environment covers an area of 6155 km^2 and consists entirely of ice-free land cover and contains a combination of three geological units – sedimentary (1%), metamorphic (7%), and intrusive (74%). Climatically the environment is cool with an average air temperature of –15.28°C and a seasonal range of –18.35°C. The wind speed within the environment is quite windy at 16.14 m/sec. The environment is moderately sloping with an average slope of 10.94°.

  Casey, Davis and Mawson are located in Environment D.

- *East Antarctic low latitude glacier tongues ('Environment H'):* Environment H is a small ice tongue environment focused around the Oates and George V Coasts between 144° and 162°E within latitudes 66°40'S to 73°S. The size of the environment (14 611 km2) is small and consists entirely of ice tongue and contains no mapped geology. Climatically the environment is warm with an average air temperature of –12.57°C, seasonal range of –16.08°C, and solar radiation of 9.88 MJ/m^2/day. The environment is windy, with an average wind speed of 16.58 m/sec. The average slope is 3.31°.
- *East Antarctic ice shelves ('Environment I'):* Environment I is a moderately sized ice shelf environment spread around the coast of East Antarctica from Kapp Norwegia (12°W) to Moubray Bay (170°E). The environment covers 273 119 km^2 and consists entirely of ice shelves and therefore contains no geology. Climatically the environment is warm in

[28] This classification system was developed by researchers from Landcare New Zealand and has been endorsed by the Committee for Environmental Protection. Information is quoted/adapted here from Morgan *et al.* (2007), with permission.

comparison to the other environments, based upon its coastal location. Its average air temperature is –11.74°C, its seasonal range –17.7°C and the level of solar radiation, 9.83 MJ/m2/day. The environment is windy with an average wind speed of 16.66 m/sec. The slope is almost non-existent at only 2.50°.

- *Continental coastal-zone ice sheet ('Environment L'):* Environment L is a large expansive ice sheet environment encompassing areas from the coast as far south as latitude 70°S in East Antarctica and 76°S from Victoria Land right around to Dronning Maud Land and including an area along the coastline of Marie Byrd Land. The size of the environment (1 868 548 km2) is very large. It consists entirely of ice sheet and contains no mapped geology. Climatically the environment is cool in comparison with the other environments but is one of the warmer environments consisting completely of ice sheet. The average air temperature is –22.95°C, and the level of solar radiation, 9.75 MJ/m^2/day. The average wind speed within the environment is high at 15.07 m/sec. The environment is not very steep with an average slope of 7.53°.
- *Continental mid-latitude sloping ice ('Environment M'):* Environment M is an expansive ice sheet environment that covers four distinct areas all focused around the 75°S parallel. The environment (902 626 km^2) consists entirely of ice sheet and contains no mapped geology. Climatically the environment is cool in comparison to the other environments. The average air temperature is –22.76°C and the seasonal range, –20.62°C. The average wind speed within the environment is moderate at 12.14 m/sec. The environment is not steep with an average slope of only 7.38°.
- *East Antarctic inland ice sheet ('Environment N'):* Environment N is an immense ice sheet environment that covers a large swath of the continent between the 70°S and 76°S parallels from Victoria to Dronning Maud Lands. The size of the environment is enormous at 3 058 936 km^2; only environment Q is larger. The environment consists entirely of ice sheet land cover and contains no mapped geology. Climatically the environment is extremely cold with an average air temperature of –39.25°C and a seasonal range of –22.82°C. The average wind speed within the environment is moderate at 12.81 m/sec. The environment is mostly flat with an average slope of 4.09°.
- *East Antarctic high interior ice sheet ('Environment Q'):* Environment Q is a large environment focused around the South Pole. The size of the environment (3 709 111 km2) is immense and is the largest environment within the classification (by 650 000 km^2). The environment consists entirely of ice sheet land cover. Climatically the environment is extremely cold, and holds a number of distinctions: it contains the coldest annual air temperature (–47.64°C) and largest seasonal range (–29.5°C). The environment also has the third lowest level of solar radiation (7.56 MJ/m2/day). The average wind speed (9.99 m/sec) is quite calm in comparison with the other environments. It is also quite flat, with an average slope of only 3.10°.
- *McMurdo – South Victoria Land geologic ('Environment S'):* Environment S is a small environment which is focused around the McMurdo Dry Valleys, plus Ellsworth Mountains, mountains west of Ronne Ice Shelf and in southern Mac.Robertson Land. It is a small environment (28 227 km^2) compared with most of the other environments. The environment consists mostly of ice-free land cover (98%) and contains a combination of three geological units – sedimentary (47%), intrusive (24%), and volcanic (8%). Climatically the environment is cold with an average temperature of –26.21°C and a seasonal range of –23.0°C. The average

wind speed for the environment is calm, at only 10.26 m/sec, but it is a very steep environment with an average slope of 24.12°.

- *Inland continental geologic ('Environment T'):* Environment T is a small but extensive terrestrial environment which encompasses a number of locations around the continent, in particular in North Victoria, Mac.Robertson and Dronning Maud Lands and a small part of northwest Marie Byrd Land. While the environment is diverse, it covers only 24 742 km^2. Interestingly, a common thread among the environments is their location between the 70°S and 75°S parallels. The environment consists entirely of ice free land cover and contains a combination of all four geological units – sedimentary (11%), metamorphic (14%), intrusive (71%), and volcanic (1%). The environment is cold, with an average air temperature of –25.98°C, and its seasonal range is –19.64°C. The average wind speed within the environment is above average at 14.95 m/sec. Environment T is a steep environment with an average slope of 23.53°.
- *North Victoria Land geologic ('Environment U'):* Environment U is a moderately sized environment located around North Victoria Land but can also be found at Mac.Robertson, Dronning Maud and Marie Byrd Lands. The environment covers an area of 30 578 km^2 and consists of both ice free (52%) and ice sheet (48%) land covers. This environment is the only one within the classification that has a high proportion of two separate land covers. Geologically the areas of ice-free land cover contain a combination of all four geological units – sedimentary (30%), metamorphic (5%), intrusive (6%), and volcanic (9%). Climatically the environment is cold with an average air temperature of –25.62°C and a seasonal range of –18.45°C). The environment is moderately windy with an average wind speed of 13.78 m/sec. The environment is an extremely steep one with an average slope of 30.45°, making it the steepest environment within the continent.

Indicative maps are provided at Appendix 6

4.3 Biodiversity

A biogeographic analysis incorporating the above spatial framework for physical features divides the continent into distinct bioregions[29]. The bioregions within the area of AAP operations are staged (Appendix 7) include habitats and landscapes that are regarded as rare, or extremely rare, for example:

- coastal oases[30]
- concentrations of fjords[31]

---

[29] Terauds *et al.* (2012). A sixteenth region has since been proposed, namely the Prince Charles Mountains.
[30] Antarctic Treaty Secretariat (2014).
[31] Fjords individually, are very rare in Antarctica. The concentration of fjords found in East Antarctica (i.e. the Vestfold Hills, Princess Elizabeth Land) is unique (AAD 2020b). Ellis Fjord, within this group, is one of two locations in Antarctica where extensive living reefs formed by tube-building worms have been found.

- intertidal mudflats[32]
- areas of meromictic lakes[33]

Antarctica's visible life is predominantly confined to lower altitude areas in coastal regions; more than 99% of Antarctica's biodiversity is concentrated in areas that are permanently ice free. Much of Antarctica's biodiversity comprises the lesser-studied and sometimes highly-localised microbiota found in soils, lakes and ice. Microbial communities include cyanobacteria, bacteria and protozoa. Many of the terrestrial invertebrates found in Antarctica (mites, tardigrades, nematodes, rotifers and others) are endemic, and in some cases endemic to particular ice-free regions.

East Antarctica's terrestrial vertebrate fauna comprises seals and seabirds (see Appendix 8), the latter visiting or breeding in East Antarctica in their millions, some foraging widely. Most wildlife concentrations are present on land or near-shore areas in summer. Adélie penguins, snow petrels, Antarctic petrels and other seabirds use ice-free habitats for nesting. Some petrel species nest in rock fissures and crevices.

Known or regularly encountered concentrations of wildlife along potential flight paths have been mapped (a list of the maps is at Appendix 9) and the maps consolidated in the AAD's *Flight path guidelines – avoiding wildlife in East Antarctica*. A list of areas where operations are liable to occur in the vicinity of wildlife is provided at Appendix 10. These areas include:

- the Rauer Islands where an estimated 105 000 pairs of seabirds breed
- the immediate Davis station area where 100 to 150 southern elephant seals annually haul out
- areas where Weddell seals pup in large concentrations, including Weddell Arm, Shirokaya Bay and Tryne Fjord, near Davis
- the broader Vestfold Hills area which provides breeding and other habitat for migratory, threatened and vulnerable species, and hundreds of thousands of seabirds
- Béchervaise and Welch Islands where in excess of 22 000 pairs of Adélie penguins breed within a 10 km radius of Mawson

Some areas of wildlife (and abiotic features) have been included in a network of Antarctic Specially Protected Areas (Appendix 11) and are the subject of site-specific management plans.[34] They include the Vestfold Hills' Hawker Island where Antarctica's southern-most colony of southern giant petrels breeds (~30 pairs, 300 m offshore), and Amanda Bay (75 km from Davis) which is habitat for several thousand pairs of emperor penguins. Other sites have been identified as Important Bird Areas (Appendix 12). Of these, eight are located in the Vestfold Hills.

Bird sightings at Wilkins are relatively rare notwithstanding recordings of individual skuas having been made as far inland as the South Pole.

---

[32] One such mudflat is at the head of Heidemann Bay, near Davis (AAD 2020b).

[33] Meromictic lakes are rare on a global scale (AAD 2020b). The planet's largest concentration of meromictic lakes is found in the Vestfold Hills.

[34] The designation process has not however been entirely strategic from a biodiversity conservation perspective (see, for example, Shaw *et al*. 2014), and is under review.

East Antarctica also supports small but regionally significant areas of algae, lichens and moss. Vegetation must contend with protracted periods of low temperatures, low water availability, low nutrient loads, and salinity and sand and ice abrasion. Their local distribution reflects these and other environmental constraints and impacts. Epilithic algae are found in areas that have surface flowing water and/or associated with bird colonies where nutrients are available from guano.

Outside of the Antarctic Peninsula, the Windmill Islands in Wilkes Land supports some of the most extensive and best-developed plant communities on continental Antarctica – in effect, miniature old growth forests. A single moss shoot may be over 100 years old. The regional flora comprises at least 36 species of lichen, six bryophytes, 150 non-marine algae and at least 120 fungal taxa. The vegetation of Bailey Peninsula (where Casey is located) is exceptionally well-developed and diverse with turf up to 30 cm in depth. Mosses have been collected from as far south as 84°30′ – *Ceratodon purpureus* at Mt Kyffin, Southern Victoria Land.

4.4 Human environment

Government stations and field programs, including those of Australia, Belarus, China, India, Italy, France, the Russian Federation and the USA, are spread throughout East Antarctica.[35] The most station-dense region is the Larsemann Hills, a coastal ice-free area on the south-eastern coast of Prydz Bay. Here, an Australian summer facility, and Zhongshan (China) and Progress (Russia), are located within ~3 km of each other on a peninsula (Broknes) crossed by ~15 km of unsealed roads. Bharati (India) and a 2000 m Russian skiway are located to their west and ~7 km to their south respectively.

Australia's three continuously-occupied stations – Casey in Wilkes Land, Davis in Princess Elizabeth Land, and Mawson in Mac.Robertson Land – serve as coastal hubs for AAP activities. Wilkes, built by the US and occupied by Australia from 1959 to 1969, lies 3 km to Casey's north and, one building aside, is no longer habitable. The station and its waste dumps span some 32 ha.

Casey is on the west coast of Law Dome, an almost circular 200 km diameter ice cap rising to a height of 1395 m, 110 km inland. The stands of moss and lichen in Casey's vicinity are so significant that Casey is often referred to as the' Daintree of Antarctica'. Casey is accessed by ship and inter and intra-continental aircraft.

Davis is in the Vestfold Hills, a triangular ice-free area of ~400 km^2. The region is visually distinctive and considered to be one of the most significant oases in Antarctica, the Vestfold Hills bearing rock exposures with crustal histories in the 2.5 billion year range. The area's hills are of low relief (< 160 m) and are intersected by numerous fjords and lakes. Davis is accessed by ship and intra-continental flights, most often by ski-equipped fixed-wing aircraft originating from Casey/Wilkins.

[35] Non-government activity in East Antarctica is usually ship-supported and focussed on the Commonwealth Bay region where the huts of the Australasian Antarctic Expedition of 1911-14 are located.

Mawson, established in 1954, is the oldest, continuously-occupied facility south of the Antarctic Circle. The station is located on the south-eastern shore of Horseshoe Harbour, a small ice-free rock outcrop on the edge of the continental ice cap. The coastline to both Mawson's east and west is mostly sheer ice cliffs, while the continental ice sheet behind it attains a height of some 1000 m within 35 km. The station is accessed by ship and intra-continental flights, most often by fixed-wing aircraft originating from Davis.

Most of the stations' extant buildings are post-1978 when the last major rebuilding program took place; many are now ending their design life. Buildings are serviced by above-ground reticulated water, power and sewerage systems. Electrical power is provided by diesel generators, at Mawson supplemented by wind energy.

Station operations are supported by a fleet of vehicles (> 80 at Casey), ranging from light 4WD vehicles, quads and skidoos, to tracked all-terrain Hagglunds and heavy over-snow bulldozers. Gravel needed to maintain roads at Casey and Davis is obtained by quarrying on the stations' outskirts.

Summer-focussed aviation operations are directly supported by helipads and operational buildings within the Casey, Davis and Mawson precincts. Semi-permanent facilities are also concentrated adjacent to the Wilkins runway, and at Davis, Casey and Mawson SLAs.

Other elements introduced to the landscape include field huts and depots, some of the former having helicopter landing pads adjacent to them.

Other signs of human activity are also scattered throughout the region. They include Australia's and other countries' roads, automatic weather stations, antennae, caches, signage, bamboo and drum route markings, fencing, scientific equipment and markers, vehicle tracks, excavations, bollards, navigation beacons, cairns, graves, plaques and memorial crosses.

Components of the environment, in particular in the stations' vicinity, have been impacted by fuel spills, water drainage change, vehicle use, windblown debris, incinerator emissions, road works, concrete dust, earthworks, the use of explosives (to make gravel) and the disposal of minimally-treated waste water.

4.5 Heritage values

Australia's aviation operations intersect with areas where structures and features of historic importance are located. These structures and features have been attributed value on account of their:

- importance in the course, or pattern, of Australia's natural or cultural history
- possession of uncommon, rare or endangered aspects of Australia's natural or cultural history
- potential to yield information that will contribute to an understanding of Australia's natural or cultural history
- importance in demonstrating the principal characteristics of (i) a class of Australia's natural or cultural places; or (ii) a class of Australia's natural or cultural environments

- special association with the life or works of a person, or group of persons, of importance in Australia's natural or cultural history

They include the Old Paint Store at Davis (as one of the buildings from the first ANARE station on Heard Island, and the only surviving example of its type) and the Platcha field hut (the oldest field base for scientific studies in the Vestfold Hills and the only remaining example of an early remote ANARE weather station).

Two sites – Mawson station and the Australasian Antarctic Expedition (AAE) huts at Cape Denision – have been included on Australia's National Heritage List.

East Antarctic sites and structures given formal Antarctic Treaty system protection include Sir Douglas Mawson's rock cairns on Proclamation Island (HSM #3) and at Cape Bruce (HSM #5); Sir Hubert Wilkins' 1939 rock cairn at Walkabout Rocks, Vestfold Hills (HSM #28); Klarius Mikkelsen's 1957 cairn in the Tryne Islands, Vestfold Hills (HSM #72), and the AAE huts (HSM #77). HSM #77 forms part of Antarctic Specially Protected Area (ASPA) #162. The majority of these sites are accessed by air.

Many of the region's topographical features bear the names of members and supporters of early Australian exploration and mapping efforts. Aviation has contributed to such features' identification, mapping and access.

4.6 Wilderness, aesthetic and intrinsic values

Areas to which aircraft currently operate, and are expected to operate to into the future, include areas of considerable if not outstanding aesthetic value, as evidenced by the reactions of AAP personnel and others to the environment.[36] The region has been described as exquisite, beautiful, sublime, amazing, unparalleled, magical, awesome, magnificent and heart-achingly lovely – even beyond description – and the experiential aspects as exhilarating, overwhelming, breath-taking and mind-blowing.[37] Such reactions are the product of engagement with the environment and its features on macro and micro scales (Appendix 13, Plates 1-3), a sense of wonderment or appreciation variously deriving from the sight of the vast and expansive Antarctic plateau; concentrations of intensely coloured lakes; the formation and retreat of sea ice; the clarity of the near-shore water; the variety, patterns and textures of geology at landscape scale through to individual rocks; and/or the abundance or engaging behaviour of wildlife. Experiences of Antarctica's wilderness values are similarly associated with the continent's remoteness and senses of solitude, discovery and scale.

As the Madrid Protocol acknowledges, Antarctica also possesses intrinsic value.

---

[36] Accounts that are negative most often focus on the visual intrusion of stations and their detritus, or appear to have been triggered by experiences of physical hardship (see especially, early explorers' narratives).

[37] Burns (2001) includes a compilation of responses. See also the AAD's 'Station Updates' published weekly at https://www.antarctica.gov.au/news/stations/.

5. Potential environmental impacts

5.1 Introduction

The authorisation of the proposed activity will result in a range of direct and indirect impacts on the Antarctic environment.

5.2 Spatial extent and intensity

The impacts of the current aviation paradigm may extend across the following environmental domains described in greater detail in Section 4:

Domain	Descriptive label	Main operational areas
D	East Antarctic coastal geologic	Casey, Mawson, Beaver Lake, Larsemann Hills, Bunger Hills, Davis and the Vestfold Hills
H	East Antarctic low latitude glacier tongues	Mertz, Ninnis and Rennick Glacier tongues
I	East Antarctic ice shelves	Amery, West, Shackleton and Cook Ice Shelves
L	Continental coastal-zone ice sheet	Oates, Princess Elizabeth, Wilkes and Enderby Lands, Law Dome
M	Continental mid-latitude sloping ice	Mac.Robertson Land; Fisher, David and Lambert Glaciers
N	East Antarctic inland ice sheet	Dronning Maud Land
Q	East Antarctic high interior ice sheet	South Pole, Vostok, Dome C
S	McMurdo – South Victoria Land	Vinson Massif, southern Prince Charles Mountains
T	Inland continental geologic	Groves Mountains, Mawson Escarpment
U	North Victoria Land geologic	Prince Charles Mountains

Operations will correspondingly span and potentially impact the biogeographic regions known as :

- ACBR 5 – Enderby Land
- ACBR 7 – East Antarctica

and to a lesser extent:

- ACBR 6 – Dronning Maud Land
- ACBR 8 – Northern Victoria Land
- ACBR 9 – Southern Victoria Land
- ACBR 13 – Adélie Land
- ACBR 16 – Prince Charles Mountains

The nature and intensity of impacts will be highly variable; areas in the vicinity of Wilkins, Casey, Davis and Mawson are likely points of impact concentration.

5.3 Impacts on air quality through emissions

Atmospheric emissions, including greenhouse gases, are generated by the combustion and evaporation of fuels in the course of aircraft overflights, landings, take-offs and ground manoeuvring, and through surface vehicle and generator use. These emissions include smoke (soot), sulphur oxides (SO_x), oxides of nitrogen (NO_x), carbon monoxide (CO), carbon dioxide (CO_2) and unburned hydrocarbons (HC), and have the potential to affect air quality.

Emissions vary with fuel, aircraft, engine type and operating conditions (payload, weather encountered, altitude etc.). Soot levels are liable to be highest during aircraft take-off and climb-out whereas unburned HC and CO_2 are primarily associated with engine operation at low power, especially during ground idle.

Aircraft condensation trails may be produced in the course of water vapour emission as a by-product of combustion although these 'contrails' are expected to be dispersed as ice particles evaporate in the lower atmosphere.

The potential impacts of the other emissions, especially at the local level, are not well understood; limited monitoring has been undertaken of AAP operations to date. Monitoring undertaken to determine the impacts of flights to the Windmill Islands (Casey and Wilkins) region, and the ground support thereof, found a major decrease in air quality at Casey between monitoring events (i.e. sampling in the 2007-08 and 2008-09 summers) that if continuing to trend in the same way, could have a 'severe impact on air quality, and possibly on moss communities downwind of the station.'[38]

The highest polluters by flight of the fixed-wing airframes potentially used are Hercules and C17s.

Of the two types of helicopters potentially used, the twin-engine models are expected to produce the greatest exhaust gas emissions. However, as concluded in a 1994-prepared EIA of earlier models, 'even at short distances from the operating area, there is a high probability that levels of contaminants will be negligible or undetectable.'

5.4 Impacts on water, snow and ice quality/processes through emissions to the atmosphere

Particulate fallout in line with the above (and also attributable to sources external to Antarctica), has been recorded in the continent's snow and ice. Snow melt may result in the transport of contaminants into lakes and the marine environment.[39]

---

[38] The monitoring was undertaken in 2008-10 by M. Gasparon, University of Newcastle, under contract to the AAD.

[39] It is thought that a recording of 3.2 Pb/BA or above may be regarded as unambiguous evidence of local anthropogenic input – anything below may represent the types of variation typically found in modern Antarctic snow. Diesel and jet fuel do not contain added metals and their combustion is not expected to cause the release of large amounts of metals. They may however contain 'natural' metal traces, and contamination may occur following storage and during the combustion process itself (Gasparon 2008).

It is possible, that some change in lake chemistry could occur as a result of the deposition of fuel particulates given that helicopters fly regularly and at low altitudes over lakes in the Vestfold Hills (and elsewhere).

5.5 Impacts on water, snow and ice quality/processes through other releases and activities

Based on past performance, exhaust spatter, droplets of oil etc., fragments of cardboard, rubber and plastics, and pieces of bamboo can be expected to contaminate snow and ice extending to ~5 km from Wilkins, along the Casey–Wilkins route, and at SLAs.

In the event of a large aircraft emergency on take-off (e.g. loss of an engine due to fire or bird strike) it may be necessary to dump several thousand litres of fuel. The likelihood of this occurring is considered to be small.

Operations conducted near lakes and water courses such as those concentrated in the Vestfold Hills create scope for the irreversible physical, chemical and biological contamination of the environment.

Losses of ATK (used for aircraft refuelling), SAB (used for infrastructure needs and refuelling most of the vehicle fleet), ULP, lubricants and hydraulic fluids may impact water, snow and ice quality. More than 500 000 L of ATK may be used or managed each season – fuel drums are sometimes handled as many as nine times in the process of packing through to delivery and use on the continent.

Notwithstanding the mitigations currently in place to minimise fuel handling risks, the residual environmental risks in relation to current operations have been rated as high.

Releases may occur through, for example, bulk fuel storage or pipework failures or damage, and spills during vehicle refuelling and maintenance. Incidents involving drummed fuel spillage may arise from having to jettison unstable sling-loads, dig drums out of snow, move drums using large machinery, and operate machinery near drums for other purposes. [40]

Depending on the affected substrate, spills may quickly enter marine areas or slowly migrate over decades. Their clean-up presents a range of unique and complicated challenges even when close to stations. Only limited evaporation of spilt liquids may occur.

Planned and accidental releases of untreated waste water from Wilkins and elsewhere may include urine, pathogens and industrial contaminants, adding nutrients and chemicals to their receiving environments.

The maintenance of the runway at Wilkins, berm construction, and SLA and road grooming/grading involves the mechanical relocation of thousands of tonnes of snow. The presence of

[40] Between the 1980s and 2015 there have been 44 reported Australian spills in the Antarctic and sub-Antarctic totalling 461 137 L diesel; 1850 L ATK, and 7022 L hydraulic oil, ULP and glycol. The frequency of spills related to pipework and storage has reduced with the replacement of aging infrastructure. More recently a gasket failure during weekly fuel transfer in September 2018 resulted in an estimated leak of 3500 L of which an estimated 2000 L remained in the environment following the first season of clean-up. The AAD has spent > $15 M researching and trialling clean-up techniques suitable for Antarctica.

buildings generates the formation of drift or blizz tails that may extend for many hundreds of metres.

Air-drops have the potential to release the contents of packaged cargo. Any liquids and other materials accidentally released into the environment may be difficult if not impossible to retrieve.

5.6 Impacts on biota through habitat alteration

The accumulation and deposition of aircraft and vehicle exhaust has the potential to affect habitat and the species found therein. The risks to wildlife through chemical contamination of the environment associated with routine aviation operations is however regarded as 'very low.'[41]

Areas of moss may be subjected to rotor-wash generated dust, and other habitat alteration may result from helicopter and UAV operations in ice-free areas.

Habitat alteration or destruction may also result from fuel spills (as described above), and other materials management decisions or failures. Wildlife is not expected to come into direct contact with spilt fuel unless the incident is coastal.

The stockpiling of large numbers of empty ATK drums on Davis' beach may – and particularly if in conjunction with other activity in the area (e.g. resupply operations and spill remediation works) – alter elephant seals' haul-out behaviour in the course of one or more summers.

5.7 Impacts on wildlife through noise disturbance and visual stimuli

The operation of aircraft (both conventional and unmanned), support vehicles and generators, and human activity in general, may disturb wildlife, in particular breeding and moulting birds by virtue of the noise generated and the potential for species to regard aircraft as a large predator.[42]

The noise generated by aviation activities is expected to vary according to aircraft type, take-off weight, thrust, flying and approach altitudes, and the landing terrain's altitude and meteorological conditions. The duration of exposure, the number of events of exposure, and the maximum level of noise reached are relevant to the consideration of impacts.

Seventy decibels is often used as a threshold of unacceptability in the context of human exposures to noise[43] although World Health Organisation threshold guidelines are considerably more conservative.

---

[41] By specialists attending an aviation monitoring workshop held in conjunction with the 3rd International Conference on Contaminants in Freezing Ground held in Hobart in April 2002.

[42] e.g. Manci *et al.* (1998).

[43] Community consultation processes, primarily related to human health considerations and proximity to airports, often use 'N70' as a measure, i.e. the number of aircraft noise events per day exceeding 70 dB(A). dB(A) or A-weighted decibels are an expression of the relative loudness of sounds in air as perceived by the human ear.

Most species are particularly sensitive to disturbance between late September and early May—the period in which Antarctic aviation operations are concentrated.

Disturbance may manifest as fleeing behaviour, confusion and panic, and in extreme cases result in impaired breeding performance, injury and even mortality.[44]

The magnitude of the impacts on wildlife from noise and visual stimuli is expected to vary between species and their breeding season phase. Southern giant petrels in particular are liable to leave their nests when disturbed.[45]

Disruptions to the orderliness of Adélie penguin colonies results in fighting and the exposure of eggs and chicks to predation; south polar skuas may profit from such activities by taking unattended eggs and chicks.[46]

Possible reactions by breeding seals to overflights by large fixed-wing aircraft include, but may not be restricted to, female seals breaking lactation and abandoning their pups to escape into the water for unknown periods. Such reactions have the potential to accumulate over time with implications for breeding success and population numbers.

The impacts of disturbance may be exacerbated by the effects of climate change and other stressors.

A review of the literature identifies three thresholds of concern for wildlife:

- 55 dB – observable effects
- 65 dB – masking effect
- 70 dB – significant behavioural effect

An aircraft event level greater than 15 dB over a general ambient noise level of 50 dB also has the potential to mask certain noises.[47]

Aviation noise impacts have the potential to extend over large areas of wildlife habitat. The 65 dB footprint of a C17 approaching and departing a landing site is in the order of 260 km^2, and that of a Basler is around 28 km^2. Their 70 dB footprints are in the order of 127 km^2 and 12 km^2 respectively.

Helicopter operations in coastal areas may present additional and/or different disturbance risks on account of their intensity. The aerial resupply of a station may involve as many as 1000 ship-shore sorties, and prolonged hovering.

While birds found in nunataks and mountain areas can be exposed to operations, Wilkins is believed to be sufficiently distant from areas of breeding habitat for wildlife to be affected by the day-to-day noise generated by camp and runway maintenance activities.

[44] e.g. Rounsevell and Binns (1991).
[45] e.g. Antarctic Treaty Secretariat (2016).
[46] e.g. Creuwells (2011).
[47] e.g. Manci *et al*. (1998).

5.8 Impacts on wildlife through direct strikes or entanglement

Antarctic species occasionally collide with aircraft and infrastructure.[48] Instances can go unnoticed because of the observed speed with which skuas collect carcasses.

Wildlife may also become entangled in any air-drop equipment that is not retrieved, or consume materials dispersed should loads disband.

5.9 Disease introduction risks

A risk exists of commercial poultry diseases being transmitted from commercial poultry products to wildlife populations. This risk, although small, could be catastrophic.[49] Poultry products are supplied to the Wilkins Aerodrome camp; there are no wildlife populations in the camp vicinity.

5.10 Impacts associated with introductions and species transfers[50]

Non-native species and other biological contaminants (e.g. soil, webs, nests, bird faeces) may be transported in aircraft, air-dropped, entrained on exteriors and cargo, and/or on the clothing and footwear of aircraft crew and other travellers on international flights. Contaminants may in turn be transported between biogeographic regions.

Species introduced by aviation (and other pathways) have the potential to effect changes in the terrestrial environment by impacting upon the distribution, abundance or productivity of indigenous species or populations of species, including those identified as endangered or threatened. They may also compromise Antarctica's scientific values.

Aviation activities raise additional and or specific concerns (i.e. over and above those attached to the introduction risks via shipping operations) due to:

- there being complete reliance on contractors adopting good biosecurity practices when aircraft enter the Antarctic Treaty area from departure points outside Australia
- the passage of ferry flights through regions in which cold-adapted species are present
- the greater number of personnel and changeovers or 'churn' involved
- the short transit times involved facilitating introductions' potential live delivery
- the ease with which aviation can transport species – native and non-native – between remote 'habitat islands'

---

[48] Program personnel are briefed that bird strikes constitute reportable incident; occasional reports have been made. Program reports of aircraft–bird interactions include that of a skua colliding with a UAS that it attacked when defending its territory.

[49] 'Use of poultry products', AAD, 24 July 2017.

[50] Legislative (*ATEP Act*) controls exist for intentional imports to Antarctica.

Propagules (seeds, spores, moss fragments etc.) will not reproduce if landed in an ice field, but could do so if transported on to Casey and elsewhere.[51]

The impacts of exotic species and the impacts of domestic species' transfers – native or otherwise – are likely to prove irreversible.[52]

No quarantine service or system is able to totally prevent introductions, and there is little agreement on the extent to which biological, and in particular microbiological redistributions can be prevented.

5.11 Impacts on geology and vegetation

Antarctic soils and vegetation can be readily and permanently impacted by chemical contamination as described above. Evidence of soil contamination by fuel may persist for 100 years or more.[53]

Soils and vegetation may also be subject to mechanical disturbance or damage through vehicular and foot traffic. This disturbance is expected to be greatest at Casey as the support of Wilkins generates a comparatively high volume of traffic into the station's ice-free environs where moss and lichen are prevalent.

The impacts of helicopters landing on soft pavements are expected to be minimal compared to those associated with surface travel, evidence of which may last for decades. Indeed the ability to fly over ice-free areas has enabled managers to identify damage caused by surface travel – without compounding the issue.

Any building or replacement of helicopter landing pads adjacent to field huts in ice-free areas can be expected to result in some additional highly-localised disturbance. The construction of helipads adjacent to field huts in ice free areas may also have the positive impact of reducing the dispersal of dust associated with helicopter landings at other sites.

Crashed UAS can pose a risk to geology and vegetation. Such aircraft can be especially difficult to fly in in Antarctica.[54] The greater the mass and velocity, the greater the risk of harm through physical impact. If UAS crash in an inaccessible location, their components (including metals, plastics, solders and batteries) will remain in the environment and degrade very slowly in the cold conditions, if at all.

---

[51] Nevertheless the Madrid Protocol's wording suggests that all human-mediated introductions of non-native species are problematic rather than only those with the potential to establish and displace, or otherwise impact upon existing assemblages.
[52] e.g. flies introduced to Casey more than 15 years ago continue to evade eradication efforts even though they are confined to station infrastructure.
[53] Various authors in Australia (2006). Blanchette *et al.* (2004) found polyaromatic hydrocarbons and other chemicals in soils in the vicinity of 'heroic era' huts in Antarctica.
[54] Inversion conditions often create calm conditions in a shallow pocket at the surface and storm force winds at relatively low altitude. Some navigation or stabilisation systems can be affected by the high magnetic variability experienced near the magnetic poles. Communications systems may affect, or be affected by, station operations such as VHF radio, and science and weather balloon sonde communications, and cold temperatures can substantially reduce battery life.

Soils and vegetation may also be exposed to non-native species and other biological contaminants (e.g. soil, webs, nests, bird faeces) transported in aircraft, air-dropped, entrained on exteriors and cargo, or on the clothing and footwear of aircraft crew and other travellers.

5.12 Impacts on research and scientific values

Aviation assists researchers' access to and exploitation of the continent's contribution to knowledge by facilitating the collection of data. Conversely, some of the consequences of aviation, such as the contamination of snow by emissions, may undermine some areas' potential for future research noting that the relatively pristine nature of Antarctica's snow and ice is an advantage for studies of levels of anthropogenic pollutants worldwide.[55]

Similarly, aircraft taskings will increase the potential for terrestrial microbial habitats to be impacted by microbial and genetic contamination; fewer 'pristine' sites will likely exist over time.

Any increase in the number of people involved in supporting aviation could reduce the number of Program places available to scientists.[56]

5.13 Impacts on wilderness and aesthetic values

The wilderness and/or aesthetic values of the area of AAP operations may be derogated by the presence of caches, weather stations, infrastructure and the like that are linked to aviation. Such impacts and installations may be widely scattered and permanent or at least semi-permanent fixtures. The route to Wilkins, for example, is currently marked by canes and drums placed at 3-5 km intervals. Aviation's impacts combine with those of other AAP activities in East Antarctica (Appendix 13, Plate 4) from which they currently differ mostly in their scale and permanence.

Most visitors to East Antarctica are associated with research expeditions and likely expect the presence of human elements in the landscape. Such expedition members may regard the visual intrusions associated with aviation in its current form as trivial when examined against, for example, the presence of abandoned stations and waste disposal sites.

Similarly, litter in the Antarctic environment offends some onlookers while for others it is par for the course, as elsewhere. Aviation operations may contribute to the load, in particular should air-drop parachutes and the contents of damaged loads and energy dissipating materials etc. not be retrieved.

Aviation noise and aircraft sightings may also detract from the enjoyment of scenery, isolation, silence and other remote wilderness experiences.

[55] e.g. Boutron and Wolff (1989) and Duce (1972) in AAD (1990).

[56] The ratio of scientists to other Program participants across Australia's stations is typically 1:5.

5.14 Impacts on heritage values[57]

Sites and artefacts of actual or potential heritage significance are scattered throughout East Antarctica however historic structures are more likely to be negatively impacted by exposure to extreme weather conditions than they are by aviation-related activities. Indeed, improved conservation outcomes may be facilitated by the use of aircraft as, potentially, the only viable means of getting access to especially remote sites.

Aviation operations to remote locations may facilitate the discovery of early expedition artefacts of heritage significance.

5.15 Second order and cumulative impacts

East Antarctica has been home to more than 50 years of exploration, scientific activity and tourism, and most programs' operations in the region – Australia's included – are growing spatially and in intensity.

Extensions of existing facilities and increases in personnel, flights, fuel consumption etc. by around 10% are among categories of activity that might reasonably be expected to have a significant impact on the environment.[58]

Australia's stations and field facilities have incrementally grown since they were established. The number of AAP participants is also generally increasing, as indicated by the following passenger figures:

1982-83	1992-93	2002-03	2012-13	2019-20
275	430	480	594	551[59]

Accordingly, the proposed activity can be expected to contribute to:

- pressures on Antarctica's rare ice-free areas where human impacts are already disproportionately concentrated[60]
- local pollution of the environment
- the general disturbance of wildlife
- a reduction in inviolate areas, wherever they remain
- impacts on Antarctica's aesthetic and wilderness values

[57] The Madrid Protocol and the *AT(EP) Act* do not define heritage values but require that they are protected. The *EPBC Act* (s.528) defines the 'heritage value' of a place as including the place's natural and cultural environment having aesthetic, historic, scientific or social significance, or other significance, for current and future generations of Australians. Heritage values may exist on local, community, national or international levels.

[58] SCAR (1985).

[59] Individuals making multiple visits/season for the same purpose are counted once.

[60] 76% of programs' infrastructure is situated within ice free regions within 5 km of the coast – environmentally significant and sensitive areas equating to 0.06% of the continent (Brooks *et al.* 2009).

Separate to this IEE, the AAD has commenced an environmental assessment and approval process for the construction and operation of an aviation hub in the Vestfold Hills – a project that is unprecedented in its scale and complexity.[61] Inter-continental flights to the aerodrome are expected to commence in around 2040 and to occur year-round, approximately once per month between May and September and three times per month between October and April.

The construction of the 'Code 4E' runway – 4.5 km from Davis and 2700 m in length – involves large-scale earthworks (~3 000 000 m^3 of cut and fill) including rock blasting, crushing and screening; making various access tracks and roads; laying and grouting ~11 500 pre-cast concrete pavers; building hangars, expeditioner processing facilities, a storage shed, bulk fuel containments and an air services centre; and installing elevated lighting 420 m from the runway ends.

New facilities needed to support the aerodrome's construction include a second wharf, a heated explosives storage building, a construction hard stand area, a new mechanical workshop and lay down and materials storage facilities. New accommodation, living quarters, water production facilities, wastewater treatment facilities, bulk fuel storage and site services will also be needed to support a construction phase population of ~250 (i.e. an additional 130 personnel). This infrastructure is expected to take seven years to complete and to increase the landscape physically disturbed by Davis' presence by an estimated 220 ha.

Early season flights onto the Davis sea ice by large fixed-wing aircraft, if realised, could also add to the impacts of aviation on the region's wildlife.[62] As these impacts could be significant and cumulative, flights to the sea ice in this area will only be considered in exceptional circumstances, that is, on the basis that no other option exists to support a critical AAP need in the next five years.[63]

The aviation arrangements described in this IEE will also intersect with the operations of the AAD's new traverse capability to be based out of Casey, and Australia's new icebreaker, RSV *Nuyina,* which is due to enter into service in 2021.

[61] AAD (2020c). As of January 2020, an *AT(EP) Act* PA, and an *EPBC Act* referral (see AAD 2020b) have been completed.

[62] Although these may be an option considered between 2020 and 2025, there is currently insufficient information on this potential activity (e.g. seasonal timing and likely landing sites) to factor the impacts in this IEE.

[63] One such flight was undertaken in 1985 to evacuate a critically injured expeditioner.

6. Mitigation measures

6.1 Introduction

The environmental impacts of aviation may be lessened by adopting the policies and procedures outlined in this section. It is anticipated that these mitigations will form environmental authorisation conditions and be incorporated in standard operating procedures (where not already).

6.2 General measures

Governance

- Aviation operations will be conducted such that they comply with legislative instruments and Australian policy related to environment protection – including ASMA and ASPA management plans.
- New aviation contracts and inter-agency arrangements will include an environmental/ legislative compliance requirement.
- Compliance with the environment protection legislation and the mitigation measures identified in this IEE will be reported upon.
- The AAD as proponent will make reports to the Minister (or his/her delegate under the *AT(EP) Act* 1980) on the outcomes of monitoring specific to the conduct of aviation.
- Incidents will be logged using established AAD processes, as a means of improving capacity for adaptive management.
- Resources will be made available to clean-up spills and rehabilitate sites impacted by aviation.
- All reasonable steps will be taken to promote the return of the environment to its original condition after any pollution release or other aviation-related incident.
- The AAD will take appropriate action in response to Committee for Environmental Protection aviation-relevant advice to Antarctic Treaty Consultative Meetings on:
    - the effectiveness of measures taken pursuant to the Madrid Protocol and the need to update, strengthen or otherwise improves such measures
    - the means of minimising or mitigating the environmental impacts of activities in the Antarctic Treaty area
    - the collection, archiving, exchange and evaluation of information related to environmental protection
    - the need for scientific research, including environmental monitoring, related to the implementation of the Madrid Protocol

Training and briefing

- The briefing/training of Program participants involved in aviation operations on the continent will include content on personal accountabilities, legislated obligations, biosecurity controls, protected area locations, flight paths to avoid wildlife disturbance, identifying wildlife behaviours indicative of disturbance, and the use of fuel spill kits etc. as appropriate.[64]

  All aircrew will receive annual briefings, with helicopter pilots receiving face-to-face pre-departure briefings by the AAD Operations Manager (or equivalent position), or their delegate.

  Pilots of aircraft involved in conducting air-drops will receive a briefing by AAD staff that is specific to each operation.

- Records of briefings and registers of training completion to a satisfactory level will be maintained by the AAD's Aviation Manager (or equivalent position).
- On-site environmental management-related responsibilities will be unambiguously assigned.
- A copy of this EIA and any permit and authorisation conditions will be provided to the on-site managers of aviation operations.

Fleet management, infrastructure and facilities

- Aircraft and vehicles will be maintained such that their emissions fall within manufacturers' specifications.
- Redundant aviation infrastructure will be re-allocated or else promptly returned to Australia.

6.3 Actions to minimise the impacts of aviation on wildlife[65]

- The following distances will be maintained from concentrations of wildlife (as a minimum) unless closer approaches are specifically authorised:

[64] As per Appendix 11.

[65] Noting some aviation activities are prohibited outright by ASPA management plans. Refer also to 6.12 for additional controls applicable to aircraft engaged in air-drops and 6.4 for controls specific to unmanned aircraft.

Aircraft type	Minimum separation distance from concentrations of birds and seals[66]
Twin-engine fixed-wing aircraft	750 m (2500 feet) when flying; 930 m (3000 feet) when landing
Fixed-wing aircraft exceeding twin engines	2150 m (7000 feet)
Single-engine helicopter	750 m (2500 feet) when flying; 930 m (3000 feet) when landing
Twin-engine helicopter	1500 m (5000 feet)
Unmanned aerial systems[67]	750 m (2500 feet) when flying; 930 m (3000 feet) when landing
	Minimum separation distances from whales and other cetaceans[68]
Helicopters	500 m (1650 feet) within a 500 m (1650 feet) radius
Fixed-wing aircraft	300 m (1000 feet) within a 300 m (1000 feet) radius
Unmanned aerial systems	300 m (1000 feet) within a 300 m (1000 feet) radius

Recognising that it is difficult to detect disturbance to nesting birds from the air (except in instances of mass nest abandonment or other sudden or panicked movement), greater separation distances than those identified above will be maintained where possible.

- Overflying Important Bird Areas and other concentrations of birds and seals – at any height – will be avoided wherever possible.
- Maps of known wildlife concentrations will be carried in aircraft such that they can be referred to in flight as appropriate.
- Pre-flight planning meetings will be held between pilots and the relevant station, voyage or field leader.
- SLAs will be inspected for the presence of wildlife prior to aircraft operation – penguins, if present on SLAs, will be ushered from danger using established guidelines.[69]

---

[66] Antarctic Treaty Resolution 2 (2004) 'Guidelines for the operation of aircraft near concentrations of birds in Antarctica' suggest that:

- penguin, albatross and other bird colonies are not over flown below 2000 ft (~610 m) AGL, except when operationally necessary for scientific purposes;
- landings within 1/2 nautical mile (~930 m) of penguin, albatross or other bird colonies should be avoided wherever possible;
- a vertical separation distance of 2000 ft (~610 m) AGL and a horizontal separation of 1/4 nm (~460 m) from the coastline should be maintained where possible; and
- the coastline should be crossed at right angles and above 2000 ft (~610 m) AGL where possible.

Australian research and ADF experience indicate that a more conservative approach should be taken.

[67] UAS are not factored in Antarctic Treaty Secretariat (2004), and there is currently an absence of comprehensive, peer reviewed scientific literature available to support wildlife approach guidelines specifically for UAS. The distances adopted here reflect Australia's policy position that the approach distance in place for single-engine helicopters should be applied as a precaution.

[68] Unless authorised otherwise by a permit – see Commonwealth of Australia (2017).

[69] Reproduced at Appendix 12.

- Where operationally feasible, and to further minimise disturbance, adjustments to the line of SLAs will take into account the products of noise modelling exercises.
- Where operationally feasible, flight operation methodologies will be adopted to minimise adverse noise impacts.
- Whales will not be knowingly hovered above, approached from head on, or approached in a way that casts a shadow directly over them.

6.4 Actions to minimise the impacts of unmanned aviation operations

- Unmanned aircraft operations will be undertaken in a manner consistent with CASA administered regulations insofar as they can be applied in the Antarctic context.
- In addition to, or in concert with the above, unmanned aircraft operations will:
    - be scheduled, routed and approved by station, field and voyage leaders using the processes in place for planning conventional aircraft operations
    - only be undertaken by appropriately experienced/qualified individuals, in concert with an observer/look-out
    - only be undertaken where a strong command and control link can be maintained
    - not be undertaken where they could intersect the flight paths of other aircraft[70]
    - comply with the wildlife separation distances applicable to single engine rotary-wing aircraft (unless closer approaches are specifically authorised by a permit)
    - be discontinued if they are observed to modify animal behaviour (unless a permit has been obtained that specifically authorises wildlife disturbance)
    - not occur when weather forecasts are poor, or in conditions of poor visibility or darkness or near-darkness
    - not be flown under conditions where icing may form without proper anti-ice/de-icing function
    - be undertaken in a manner that minimises the sound emitted
    - generally necessitate the development of retrieval plans should systems fail
    - not be undertaken in the vicinity of foreign facilities without the approval of the relevant national program operator
    - not be undertaken within 30 m of historic sites and monuments, as appropriate to maintaining a buffer in the event of an unplanned landing
    - not be undertaken in an ASPA unless specifically authorised by a permit
    - be subject to a record keeping process that is available for inspection
    - undergo separate EIA if they involve aircraft that will not be recovered

6.5 Actions to minimise the unintentional import of species and other biological matter via international flights

- Mitigation measures will be employed to reduce introductions to levels that are as low as reasonably practicable. They will include:

[70] That is, within a radius of 3 nm (5.5 km) of Wilkins, SLAs and other sites where aircraft may be operating.

- obligations on service providers to undertake or organise regular, focussed, visual inspections of their aircraft's interior and exterior
  - aircraft disinsection/treatment with an Australian Government Department of Agriculture, Water and the Environment recognised residual spray or process
  - contractor inductions and training for staff directly involved in preparing cargo and flights, and pre-departure briefing of all travelling personnel
  - cargo consolidation in a biosecure area
  - an auditable, pre-loading cargo inspection regime to ensure freedom from contaminants
  - avoiding night time aircraft loading operations
  - minimising non-essential lighting during any night-time loading operations

  Procedures will be reviewed should the activity's biosecurity risk profile or the AAD's quarantine policy change.

6.6 Actions to minimise the transfer of species and other biological matter via domestic flights

- The AAD will adopt operational best-practice in intra-continental biosecurity as identified by the Council of Managers of National Antarctic Programs. The application of measures will focus on preventing transfers between biologically distinct areas.
- Mitigation measures will include:
  - obligations on aviation contractors to undertake regular cleaning of aircraft (i.e. vacuuming, emptying of seat pockets, removal of visible signs of soil etc.)
  - the supply of appropriate materials to facilitate aircraft and equipment cleaning between bioregions

  Processes will be reviewed should the activity's biosecurity risk profile or the AAD's quarantine policy undergo substantial change.

6.7 Actions to minimise disease risks associated with wildlife accessing poultry product waste generated at Wilkins

- The Wilkins Aerodrome Manager will ensure poultry products are managed in accordance with long-standing protocols specific to the facility – see Appendix 17.[71]

6.8 Actions to minimise the risks and impacts of fuel spillage

- Fuel management standard operating procedures will be regularly reviewed and updated as required.
- Fuel spill contingency plans will be maintained for sites where fuel is routinely handled or stored in bulk. Plans will be regularly reviewed and updated as required.

---

[71] Poultry meat (cooked and uncooked) and eggs are otherwise restricted to station and vessel use in Antarctica.

- Program participants will receive competency-assessed training appropriate to the level of their involvement in fuel management activities.
- Program participants' training will reference standard operating procedures and where applicable, the content of fuel spill contingency plans and the location and use of fuel spill response equipment.
- Clean-up equipment will be supplied in quantities and of a type appropriate to the location, risks and volume of fuel held.
- Spotters will be used when there is a need to use vehicles to clear snow from around fuel storage areas.
- Samples taken from drums and aircraft tanks, however small, will be containerised after their assessment.
- Designated areas will be used for refuelling on stations.
- If fuel is lost:
    - all reasonable steps will be taken to contain and clean-up the impacted environment[72]
    - the spill will be managed in accordance with plans consistent with COMNAP and CEP-identified best practice standards and procedures[73]
    - local action will be taken as soon as possible after the incident occurring

6.9 Actions to minimise risks specific to bulk fuel storage

- Any new aviation fuel containments of >1000 L will be double-skinned and/or 80% capacity bunded.
- The use of heavy vehicles will be prohibited in the vicinity of bulk fuel containment areas (other than when needed to remove or relocate units).
- Containments will be subject to a regular testing and inspection regime.

6.10 Actions to minimise risks and impacts specific to depots and drummed fuel stocks

On station

- Fuel drums will be co-located in designated areas at stations; at Mawson, drums will be stored to minimise any spillage or drum failure resulting in run-off into Horseshoe Harbour.
- Station stockpiles will be made visible through the use of brightly coloured barricades and canes as appropriate, and/or be located in areas where vehicles do not routinely operate.

---

[72] Other than where the impacts of clean up action are likely to be greater than leaving the fuel in situ.
[73] Fuel spill contingency plans have been prepared for Casey, Davis, Mawson and Wilkins.

- The bottom row of stockpiles will be held in position with wedges or fabricated drum stands to prevent collapse as stacks are created.
- Stockpiles will be managed such that drums of the same year of manufacture are grouped, and the oldest fuel can be used first.
- Fuel drums will be colour-coded in a way that ensures their year of manufacture is distinguishable.
- Periodic checks will be made of drum stocks' soundness.
- Used drums will have their bungs re-inserted and be stockpiled for no more than three seasons.

In the field

- A register of fuel caches will be maintained in real time, and will include GPS co-ordinates, and the number and age of full and empty drums.
- The removal of old aviation fuel from ASPAs will be prioritised, and no new aviation fuel caches will be established in ASPAs.
- New caches will only be established following a documented assessment of:
  - the environmental values of the proposed site and surrounding area
  - the features of the local landscape, with particular emphasis on slope, aspect, water flows, susceptibility to high winds and heavy snowfalls, and proximity to lakes, vegetation and wildlife
  - any particular challenges for clean-up actions presented by the location, landscape, and surrounding area (e.g. the area's accessibility and its susceptibility to damage from machinery or recovery equipment)
  - the prospects that exist for the timely removal of drums once emptied or expired

  Significant risks, if identified, will be referred to an *AT(EP) Act* delegate.
- Caches on ice and snow will be marked on four corners using bamboo canes, wands or similar.
- Caches will be secured to prevent their wind dispersal, while facilitating their removal.
- Drums will be stored on their sides to prevent water being drawn inside and the fuel becoming unacceptable for aviation.
- Drums will have their bungs reinstated after use.
- Resources will be allocated to ensure that unused drums are removed from field caches within six years of the drums' manufacture or caching.

6.11 Additional actions to minimise risks and impacts associated with sling-loading

- Cargo handling equipment and methods will be fit for purpose.
- The potential need for cargo to be jettisoned will be taken into account in route planning; overflying lakes and other especially vulnerable areas will be actively avoided.

- No more than 8 full fuel drums will be sling-loaded per single-engine helicopter sortie, and 12 drums per twin-engine helicopter.

6.12 Additional actions to minimise risks and impacts specific to air-drops

- Air-drops will be planned and conducted to preferentially target areas of snow and ice.
- Ice-free areas will not be used as drop zones for hazardous cargo.
- Air-drops will be restricted to routes and timings that avoid the need to fly – at any altitude – over areas where wildlife congregate to breed or moult. In particular operations to the Davis region will avoid aircraft tracking along the coast of Princess Elizabeth Land.
- Aircraft passes over drop zones will be kept to the minimum that is operationally necessary.
- Operations will be discontinued if concentrations of wildlife[74] are within a 200 m radius of the drop zone.
- Personnel situated on site to retrieve cargo and equipment following drops will be able to communicate any emerging wildlife issues to aircraft; missions will be modified or aborted if issues arise.
- After making drops, aircraft will proceed from the drop zone area using power settings that reduce the potential for wildlife disturbance.
- The parachutes used will be new or subject to an AAD-approved and auditable, washing and inspection regime to ensure their freedom from biosecurity risk material and other contaminants.
- Timber pallets will not be used.
- Operations will be planned in a way that provides for the collection and repatriation of parachutes, chords, strapping etc. for incineration or return to Australia as appropriate.
- Personnel situated on site to retrieve cargo and equipment following drops will possess sufficient spill mats or other means of containing any spilt fuel.
- Vehicles on site to retrieve cargo and equipment will not be driven within 200 m of wildlife.
- Post-activity reports will include information on any materials that are not recovered, and any recommendations for improving practices.

[74] Twenty or more birds or seals.

6.13 Actions to protect heritage

- Program participants will be briefed to report the discovery of any caches, artefacts etc. that may pre-date 1958.[75]
- Aircraft will maintain a buffer zone around historic sites and monuments that have international Antarctic community recognition.[76]

6.14 Other actions to protect the environment

- Domestic flights will be scheduled and routed so as to minimise the potential need for unplanned safety-related actions contrary to the environment protection mitigations identified and/or that could impact on the environment.
- Waste generated on board international flights will be retained on board for off-loading at airports outside Antarctica.
- Waste generated on board domestic flights and at Wilkins and SLAs will be handled via established processes that, as a minimum, comply with the waste management annex to the Madrid Protocol. To this end:
    - the preferred approach to managing waste will be its removal from Antarctica
    - materials not removed from Antarctica will be recycled or re-used where possible
    - waste/materials will be stored in a way that prevents their wind dispersal and access by wildlife
    - grey water generated at SLAs < 50 km from a station will be returned to station for treatment
- Inventories will be maintained of the location and nature of equipment, fuel, waste etc. left in the field on account of unplanned operational circumstances.
- To avoid pollution risks, cargo will not be pre-positioned at SLAs if it cannot be properly secured or containerised within existing infrastructure.
- Overnighting aircraft at Mawson will be avoided on account of the potential for aircraft destruction by extreme katabatic winds.
- No aviation support vehicles will be parked in areas where mosses and lichens are evident.
- Disintegrating bamboo canes will be regularly retrieved from vehicle routes.

[75] Discoveries of pre-1958 remains are provided interim protection in accordance with Resolution 5 of the 2001 Antarctic Treaty Consultative Meeting, until Parties have had due time to consider the discoveries' full protection.
[76] A list may be found at: http://www.ats.aq/devPH/apa/ep_protected.aspx?lang=e#.

7. Monitoring

7.1 Background

Obligations to undertake monitoring are set out in the Madrid Protocol and include monitoring for unforeseen impacts and environmental change, and the verification of predicted impacts linked to specific activities.

7.2 Previous aviation-related monitoring

Contaminant monitoring

In 2007 the AAD-contracted monitoring of the emissions associated with Airbus flights and traffic at, to, and from Wilkins.[77] It involved:

- surface snow sampling on a grid around Wilkins, the locations chosen on the basis of contaminant dispersion modelling
- snow sampling at sites along the Casey-Wilkins ground route
- the examination of electric conductivity and pH of snow samples for the real time identification of possible hot spots of salt accumulation and/or anthropogenic input
- sample analysis for trace element using inductively coupled plasma mass spectrometry or 'ICP-MS' (as a minimum)
- scanning electron microscopy of the morphology of particulate deposits
- air quality monitoring using passive 'Sigma2'air samplers
- development of contaminant dispersion models, i.e. possible scenarios of pollution distribution

In summary, the monitoring and modelling undertaken between 2007 and 2010 found:

- easily detected local human impact at Wilkins, although very small in absolute terms
- most of the impact at Wilkins was downwind
- the bulk of the contamination is confined to the vicinity (<~5 km) of the sources
- the Wilkins generator and tracked vehicles used to grade and maintain the runway are the main source of pollution (carbonaceous exhaust-derived particles, metal and rubber fragments) within the runway's area
- contamination from Wilkins' generator and the presence of the Airbus were negligible in terms of contribution to metal levels in the snow

[77] Services were provided by M. Gasparon, University of Newcastle. The impacts of operations at the Casey SLA were only partially examined.

- clear evidence of contamination from geogenic dust along the Casey – Wilkins route, near Casey, and within the Wilkins Aerodrome area – the source most likely being mineral dust and mud from tracked vehicles
- summer dust may have an impact on the stability of the snow/ice surface if operations at the Casey SLA and Wilkins increase
- a major decrease in air quality at Casey between monitoring events (i.e sampling in the 2007-08 and 2008-09 summers) that, if it continues to trend in the same way, could have a 'severe impact on air quality, and possibly on moss communities downwind of the station'[78]
- no evidence of anomaly in trace metal distribution in coastal sediments and moss and lichen; trace metal levels appeared to be similar to those observed in modern snow from other parts of Antarctica

Wildlife observations at Wilkins and ski landing areas

Air-ground officers record sightings of wildlife at Wilkins and SLAs during the operational season. The data collected are reported to the AAD's regulatory arm.

7.3 Current and future monitoring

Consistent with countries' Madrid Protocol obligations, the Council of Managers of National Antarctic Programs and the Scientific Committee for Antarctic Research advocate gathering 'vital statistics' related to human activities to provide a framework within which observed changes can be understood and cause and effect inferred.[79] The AAD reports on a range of indicators (see Appendix 16) through its online System for Indicator Management and Reporting.[80] The wildlife data described above also continues to be collected.

Photographic records enable aesthetic impacts to be examined over different time intervals.

The allocation of resources to monitoring is informed by the likely level of environmental risk attached to activities (for which a significance matrix has been developed – see Appendix 18).

[78] Although in absolute terms, this air pollution is still minimal, the summer values were higher than those measured in Greenland and similar to those of some small towns in the Northern Hemisphere (Gasparon 2009, p. 32). The increase is likely attributable in part to the increased level of activity created by the support of aviation operations.
[79] COMNAP–SCAR (2000).
[80] See http://data.aad.gov.au/aadc/soe/. The selection criteria for environmental indicators was adopted from *State of the Environment Reporting: Framework for Australia* (Department of the Environment, Sport and Territories, 1994).

8. Methods, data and references

8.1 Introduction

The preparation of this EIA involved reviewing past operations, undertaking a literature and data review, and sourcing specialist opinion.

The assessment of the likely impacts involved documenting the types of activity to be undertaken, their likely seasonal timing and duration, the geographical area affected on predominantly local and regional scales, and the probability, persistence and irreversibility of impacts.

Where there is little empirical data on values and impacts, a 'weight of evidence' approach has been applied.

8.2 Review of past activities

The AAD's incident records, and the end-of-season reports of station leaders, voyage leaders, air–ground support officers, aviation contractors and others formed the basis of a desk-top review of the environmental management of recent aviation activities.

The review sought to assist in:

- determining if/how recent aviation arrangements differed from the arrangements that were last assessed
- determining if the impacts of aviation operations were correctly identified in the last assessment, and if future impacts might differ from those predicted in previous assessments
- determining if mitigation actions and environmental management plans and protocols are being implemented and if they have been effective in addressing the risks that they were intended to manage
- identifying any other potential system failures of environmental management significance

Appendix 19 provides information on the adoption of mitigations mandated for aviation operations between 2015 and 2020.

8.3 Specialist input

Some thirty AAD staff and other AAP personnel were consulted during the development of this IEE and/or that prepared for the preceding five seasons, on which the current IEE is based. Those consulted include individuals regarded as specialists in Antarctic ecology and wildlife conservation; environmental planning; Antarctic geology and geochemistry; meteorology; Antarctic aviation; Antarctic operations including science planning and management; mechanical engineering; the design of polar infrastructure; and environmental auditing and the administration of the relevant legislation. Extensive use has been made of their judgements about potential impacts, their local area knowledge, and their assessments of practical ways to mitigate the impacts of aviation operations.

Information has also been obtained from the AAD's aviation and other contractors, and drawn from the Australian Defence Force's reviews of its operations undertaken over the last five years under the banner of Operation Southern Discovery.

8.4 Reference material

A list of documents informing the content is provided at Appendix 20. The list includes research papers and refereed volumes, the grey literature and AAD records.

The review of the scientific literature focussed on papers and volumes synthesising empirical studies of environmental impacts, many of which contain observations and recommendations that have been factored in the preparation of this assessment.

8.5 Uncertainties

Only an *initial* environmental evaluation has been progressed; the following issues are pertinent to the preparation and content of this document.

- As noted in Committee for Environmental Protection guidelines on EIA, some assumptions about the impacts of an activity cannot be tested.
- There is little or incomplete information on some of the environments in which aviation may be undertaken.
- Research on the impacts that activities have had on the Antarctic environment to date has mostly been focused on small geographical areas.
- Some of aviation's impacts are unknown and others will continue to be difficult to discern from the combination of all possible causes.
- Within the Antarctic Treaty system and in the context of Antarctica there are no agreed criteria for determining minor or transitory impacts, and there are few guidelines as to the level of impact considered acceptable in Antarctica. The *significance* of any impact – on Antarctica or elsewhere – remains a value judgement.[81]
- There is no agreed understanding among Antarctic Treaty Parties of the meaning of the term 'wilderness' notwithstanding protracted efforts to produce guidelines/criteria for wilderness' assessment. (However, wilderness is generally understood to represent a measure of the relative absence of signs of human activity; that interpretation has been used here.)
- Few useful baselines exist against which impacts can be meaningfully quantified.
- There is limited agreement on the spatial scale at which human influences should be considered, in particular with respect to biodiversity impacts. The impacts of aviation tend to be acutely localised or highly dispersed (e.g. where domestic flights track to and from multiple destinations).

---

[81] In this assessment, environment protection standards are assumed to be higher than they are for sites outside of Antarctica.

- The significance of the impact of the same activity can vary with location and timing. Locations and timings can only be predicted.
- The environmental impacts of aviation operations merge with and are often indistinguishable from impacts associated with other activities.[82]
- The significance of system failures and the 'human dimensions'[83] are especially difficult to factor in the process of identifying and managing potential impacts.
- The impacts of the aviation that falls within the scope of this IEE, combined with those of the planned Davis aerodrome and its operation, have not been examined in detail.
- Aviation impacts are assessed separately to those of other station and field activities; a holistic picture of the impacts of Australia's Antarctic program does not exist.

[82] e.g. the snow petrels breeding on Reeves Hill, near Casey, may be disturbed by quarry operations and foot traffic more than by high altitude overflights.
[83] e.g. training oversights or the involvement of personnel in the Program who have little real regard for the environment.

Appendix 1. Compliance with required content of initial environmental evaluations

Antarctic Treaty (Environment Protection) (Environmental Impact Assessment) Regulations 1993 specify the mandatory content of IEEs for the purposes of paragraph 12g (2) (a) of the *Antarctic Treaty (Environment Protection) Act 1980*.[84] This document complies with the Regulations as follows:

Required content	Part of this document where found
(a) a description of the activity, including a statement of: (i) the purpose; and (ii) the location; and (iii) the duration; and (iv) the intensity of the activity	Section 2
(b) a description of possible alternatives to the activity, including the alternative of not carrying on the activity	Section 3
(c) a description of the consequences of each possible alternative to the activity	Section 3
(d) a description of the environmental reference state with which predicted changes are to be compared	Section 4
(e) a prediction of the future environmental reference state if the activity does not take place	Section 3
(f) an estimation of the nature, extent, duration and intensity of the likely direct impacts of the activity	Section 5
(g) consideration of possible indirect impacts of the activity	Section 5
(h) consideration of the cumulative impacts of the activity in the context of other activities in the same area that are planned, in progress, or reasonably foreseeable when the evaluation is being prepared	Section 5 Section 8
(i) consideration of the effects of the activity on scientific research and other uses and values, including historic values, of the areas that will be affected by the activity	Section 5
(j) identification of unavoidable impacts of the activity	Section 5
(k) a description of the methods and data used to forecast the impacts of the activity	Section 8
(l) identification of uncertainties and lack of knowledge relevant to preparation of the evaluation	Section 8
(m) identification of measures, including monitoring programs, that are proposed to be taken to: (i) minimise or mitigate impacts of the activity; and (ii) detect impacts of the activity that were not predicted in the evaluation; and (iii) provide early warning of adverse effects of the activity; and (iv) deal promptly and effectively with accidents	Section 6 Section 7
(n) a description of: (i) consultation of persons and organisations, other than the proponent of the activity, during preparation of the evaluation; and (ii) the comments received from persons consulted; and (iii) how the matters raised during consultation have been addressed	[to be added following consultation]
(o) a summary, in language that is not technical, of the information described in paragraphs (a) to (n) inclusive	Appendix 2
(p) a statement of the arrangements that will be made to report to the Minister the results of the monitoring	Section 6
(q) the name and address of the person who prepared the evaluation	reverse title page

[84] In some areas the Regulations' requirements exceed the requirements of the EIA-related annex (Annex I) of the Madrid Protocol.

Appendix 2. Environmental impact assessment summary

Description of the proposed activity

The activity for which an initial environmental evaluation ('Environmental Impact Assessment: Australian Antarctic Program aviation operations 2020–2025') has been prepared in accordance with the *Antarctic Treaty (Environment Protection) Act* 1980 – is the continued aviation support of activities directed at the achievement of Australian Government goals in and for Antarctica. This support involves, or may involve:

- operations in the Antarctic Treaty area (south of 60°S) using, predominantly, Airbus A319 ER/ACJ 319 LR, Hercules LC-130H, Hercules C130J, C17-A Globemaster III, Basler BT-67, De Havilland DHC-6 Twin Otter and Eurocopter AS350 B3 aircraft in varying combinations
- the ongoing operation of Wilkins, a seasonally-operated aerodrome inland of Australia's Casey station
- deployments of portable buildings, automatic weather stations, runway markers, wind socks and the like needed to support aviation operations
- air-drops
- air-to-air refuelling of C17 aircraft
- the storage and depoting of large volumes of aviation fuel at multiple sites
- the maintenance of ski landing areas and a network of supporting over-snow 'roads'
- the use of unmanned aircraft for operational and scientific purposes
- projects to decommission any aviation-related facilities that become redundant

Alternatives

The use of other aviation-underpinned systems to support the Program are at least theoretically possible. The following necessarily 'high-level' alternatives to the main components have been (re)considered:

- discontinuing inter-continental flights and relying on shipping
- discontinuing intra-continental flights
- varying landing sites and surface types for fixed-wing aircraft
- varying the scale, location etc. of infrastructure and ancillary installations
- no aviation operations

These alternatives have been rejected for environmental, regulatory, financial, safety and/or practical (program delivery) related reasons.[85]

Most of the activities and their impacts considered in the current assessment are not new; their cessation would be unlikely to trigger an immediate and substantial improvement in environmental outcomes.

Assessment of potential impacts

Aircraft operations and air-supported programs are expected to result in impacts on the environment, both directly and indirectly. Impacts may be:

- greatest in East Antarctica's coastal areas and at, or radiating from sites of long-established infrastructure
- on air quality, through emissions
- on water, snow and ice quality/processes, through emissions to the atmosphere and other releases and activities
- on wildlife, through habitat alteration, noise disturbance and visual stimuli
- associated with introductions of non-native species, and the transfer of species within Antarctica
- on geology and vegetation, in particular through mechanical damage and habitat disturbance associated with vehicle use
- on research and scientific values
- on the wilderness and aesthetic values of East Antarctica

Even taking all care and with sound mitigations in place, some of these impacts will be unavoidable if the activity as described proceeds.

Methods and data

The preparation of this environmental impact assessment was informed by a review of past aviation and aviation support activities; monitoring outcomes; site visits; specialist input; professional judgements on potential impacts and workable mitigations; empirical studies; the grey literature; and an earlier process providing for public comment.

The development of this assessment has however been challenged by:

---

[85] Note though that in May 2018 the Australian Government announced it intends to construct a paved runway in the Vestfold Hills, near Davis in Princess Elizabeth Land. The development of the Davis aerodrome and the conduct of operations to this facility are the subject of a separate environmental impact assessment and approval process. The anticipated timeframes for construction (with flights commencing around 2040) mean that this option would not be available for aviation operations between 2020 and 2025.

- an inability to test some assumptions
- the paucity of information on some of the environments in which aviation may be undertaken
- the paucity of information on some of the past and potential impacts of specific aircraft and their operations
- difficulties in discerning aviation's past impacts from the combination of all possible causes
- the lack of an agreed understanding of what are aesthetic values, and the meaning of the term 'wilderness', in the context of Antarctica

Furthermore, while some impacts can be measured, their *significance* remains a value judgement.

Mitigation and monitoring

Mitigation measures have been identified to minimise the impacts of Australian Antarctic Program aviation operations forecast to occur between 2020 and 2025. They include measures to:

- minimise disturbance to wildlife (e.g. the setting of minimum distances at which concentrations of wildlife can be approached)
- minimise the unintentional import and regional transfer of species and other biological matter (e.g. the development of contractor requirements with respect to aircraft cleanliness)
- minimise the risk and impacts associated with fuel storage and handling (e.g. requirements for on-site holdings of spill clean-up equipment)

The AAD as operator anticipates that aviation's ongoing authorisation will be conditional on the implementation of the measures identified.

The ongoing analysis of incident reports will provide for the identification of any trends or new risks, and areas where the need for further controls might be indicated.

Conclusion

The activity's impacts on the environment will be tenable if the proposed mitigation measures are implemented.

COMMONWEALTH OF AUSTRALIA

ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999
DECISION THAT ACTION IS NOT A CONTROLLED ACTION

Pursuant to section 75 of the *Environment Protection and Biodiversity Conservation Act 1999*, I, DAVID ALASTAIR KEMP, Minister for the Environment and Heritage, decide that the proposed action, set out in the Schedule, is not a controlled action. Provided that the proposed action is taken in the manner described in the Schedule, the provisions of Part 3 of the EPBC Act set out in the Schedule are not controlling provisions.

SCHEDULE

The proposed action by the Australian Antarctic Division to develop and operate an air transport system for inter-continental flights between Australia and Antarctica, and intra-continental flights within Antarctica, and as described in the referral received on 12 September 2002 under the Act (EPBC 2002/801).

Provisions of Part 3

The relevant provisions of Part 3 are:

- sections 18 and 18A (Listed threatened species and communities);
- sections 20 and 20A (Listed migratory species);
- section 28 (Protection of the environment from Commonwealth actions).

Manner in which the proposed action is to be taken:

- Operational flight paths and flight guidelines will be developed and implemented to minimise the potential for wildlife disturbance or impacts on sensitive marine and Antarctic environments.
- Modelling of noise footprints for aircraft, to aid in assessing noise related impacts and planning of operations, will be undertaken to assist in development and implementation of flight operational protocols and guidelines to minimise disturbance to fauna.
- The requirements for interacting with cetaceans within the Australian Whale Sanctuary (Part 8, Division 8.1, Clause 8.05 of the *Environment Protection and Biodiversity Conservation Regulations 2000*) will be incorporated into flight operational protocols and guidelines, as appropriate.
- Monitoring programs to verify impact predictions, identify unexpected impacts, and to ensure impacts remain within any required limits will be developed and implemented.
- The monitoring program will also specifically address the potential for noise disturbance to the Southern Giant Petrel and the Wilson's Storm Petrel and any measures needed to avoid impacts.
- The flight operational protocols and guidelines will be reviewed and updated against the results of the monitoring programs on an annual basis, for the first five years of operation, and thereafter on a five yearly basis.
- Flight operational protocols and guidelines, and monitoring programs relevant to identification and minimisation of environmental impacts, will be developed in consultation with relevant expert agencies, including Environment Australia.

Dated this 14th day of October 2002

David Kemp

MINISTER FOR THE ENVIRONMENT AND HERITAGE

Appendix 4. Infrastructure, plant and equipment at Wilkins Aerodrome[86]

Infrastructure

Structure	Size	Function
Main camp		
2-storey (orange) building	260 m^3	operations (forecasting, office space), sleeping for 1, and departure lounge, toilet (urinal)
20’ (red) MECC Weatherhaven shelter	78 m^3	medical facility for flying operations
20’ (red) container	36 m^3	sleeping and office for Aerodrome Manager
20’ (white) generator van	36 m^3	power supply
Hon. R.J.L. Hawke AC Living Quarters – 2-storey (green) building	432 m^3	kitchen, dining, showers, incinerator toilets, laundry, TV/recreation room, office/storage, and water manufacture and storage
2 x 40’ (dark green) containers	72 m^3	sleeping for 8
20’ split (red) container	36 m^3	sleeping for 4 (2 x 2)
2 x 20’ (navy) containers	72 m^3	storing Polaris, waste etc.

Laydown area		
container (dark blue) & E box (orange)	54 m^3	spare (vehicle) parts
20’ (light blue) generator/van	36 m^3	power supply
container (dark green), drums	36 m^3	workshop
garage	130 m^3	heavy vehicle repair; servicing and garaging

Area 3		
20’ container	36 m^3	storage
20’ split container	36 m^3	sleeping for 4

Other		
20’ fuel container x 2	36 m^3	storage and transport of 14 000 L fuel

[86] These lists are indicative; changes may be made from one year to the next. A second garage is planned during the life of this IEE. When expedient and spare, some plant equipment may also be used at the SLA and alternate landing area north of Wilkins.

Plant and equipment

Plant and equipment	No.	~Annual hours or mileage	Fuel	Primary use
generator (3 x 125 kVa, 1 x 90 kVA)	4	5500	SAB	2 x main camp power, 1 x workshop power; aircraft ground unit
Case 485/435 Quadtrac tractor	3	800	SAB	runway preparation, towing proof roller, moving buildings etc.
Caterpillar D7R bulldozer	3	700	SAB	runway preparation, moving snow
Caterpillar 14H grader	1	70	SAB	moving snow
Caterpillar 966H loader	2	150	SAB	moving snow
Prinoth BR 350 snow groomer	2	600	SAB	tilling runway for friction
Hagglunds all-terrain vehicle, flat try	1	500	SAB	general camp support; waste etc. transport to Casey and stores to Wilkins
Terra bus	1	2000 km	SAB	passenger transport
Prinoth BR350 trooper	1	300	SAB	personnel and patient transport
Toyota 4x4 Landcruiser	1	500 km	SAB	scissor lift for medivacs and cargo offloading and loading
Toyota Hilux ute	1	2000 km	SAB	local transport, runway friction testing
Polaris Ranger utility vehicle	2	200	ULP	local transport
Arctic Cat skidoo/snowmobiles	2	80	ULP	local transport
Overassen snow blower	2	170	SAB	clearing snow off runway etc.
Caterpillar 297 multi terrain loader / skid steer ('Bobcat')	3	200	SAB	refilling snow melter for water supply
88 T proof roller	1			proof rolling
Tracked tank trailer	1	-	-	local grey water disposal – 2500 L capacity
Tracked tank trailer (bunded)	2	-	-	fuel transport from Casey to Wilkins – 2 x 14 000 L capacity
sleds	15+	-	-	moving buildings and containers

Appendix 5. Possible landing sites[87]

Landing sites (ski and/or wheels)	Primary purpose	Max. # drums on site	Notes
Beaver Lake	staging for programs in the Prince Charles Mountains	40	unprepared ice; depot
Bunger Hills	depot for flights for flights between Casey and Davis	40	unprepared ice; facilities (Edgeworth David)
Casey (sea ice)	alternate for Casey SLA		Mitchell Peninsula; early and late season
Casey (inland of SLA)	alternate for Casey SLA or Wilkins		e.g. at waypoint 'A019' between Casey and Wilkins
Davis (sea ice)	station access		early and late season, includes Plough Island vicinity
Depot Island	depot for flights west of Mawson	5	
Dingsor Dome	depot for flights between Davis and Mawson	10	alternate to Mount Hinks
Dome A	access to Kunlun (China)		Chinese facility
Dome C	access to Concordia (France/ Italy)		French/Italian facility
Dumont d'Urville	access to Dumont d'Urville (France)		French facility
Grove Mountains	regional science; depot for flights to Dome A	20	drums outside ASPA
Mawson (inland) – Rumdoodle	station access		plateau, blue ice
Mawson (sea ice)	station access		early and late season
McMurdo	access McMurdo (USA) for onward flights to the Casey region		American-controlled, various sites/facilities
Mirny	access Mirny (Russia) and depot for flights from Casey to Mawson		Russian facility
Mt Hinks	depot for flights between Davis and Mawson	5	
Larsemann Hills	access to Progress (Russia), Zhongshan (China) and Law Base; depot for flights to Groves Mountains etc.	20	preferred fuel depot site is in the vicinity of Progress 1 (Russia): Law Base is in a water catchment
Richardson Lake	potential depot for flights west of Mawson	5	
Sansom Island	depot for flights between Davis and Mawson	100	fixed-wing landings on sea-ice
Turk Glacier	potential depot for field project support	5	
Vostok	access Vostok (Russia)		Russian facility

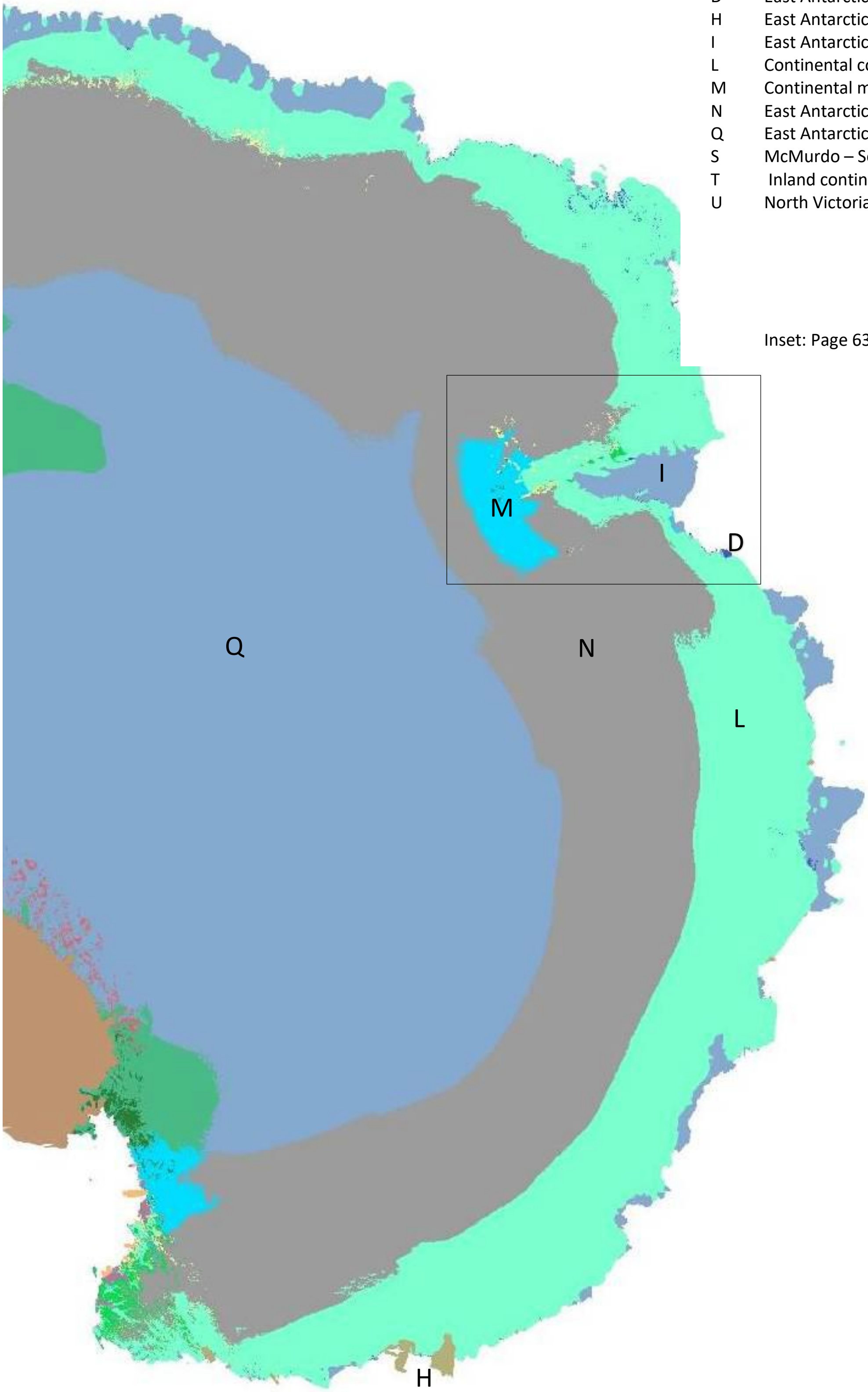
[87] In addition to AAD-maintained SLAs and Wilkins Aerodrome. This list is indicative only.

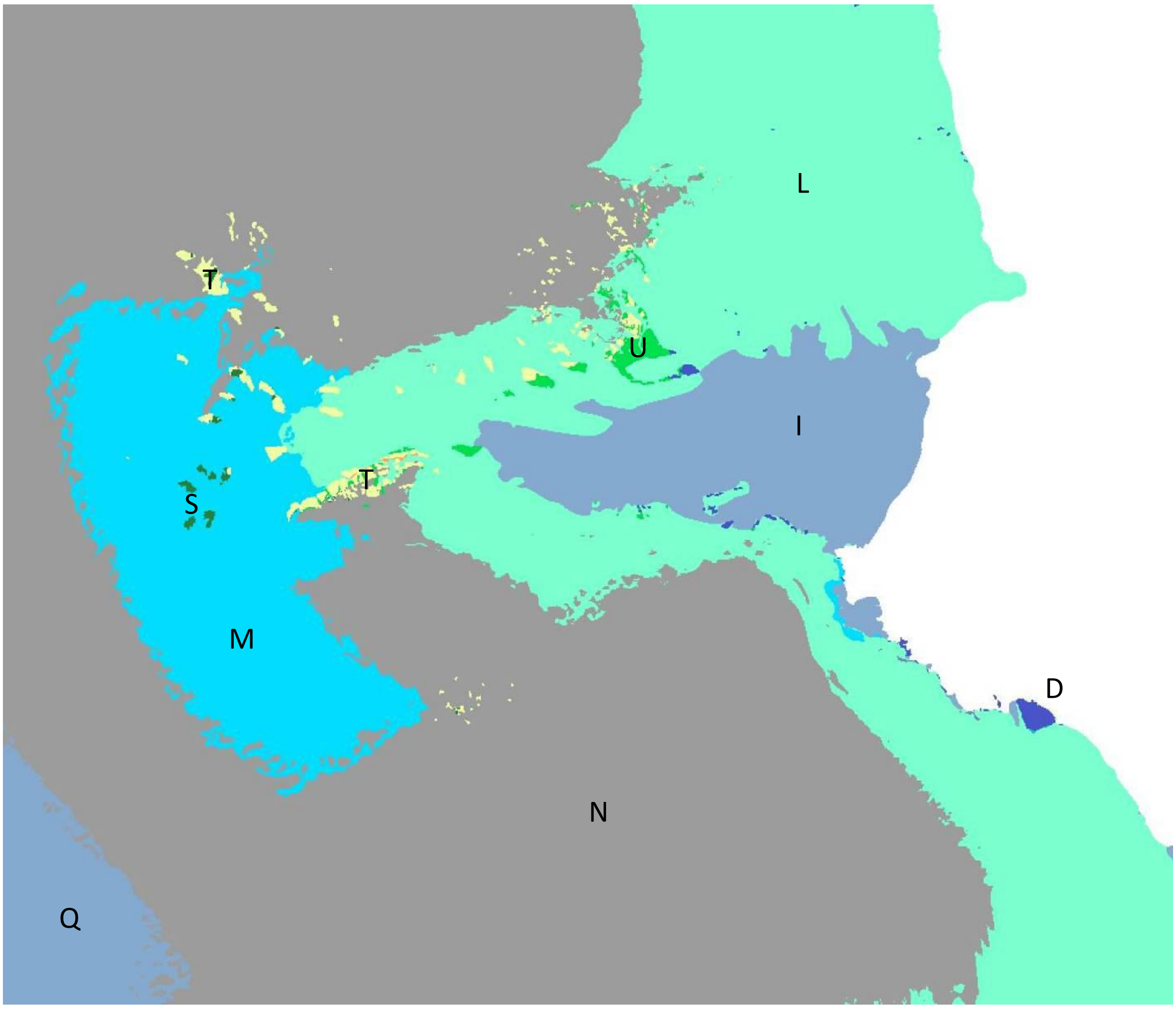
Appendix 6. Environmental domains – East Antarctica

KEY

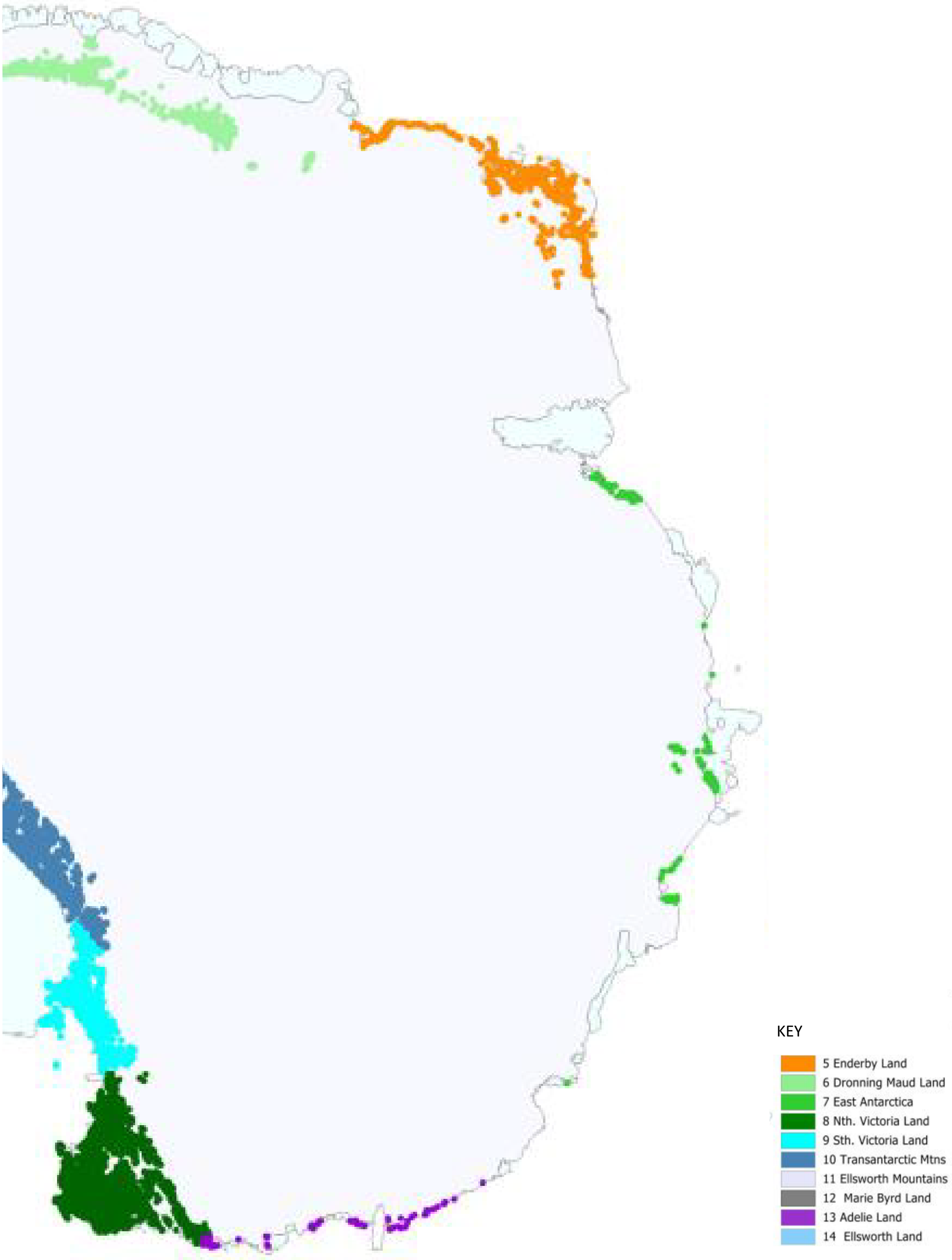
D East Antarctic coastal geologic
H East Antarctic low latitude glacier tongues
I East Antarctic ice shelves
L Continental coastal-zone ice sheet
M Continental mid-latitude sloping ice
N East Antarctic inland ice sheet
Q East Antarctic high interior ice sheet
S McMurdo – South Victoria Land geologic
T Inland continental geologic
U North Victoria Land geologic

Inset: Page 63




L
T
U
I
T
S
M
D
N
Q

Appendix 7. Biogeographic regions and their biodiversity – East Antarctica



Bio-geographic region	Number of records	Number of species	Area (km^2)	Standard-ised species richness (species/ km^2 *100)	Landscape	Biodiversity summary
5 – Enderby Land	2973	261	2152	12.1	coastal and inland ice-free land, some large contiguous areas	dominated by mosses, lichens
6 – Dronning Maud Land	873	177	5500	3.2	inland ice free areas (?)	relatively low lichen and fungi diversity compared to other areas
7 – East Antarctica	5823	475	1085	43.8	mainly coastal areas of patchy ice free land	dominated by lichens, mosses and relatively high invertebrate biodiversity (mites, tardigrades, nematodes)
8 – Nth Victoria Land	3070	255	9522	2.6	dry valleys, extensive contiguous ice free areas, mountainous	dominated by lichens, mosses and few invertebrates (mites and nematodes)
9 – Sth Victoria Land	2216	354	10368	3.4	dry valleys stretching from interior to coast– extensive contiguous ice-free areas, mountainous	dominated by lichens, mosses and few invertebrates (mites and nematodes)
13 – Adélie Land	21	9	178	5.1	small pockets of exposed ice free areas, mostly near coast, katabatic winds	very low diversity, dominated by lichens
(16) – Prince Charles Mountains	528	95	n/a*	n/a	mountainous ice-free	relatively high invertebrate diversity, comparatively low bryophyte diversity

Compiled by: A. Terauds, AAD, March 2015.

Appendix 8. East Antarctic vertebrate fauna

Birds[88]

Scientific name	Common name	IUCN Red List category	EPBC Act status
Pygoscelis antarcticus	Chinstrap penguin	Least Concern	
Aptenodytes forsteri	Emperor penguin	Near Threatened	
Pygoscelis adeliae	Adélie penguin	Near Threatened	
Fulmarus glacialoides	Southern fulmar	Least Concern	
Thalassoica antarctica	Antarctic petrel	Least Concern	
Pagodroma nivea	Snow petrel	Least Concern	
Halobaena caerulea	Blue petrel	Least Concern	
Pachyptila desolata	Antarctic prion	Least Concern	
Pachyptila belcheri	Slender-billed prion	Least Concern	
Pterodroma mollis	Soft-plumaged petrel	Least Concern	
Aphrodroma brevirostris	Kerguelen petrel	Least Concern	
Pterodroma lessonii	White-headed petrel	Least Concern	
Daption capense	Cape petrel	Least Concern	
Oceanites oceanicus	Wilson's storm-petrel	Least Concern	
Fregetta tropica	Black-bellied storm-petrel	Least Concern	
Catharacta maccormicki	South Polar skua	Least Concern	
Larus dominicanus	Kelp gull	Least Concern	
Sterna paradisaea	Arctic tern	Least Concern	
Sterna vittata	Antarctic tern	Least Concern	
Pygoscelis papua	Gentoo penguin	Near Threatened	
Eudyptes chrysolophus	Macaroni penguin	Vulnerable	
Diomedea exulans	Wandering albatross	Vulnerable	Vulnerable
Thalassarche chrysostoma	Grey-headed albatross	Endangered	Endangered
Phoebetria palpebrata	Light-mantled albatross	Near Threatened	
Macronectes giganteus	Southern giant petrel	Least Concern	Endangered
Procellaria aequinoctialis	White-chinned petrel	Vulnerable	
Macronectes halli	Northern giant petrel	Least Concern	Vulnerable
Ardenna tenuirostris	Short-tailed shearwater	Least Concern	
Ardenna grisea	Sooty shearwater	Near Threatened	Vulnerable
Pterodroma inexpectata	Mottled petrel	Near Threatened	
Thalassarche melanophris	Black-browed albatross	Near Threatened	Vulnerable
Catharacta antarctica	Brown skua	Least Concern	

[88] Edited Antarctic-wide search from BirdLife International: http://www.birdlife.org/datazone/species/search (28 January 2015).

Seals

Scientific name	Common name	IUCN Red List category	EPBC Act status
Mirounga leonina	Southern elephant seal	Least Concern	Vulnerable
Lobodon carcinophagus	Crabeater seal	Least Concern	
Arctocephalus gazella	Antarctic fur seal	Least Concern	
Phocarctos hookeri	Hooker's sea lion	Vulnerable	
Hydrurga leptonyx	Leopard seal	Least Concern	
Leptonychotes weddelli	Weddell seal	Least Concern	
Ommatophoca rossi	Ross seal	Least Concern	
Arctocephalus tropicalis	Sub-antarctic fur seal	Least Concern	Vulnerable
Arctocephalus pusillus	Australian fur seal	Least Concern	
Arctocephalus forsteri	New Zealand fur seal	Least Concern	

Cetaceans

Scientific name	Common name	IUCN Red List category	EPBC Act status
Eubalaena australis	Southern right whale	Least Concern	Endangered
Caperea marginata	Pygmy right whale	Data Deficient	
Balaenoptera acutorostrata	Minke whale	Least Concern	
Balaenoptera borealis	Sei whale	Endangered	Vulnerable
Balaenoptera musculus	Blue whale	Endangered	Endangered
Balaenoptera physalus	Fin whale	Endangered	Vulnerable
Megaptera novaeangliae	Humpback whale	Least Concern	Vulnerable
Physeter macrocephalus	Sperm whale	Vulnerable	
Kogia breviceps	Pygmy sperm whale	Data Deficient	
Mesoplodon grayi	Gray's beaked whale	Data Deficient	
Mesoplodon bowdoini	Andrews' beaked whale	Data Deficient	
Mesoplodon mirus	True's beaked whale	Data Deficient	
Ziphius cavirostris	Cuvier's beaked whale	Least Concern	
Mesoplodon hectori	Hector's beaked whale	Data Deficient	
Tasmacetus shepherdi	Shepherd's beaked whale	Data Deficient	
Berardius arnuxii	Arnoux's beaked whale	Data Deficient	
Mesoplodon densirostris	Blainville's beaked whale	Data Deficient	
Mesoplodon layardii	Strap-toothed beaked whale	Data Deficient	
Hyperoodon planifrons	Southern bottlenose whale	Least Concern	
Orcinus orca	Killer whale	Data Deficient	
Pseudorca crassidens	False killer whale	Data Deficient	
Globicephala melas	Long-finned pilot whale	Data Deficient	
Lagenorhynchus obscurus	Dusky dolphin	Data Deficient	

Lagenorhynchus cruciger	Hourglass dolphin	Least Concern	
Tursiops truncatus	Bottlenose dolphin	Least Concern	
Delphinus delphis	Common dolphin	Least Concern	
Lissodelphis peronii	Southern right whale dolphin	Data Deficient	
Australophocoena dioptrica	Spectacled porpoise	Data Deficient	

Appendix 9. Wildlife concentration map list[89]

Region	Map title
Casey area	Ardery and Odbert Islands Antarctic Specially Protected Area #103 Browning Peninsula and Peterson Island Casey and Clark Peninsula approach path (helicopters) Casey station – final approach (helicopters) Frazier Islands (Nelly, Dewart and Charlton) Antarctic Specially Protected Area #160 Windmill Islands and Casey Windmill Islands and Casey – separation distances Windmill Islands and Casey – main wildlife concentrations Holl, Ford and Herring Islands
Davis area	Davis approach paths (helicopters) Davis station – final approach (helicopters) Hawker Island Area Antarctic Specially Protected Area #167 Hop and Filla Islands Larsemann Hills including Stornes Antarctic Specially Protected Area #174 Long Peninsula and Long Fjord Magnetic, Turner and Bluff Islands Marine Plain Antarctic Specially Protected Area #143 Rauer Group – separation distances Rauer Group – wildlife concentrations Tryne and Wyatt Earp Islands Vestfold Hills and Davis Vestfold Hills and Davis – separation distances Vestfold Hills and Davis – main wildlife concentrations
Mawson area	Béchervaise and Welsh Islands Holme Bay and Mawson Holme Bay and Mawson – separation distances Holme Bay and Mawson – main wildlife concentrations Mac.Robertson land coast and Mawson Mawson station – final approach path (helicopters) Mawson approach paths (helicopters) Scullin and Murray Monoliths Antarctic Specially Protected Area #164 Taylor Rookery Antarctic Specially Protected Area #101
Other areas	Cape Denison, Commonwealth Bay Antarctic Specially Protected Area #162 Amanda Bay Antarctic Specially Protected Area #169

[89] The maps listed are available from the AADC, and are included in the AAD publication *Flight path guidelines – avoiding wildlife in East Antarctica*.

Appendix 10. Main wildlife breeding locations in aviation operational area

Common name	Location
Emperor penguin	Enderby Land, Umbeashi (68º3’S, 43º0.6’E) Enderby Land, Amundsen Bay (66º55'S, 50ºE) Enderby Land, Kloa Point (66º37'58"S, 57º19'E) Enderby Land, Fold Island (67º19'58"S, 59º22'58"E) Kemp Land, Taylor Glacier (67º28'1"S, 60º52'58"E) (90 km W of Mawson) Kemp Land, Auster Rookery (67º22'58"S, 64º1'58"E) (51 km ENE of Mawson) Mac.Robertson Land, Cape Darnley (Flutter Rookery) (67º49'58"S, 69º45'E) Princess Elizabeth Land, Amanda Bay (69º16'1"S, 76º49'58"E) (90 km W of Davis) Princess Elizabeth Land, West Ice Shelf (66º32’S, 81º49.5’E) Princess Elizabeth Land, Barrier Bay (67º13’S, 81º52’E) Princess Elizabeth Land, Haswell Island (66º32'59"S, 92º58'1"E) Queen Mary Land, Shackleton Ice Shelf (64º40'1"S, 97º30'E) Queen Mary Land, Bowman Island (65º4'58", 102º49'58") Wilkes Land, Peterson Bank (65º55'58"S, 110º12'E) (44 km NNW of Casey) Wilkes Land, Dibble Glacier (66º6’S, 134º47.4’E) Wilkes Land, Pte Géologie (66º40'1"S, 140º1'E) Wilkes Land, Ninnis Glacier (68º12', 147º11'59"E) Oates Land, Davis Bay (69º40'S, 158º30'E)
Adélie penguin	Colonies on coastal islands and ice free areas throughout East Antarctica including Windmill Island group, Vestfold Hills, Rauer group
Wilson's storm petrel	Coastal ice free areas throughout East Antarctica including Vestfold Hills, Windmill Islands, Mawson region
Antarctic skua	Coastal ice free areas throughout East Antarctica including Vestfold Hills, Windmill Islands, Mawson region
Southern giant petrel	Windmill Islands: Frazier Islands (breeding) Davis area: Hawker Island (breeding), Long Peninsula (non-breeding) Hop Island, Rauer Group (non-breeding) Mawson area: Rookery Islands – Giganteus Island (breeding)
Southern fulmar	Coastal ice free areas throughout East Antarctica including Vestfold Hills, Windmill Islands, Mawson region
Antarctic petrel	Coastal ice free areas throughout East Antarctica including Vestfold Hills, Windmill Islands, Mawson region
Cape petrel	Coastal ice free areas throughout East Antarctica including Vestfold Hills, Windmill Islands, Mawson region
Snow petrel	Coastal ice free areas throughout East Antarctica including Vestfold Hills, Windmill Islands, Mawson region
Southern elephant seal	Hauled out for moulting on ice free land around Casey and Davis
Crabeater seal	Rest, breed and moult on sea ice, haul out on land throughout East Antarctica
Leopard seal	Hauled out on sea ice, land throughout East Antarctica
Weddell seal	Fast ice zone, hauled out on sea ice to rest, moult and pup throughout East Antarctica
Ross seal	Pack ice and coastal ice throughout East Antarctica

Appendix 11. Protected areas within East Antarctica

Site name	Ref. #	Key values underpinning protection	Provision for helicopter landings[90]	Provision for fixed-wing landings	Provision for over-flight[91]
Amanda Bay (Davis region)	ASPA 169	wildlife	✓		✓
Ardery & Odbert Island (Casey region)	ASPA 103	wildlife	✓		✓
Clark Peninsula (Casey region)	ASPA 136	vegetation			✓
Frazier Islands (Casey region)	ASPA 160	wildlife			✓
Haswell Island (Mirny region)	ASPA 127	wildlife			✓
Hawker Island (Davis region)	ASPA 167	wildlife			
Larsemann Hills	ASMA 6	limnology, geology	✓	✓	✓
Marine Plain (Davis region)	ASPA 143	geology	✓		✓
Mawson's Huts, Cape Denison	ASPA 162	heritage	✓		
Mount Harding, Groves Mountains	ASPA 168	geomorphology, wilderness/ aesthetic	✓	✓	✓
North-eastern Bailey Peninsula (Casey region)	ASPA 135	vegetation			✓
Rookery Islands (Mawson region)	ASPA 102	wildlife	✓		✓
Scullin and Murray Monoliths (Mawson region)	ASPA 164	wildlife, aesthetic	✓		✓
Stornes (within Larsemann Hills ASMA)	ASPA 174	geological	✓		✓
Taylor Rookery (Mawson region)	ASPA 101	wildlife	✓		

[90] In accordance with the areas' management plans, downloadable from the Antarctic Treaty Secretariat's database at: http://www.ats.aq/devPH/apa/ep_protected.aspx?lang=e. Restrictions applicable to each site vary and may constrain the type of aircraft that may be used, visit timings (e.g. to only when wildlife is not present), landing sites (e.g. to a designated helipad, or sea ice only) and visit purpose (e.g. scientific and management only).

[91] i.e. transits unrelated to management or scientific activities in the area. (ASPA overflights still require permits and may be restricted to timings outside wildlife breeding periods.)

Appendix 12. Important Bird Areas within East Antarctica[92]

Important Bird Area	Ref. #	Trigger species	Potential conservation issues
Enderby Land / Kemp Land			
Mount Biscoe	ANT116	Adélie penguin	None known
Cape Batterbee	ANT117	Adélie penguin	None known
Kloa Point	ANT118	Emperor penguin	None known
Mac.Robertson Land			
Taylor Rookery	ANT119	Emperor penguin	None known
Gibbney Island	ANT120	Adélie penguin	None known
Rookery Islands	ANT121	Adélie penguin	None known
Klung Island / Welch Island	ANT122	Adélie penguin	None known
Andersen Island	ANT123	Adélie penguin	None known
Kirton Island / Macklin Island	ANT124	Adélie penguin	None known
Auster Rookery	ANT125	Emperor penguin	Tourism
Scullin Monolith / Murray Monolith	ANT126	Adélie penguin Antarctic petrel	Aircraft operations
Cape Darnley	ANT127	Emperor penguin	None known
Princess Elizabeth Land			
Amanda Bay	ANT128	Emperor penguin	Tourism
Caro Island, Rauer Islands	ANT129	Adélie penguin	None known
Hop Island, Rauer Islands	ANT130	Adélie penguin	None known
Filla Island, Rauer Islands	ANT131	Adélie penguin	None known
Kazak Island / Zolotov Island	ANT132	Adélie penguin	None known
Unnamed island at Donskiye Islands	ANT133	Adélie penguin	Oil spills and aircraft operations associated with Davis station operations
Warriner Island, Donskiye Islands	ANT134	Adélie penguin	Oil spills and aircraft operations associated with Davis station operations
Gardner Island	ANT135	Adélie penguin	Oil spills and aircraft operations associated with Davis station operations
Magnetic Island and nearby islands	ANT136	Adélie penguin	Oil spills and aircraft operations associated with Davis station operations
Lucas Island	ANT137	Adélie penguin	None known
Rookery Lake / W Long Peninsula	ANT138	Adélie penguin	None known
Tryne Islands	ANT139	Adélie penguin	None known
West Ice Shelf	ANT140	Adélie penguin	None known
Queen Mary Land			

[92] Extracted from Harris *et al*. (2015).

Haswell Island	ANT141	Emperor penguin South polar skua Adélie penguin	Climate change Antarctic fisheries and local disturbance from station activities and colony visits
Shackleton Ice Shelf	ANT142	Emperor penguin	None known
Wilkes Land			
Peterson Island	ANT143	Adélie penguin	None known
Holl Island / O'Connor Island	ANT144	Adélie penguin	None known
Ardery Island / Odbert Island	ANT145	Adélie penguin Southern fulmar	None known
Shirley Island / Beall Island	ANT146	Adélie penguin	Aircraft operations associated with Davis station operations
Clark Peninsula	ANT147	Adélie penguin	None known
Berkley Island / Cameron Island	ANT148	Adélie penguin	None known
George V Land			
Cape Hunter	ANT155	Adélie penguin Antarctic petrel	None known
MacKellar Islands	ANT156	Adélie penguin	None known
Cape Denison	ANT157	Adélie penguin	Visitation associated with tourism, historical conservation work, scientific research and management
Way Archipelago	ANT158	Adélie penguin	None known

Appendix 13. Aesthetic values, East Antarctica

Plate 1. An indication of the variety of vistas of snow and ice found in the area of AAP aviation operations. All images (wind scour, crevasses, sastrugi, glacial melt, icebergs, pack ice etc.) taken from the air during domestic flights.

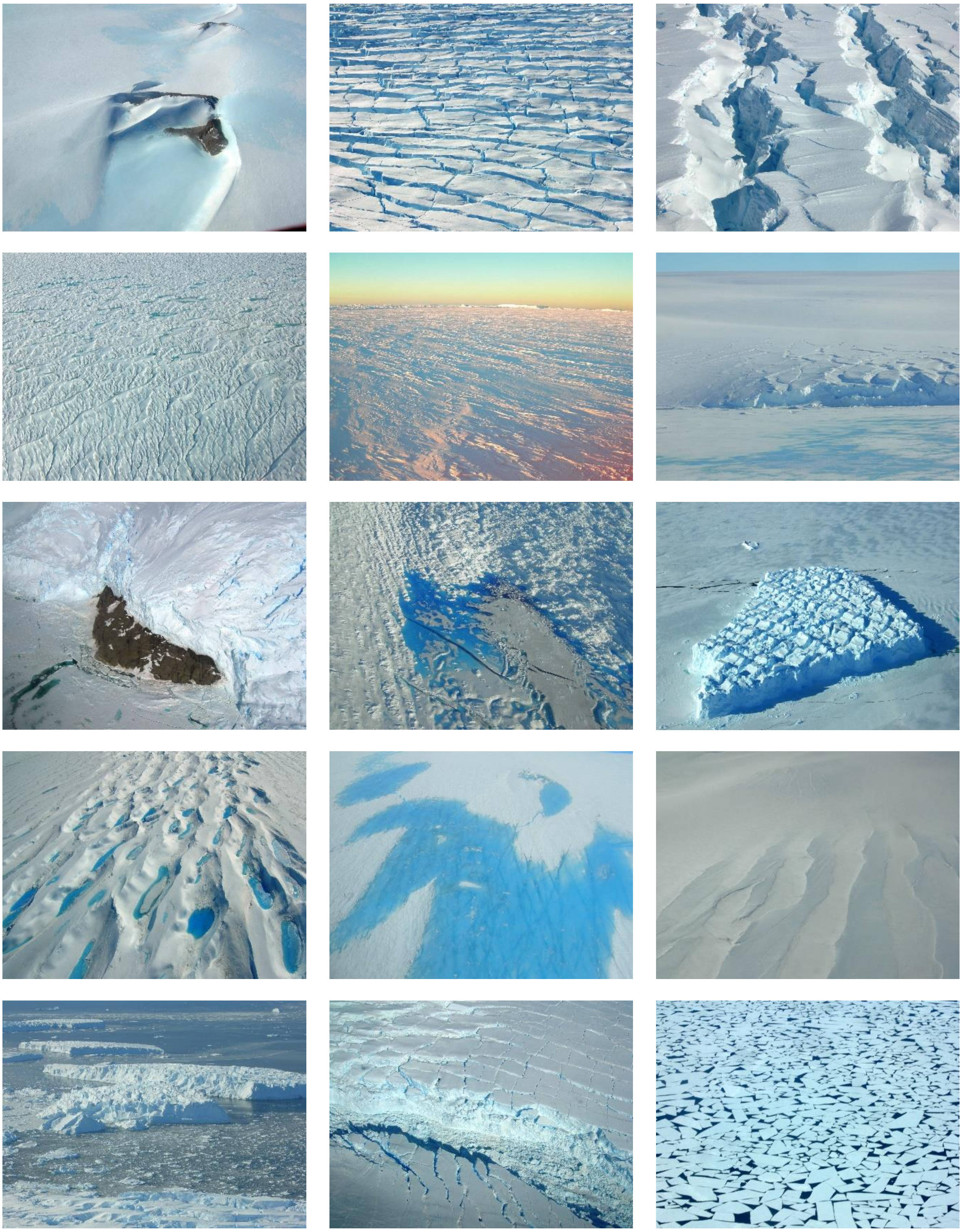


Plate 2. AAP aviation operations occur in areas classified as ‘ice free’. These areas are rare; less than 0.18% of the continent is exposed rock. Although ice-free areas may not conform to an Antarctic ideal/stereotype, their aesthetic values are comparable. All images of the Vestfold Hills oasis – from top L to bottom R: © Darren Shoobridge; Tassie Lake from the air © Richard Seton; © David Barringhaus; hills from the air © Mark Mills; Watts Lake © Kerry Steinberner; Lichen Lake © Kim Kliska.

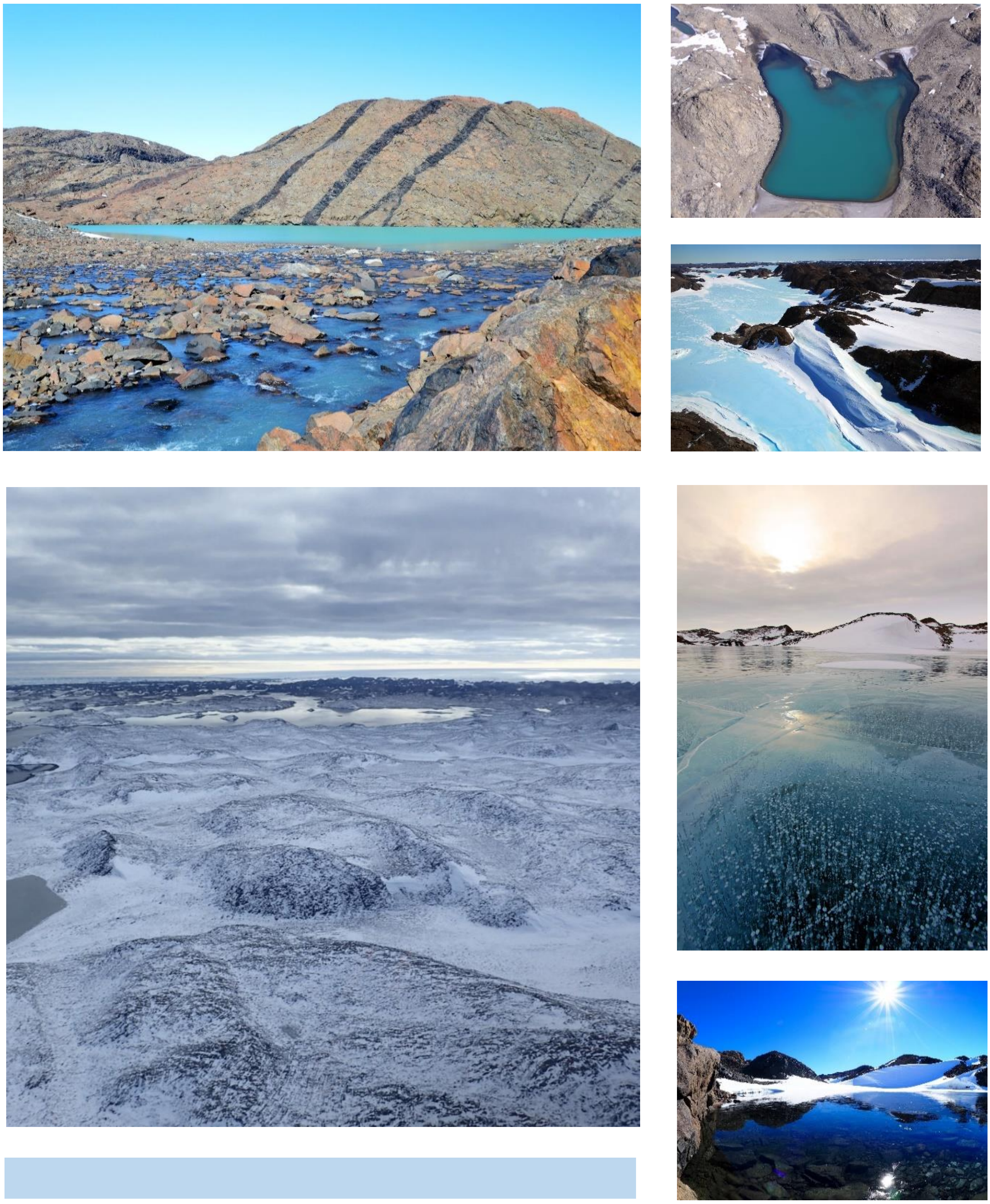
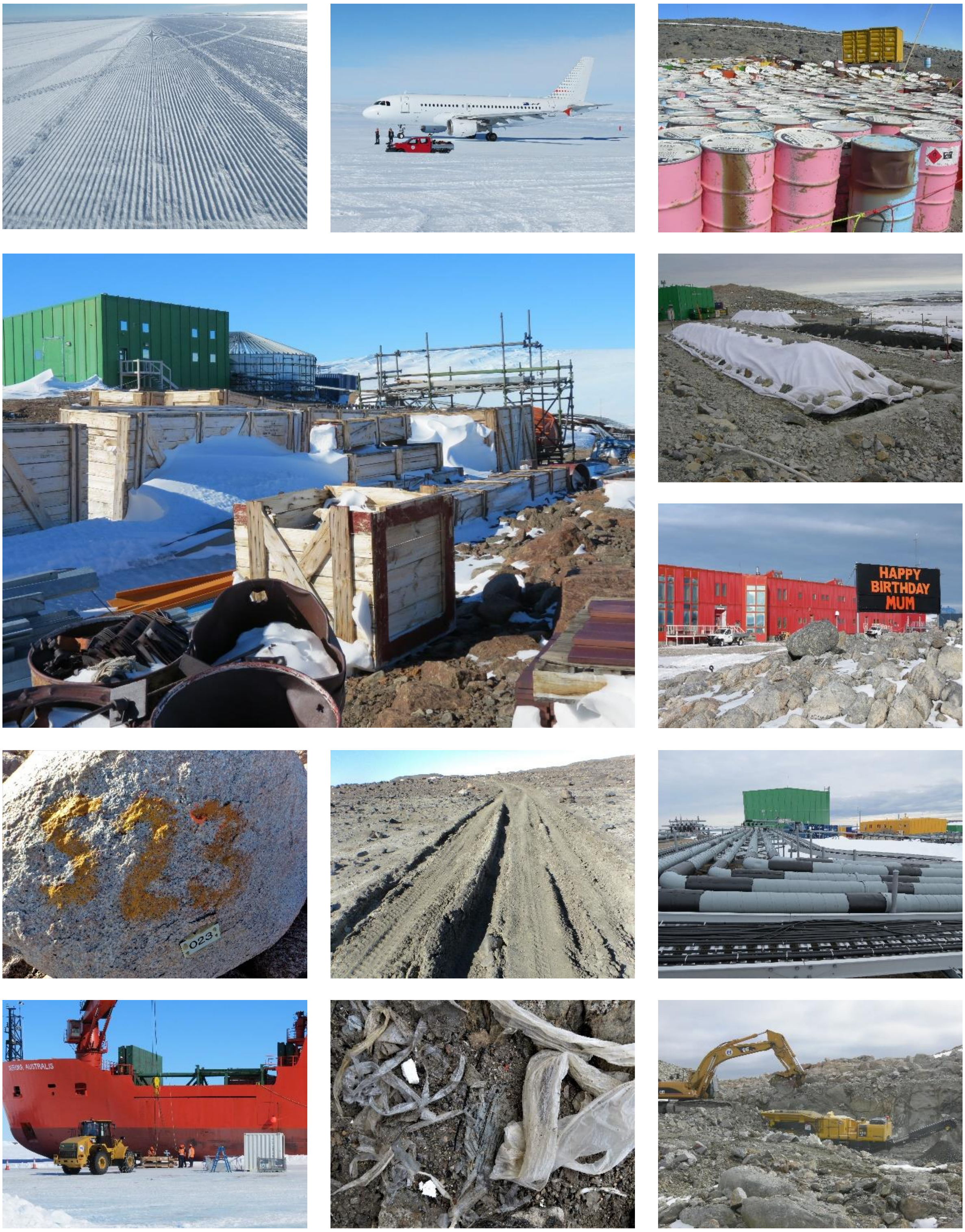


Plate 3. Micro-scale features (textures, shapes, patterns etc.) can contribute to the aesthetic appreciation of physically distinct areas within the broader landscape, such as mountain ranges, island groups and oases. Viewers' appreciation/experience of these areas may also be enhanced by subject matter knowledge, e.g. that a landscape element is rare, sizeable, or took millions of years to reach its present state. All images of geology (dykes, garnets etc.) taken <10 km from Davis in the Vestfold Hills oasis.

Plate 4. The impacts of aviation and its supporting infrastructure on East Antarctica's aesthetic values contribute to the impacts of the AAP more broadly. From top L to bottom R: groomed landing surface and vehicle tracks, inter-continental flight arrival; stockpile of empty ATK drums; storage site; fuel spill remediation works; signage; petrel nest markers; vehicle track; site services; resupply operations; wind-blown packaging materials; quarrying. All images taken in the Wilkins, Casey, Davis and Mawson areas.



Appendix 14. Content of environmental briefings

The following environmental content will be included in briefings of personnel managing aviation operations or involved in aviation activities in Antarctica:

Training element	Fixed wing pilots, engineers	HO staff managing aviation operations	Rotary wing pilots, engineers	Wilkins staff	Air-ground support officers	Winter and summer station teams	Australian program passengers	Other national program passengers
AAD environmental policy/culture and personal accountabilities	✓	✓	✓	✓	✓	✓	✓	
Antarctica's conservation values	✓	✓	✓	✓	✓	✓	✓	
Process for suggesting environmental improvement and logging incidents	✓	✓	✓	✓	✓	✓	✓	
Housekeeping and environmental management practices generally	✓	✓	✓	✓	✓	✓	✓	
Processes for cleaning/checking of personal gear, cargo etc. for contaminants	✓	✓	✓	✓	✓	✓	✓	✓
Environmental obligations arising from aviation contracts	✓	✓	✓					
Aircraft biosecurity inspection requirements	✓	✓	✓	✓	✓			
Procedure for removing wildlife from ski landing areas	✓	✓	✓	✓	✓			
Flight paths to avoid wildlife disturbance	✓	✓	✓		✓			
Use of fuel spill kits	✓	✓	✓	✓	✓	✓		
Management of poultry products at Wilkins		✓		✓	✓			
ASPA locations, and permit and management plan requirements	✓	✓	✓		✓	✓		
Environment protection legislation and its practical implementation	✓	✓	✓	✓	✓	✓	✓	
Possible offences under the *AT(EP) Act* arising from the use of aircraft	✓	✓	✓					
Monitoring and reporting requirements attached to this EIA		✓		✓				
Set up etc. of field fuel depots	✓	✓	✓		✓			
Use of station (bulk) fuel spill response equipment		✓		✓		✓	✓	

Appendix 15. Procedure for ushering penguins from ski landing areas

The following procedures developed by Barbara Wienecke (Seabird Ecologist, AAD), will be used in instances where wildlife is at risk, or the presence of wildlife is unduly hindering SLA operations.[93]

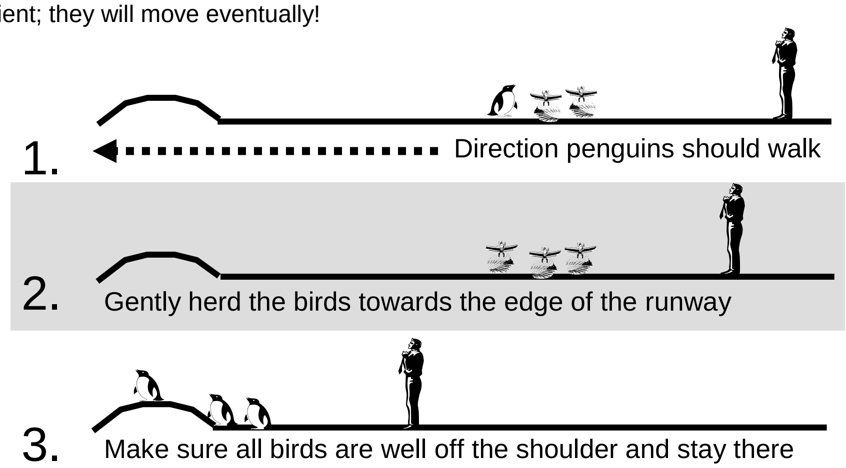
Penguins have to be **<u>well off the ski landing area/runway</u>** before a plane approaches or departs.

How to usher penguins away from danger

Penguins are by nature inquisitive, particularly the non-breeders. If they notice any action in their surroundings, they are likely to check it out. Thus, penguins will occur occasionally on the ski landing area. If so:

- approach them slowly but steadily without making loud sounds
- choose the shortest way for the penguins to get off the ski landing area/runway
- herd them by keeping yourself always between the penguins and the ski landing area/runway. If they move left, you move left to block their way back on the ski landing area/runway; they go right, you go right etc. until they are well off the ski landing area/runway.
- avoid causing penguins to panic. This may cause penguins to toboggan which can damage their flippers. That in turn may impact on their foraging ability as flippers are their only means of propulsion underwater.

Please be patient; they will move eventually!



[93] If undertaken appropriately, this action does not constitute an offence under the *AT(EP) Act*.

Appendix 16. State of the Environment reporting (monitoring) themes

Theme: Atmosphere
Monthly mean air temperatures at Australian Antarctic stations
Highest monthly air temperatures at Australian Antarctic stations
Lowest monthly air temperatures at Australian Antarctic stations
Monthly mean lower stratospheric temperatures above Australian Antarctic stations
Monthly mean mid-tropospheric temperatures above Australian Antarctic stations
Monthly mean atmospheric pressure at Australian Antarctic stations
Daily broad-band ultra-violet radiation observations using biologically effective UVR detectors Atmospheric concentrations of greenhouse gas species
Midwinter atmospheric temperature at altitude 87 km

Theme: Biodiversity
Windmill Islands terrestrial vegetation dynamics

Theme: Human Settlements
Station and ship person days
Biological Oxygen Demand (BOD) of wastewater discharged from Australian Antarctic stations Suspended solids (SS) content of wastewater discharged from Australian Antarctic stations
Waste returned to Australia
Amount of waste incinerated at Australian Antarctic stations
Monthly fuel usage of the generator sets and boilers
Monthly incinerator fuel usage of Australian Antarctic stations
Monthly total of fuel used by vehicles at Australian Antarctic stations
Monthly electricity usage at Australian Antarctic stations
Total potable water consumption at Australian Antarctic stations
Quarry operations at Australian Antarctic stations

Theme: Land
Water levels of Deep Lake, Vestfold Hills

Appendix 17. Environmental risks and control measures for use of poultry meat and eggs at Wilkins[94]

Stage in use of poultry products at Wilkins	Control measures for food and food wastes	Supplementary control measures for poultry meat and eggs including wastes	Likelihood of Antarctic wildlife exposure to poultry meat or eggs, including wastes
Transport to Wilkins from Casey	Transported in secure containers	Use clearly marked secure container dedicated to transport and storage of poultry meats and eggs.	Rare
Storage at Wilkins	Food is securely stored within the mess van (freezer or fridge for perishable food). Stores are replenished from the station every 8-10 days	Use clearly marked secure container dedicated to transport and storage of poultry meats and eggs.	Rare
Consumption at Wilkins	Most food is consumed in the mess van but some is consumed in other buildings, in vehicles and outside.	Restrict consumption of food containing poultry meat or eggs to inside the mess van	Rare
Waste management at Wilkins	Food wastes are stored in dedicated secure containers in the mess van and workshop van awaiting return to Casey.	Restrict poultry meat to boneless and skinless products to minimise waste. All poultry juices and unused portions of poultry products to be stored in clearly marked secure container dedicated to poultry wastes and frozen.	Rare
Transport of waste from Wilkins to Casey	Food wastes are transported by Hagglunds in secure containers	Use clearly marked secure container dedicated to transport and storage of frozen poultry wastes.	Rare
Waste management at Casey	Food wastes are incinerated on station by the Waste Management Officer	Station chef to process poultry wastes returned from Wilkins in conjunction with station poultry wastes	Rare

[94] From ‘Environmental management plan for Wilkins Aerodrome and aircraft operations 2019/20.’

Appendix 18. Environmental risk

Environmental consequences	**Minor**	**Moderate**	**High**	**Major**	**Critical**
Likely spatial extent of impacts	< 10 m^2 (e.g. < 3 m x 3 m or 5 m x 2 m)	< 100 m ^{2} (e.g. < 10 m x 10 m)	< 1000 m^2 (e.g. < 32 m x 32 m or 10 m x 100 m)	< 10 000 m^2 (e.g. < 100 m x 100 m or 10 m x 1000 m)	> 10 000 m^2 (e.g. > 100 m x 100 m or 10 m x 1000 m)
Likely reversibility of impacts	Reversible with minor intervention	Reversible with moderate intervention	Reversible with intensive effort	Reversible with intensive long-term effort	Effectively irreversible
Likely intensity / magnitude of environmental change *e.g. to stone polygons, moss beds, rare or unusual rock formations or mineral assemblages, ice-free areas*	Degradation or loss of < 1% of the area of local occurrences of a landscape feature	Degradation or loss of < 5% of the area of local occurrences of a landscape feature	Degradation or loss of < 20% of the area of local occurrences of a landscape feature	Degradation or loss of < 50% of the area of local occurrences of a landscape feature *or* degradation or loss of up to 5% of the area of all known occurrences of a landscape feature (globally)	Greater than 50% of the area of local examples of a landscape feature *or* degradation or loss of 5% of the area of known occurrences of a landscape feature (globally)
Change to species of fauna and flora, including threatened species	No observable change	Some individuals impacted. No population impact and no impact on threatened species	Loss of individuals. Minimal impact on population. *or* some impact on individuals of threatened species	Substantial impact on or loss of population. Potential loss of genetic diversity *or* loss of individuals of threatened species	Local extinction of species. Loss of genetic diversity *or* impact on one or more populations of threatened species
Change to environmental values of sites *e.g. biological, scientific, historic, aesthetic or wilderness value.*	No observable change	Some degradation of values	Substantial degradation or loss of values *or* Some degradation of values within nationally or internationally significant sites (ASA, ASMA and heritage managed areas)	Loss of values *or* Substantial degradation of a nationally or internationally significant site	Loss of values of a nationally or internationally significant site

Appendix 19. Review of 2015-20 aviation activities

The process of preparing this EIA included undertaking a desk top review of the compliance of 2015-20 AAP aviation operations with the conditions attached to their *AT(EP) Act* authorisation – to assist in identifying any system changes[95] and unanticipated environmental impacts, and to inform the development of additional mitigations.

2015-20 aviation authorisation condition	Compliance
The Activity must only be undertaken in the Antarctic between the date this [the activity authorisation] is signed and 31 August 2020.	
The proponent shall ensure that all persons who will be undertaking the activity: (i) understand the environmental impact assessment, this authorisation and its conditions; and (ii) are provided with a copy of the environmental impact assessment and this authorisation, and understand that they are legally bound by its conditions.	
A report describing all activities undertaken in relation to this authorisation and its conditions shall be submitted on the form provided before 31 May of each year this authorisation is in force. In the final year of the activity, the report must be submitted before the expiry of this authorisation rather than before 31 May.	
The proponent shall maintain records (including photographs) substantiating activities associated with or relevant to this authorisation, and make them available upon request to the Department. Records may be subject to audit by the Department, or used to verify compliance with the conditions of this authorisation.	
Minimise particulate contamination, such as by considering the viability of particulate filters before purchase of new plant and equipment.	
All aviation activities, including fuel storage, must be the minimum necessary to meet the objectives of the Australian Antarctic Program	
In consultation with the Australian Antarctic Division Environmental Performance Committee, develop appropriate options to monitor the impacts of aviation activities.	Monitoring has been limited to reporting the presence of wildlife at Wilkins and SLAs.
Aviation operations are to be conducted such that they comply with legislative instruments related to environment protection – including regional and local (ASMA and ASPA) management plans.	One non-compliance was reported.
New aviation contracts and inter-agency arrangements are to include an environmental/legislative compliance requirement.	
The AAD is to make reports to the Minister (or his/her delegate under the AT(EP) Act (1980)) on the outcomes of monitoring specific to the conduct of aviation.	

[95] The *AT(EP) Act* Section 12D states that if 'a change is proposed, or occurs, in an activity (*original activity*) that was being carried on immediately before the commencement of this Part; or a change is proposed, or occurs, in an activity (*original activity*) that is authorised to be carried on under this Part; the activity as proposed to be changed, or as changed, is to be treated … as being a new activity ...'

Incidents are to be logged using established AAD processes.	
Resources are to be made available to clean-up spills and rehabilitate sites impacted by aviation.	
All reasonable steps are to be taken to promote the return of the environment to its original condition after any pollution release or other aviation-related incident.	
The AAD is to take appropriate action in response to Committee for Environmental Protection aviation-relevant advice to Antarctic Treaty Consultative Meetings on: i. the effectiveness of measures taken pursuant to the Madrid Protocol and the need to update, strengthen or otherwise improves such measures ii. the means of minimising or mitigating the environmental impacts of activities in the Antarctic Treaty area iii. the collection, archiving, exchange and evaluation of information related to environmental protection iv. the need for scientific research, including environmental monitoring, related to the implementation of the Madrid Protocol	Not applicable between 2015-20.[96]
The briefing/training of program participants involved in aviation operations is to include content on personal accountabilities, legislated obligations, biosecurity controls, protected area locations, flight paths to avoid wildlife disturbance, the use of fuel spill kits, and fuel management more generally. Registers of training completion to a satisfactory level are required to be maintained by the AAD's Aviation Manager.	Some issues were identified (and are being rectified).
Helicopter pilots are to receive face-to-face pre-departure environmental briefings by the AAD Operations Manager (or equivalent position), or their delegate.	
On-site environmental management-related responsibilities are to be unambiguously assigned.	
The relevant environmental impact assessment is to be provided to aviation managers in the AAD and in Antarctica.	
Aircraft and vehicles are to be maintained such that their emissions fall within manufacturers' specifications.	
Redundant aviation infrastructure are to be re-allocated or else promptly returned to Australia.	
The following distances are to be maintained from wildlife unless closer approaches have been specifically authorised or are reasonably necessary for the construction or operation of a scientific support facility:	

[96] However the EIA for aviation for 2020-25 reflects Resolution 5 (2015) which recommends Governments take account of the information in the report *Important Bird Areas in Antarctica* in the planning and conduct of their activities in Antarctica including in the preparation of environmental impact assessments.

Aircraft type — *Minimum separation distance from concentrations of birds and seals* Twin-engine fixed-wing aircraft — 750 m (2500 feet) when flying; 930 m when landing Single-engine helicopter — 750 m (2500 feet) when flying; 930 m when landing Twin-engine helicopter — 1500 m (5000 feet) when flying; 1500 m (5000 feet) when landing *Minimum separation distances from cetaceans (i.e. whales)* Helicopters — 1000 m (1650 feet) Fixed-wing aircraft — 300 m (1000 feet) within a 300 m (1000 feet) radius *Minimum separation distances from cetaceans (i.e. whales)* Fixed-wing aircraft exceeding twin-engines — To be operated in accordance with Section 2.2 of Initial Environmental Evaluation for Australian Antarctic Program Aviation Operations 2015-2020	
Recognising that it is difficult to detect disturbance to nesting birds from the air (except in instances of mass nest abandonment or other sudden or panicked movement), greater separation distances than those identified above are to be maintained where possible.	
Overflying concentrations of birds and seals (i.e. at any height) is to be avoided wherever possible.	
Maps of known wildlife concentrations are to be carried such that they can be referred to in flight as appropriate.	
Pre-flight planning meetings are to be held between pilots and the relevant station, voyage or field leader.	
SLAs will be inspected for the presence of wildlife prior to aircraft operation – penguins, if present on SLAs, are to be ushered using established guidelines.	
Where operationally feasible, and to further minimise disturbance, adjustments to the line of SLAs are to take into account the products of noise modelling exercises.	Not applicable between 2015-20.
Where operationally feasible, flight operation methodologies are to be adopted to minimise adverse noise impacts, for example by minimising or constraining the width of circling approaches to coastal SLAs.	
Whales are not be knowingly hovered above, approached from head on, or approached in a way that casts a shadow directly over them.	
Mitigation measures are to be employed to reduce introductions to levels that are as low as reasonably practicable. They will include, as a minimum: i. obligations on service providers to undertake or organise regular, focused, visual inspections of their aircraft's interior and exterior ii. aircraft disinsection/treatment with an Australian Government Department of Agriculture-recognised residual spray or process iii. contractor inductions and training for staff directly involved in preparing cargo and flights, and pre-departure briefing of all travelling personnel iv. cargo consolidation in a biosecure area v. an auditable, pre-loading cargo inspection regime to ensure freedom from contaminants vi. avoiding night time aircraft loading operations vii. minimising non-essential lighting during any night-time loading operations	There were no specific obligations on contractors however there were some biosecurity practices incorporated in contractors' procedures. Not all cargo was consolidated in biosecure areas.

Procedures are to be reviewed should the activity's biosecurity risk profile or the AAD's quarantine policy change.	Not applicable between 2015-20.
The AAD is to adopt operational best-practice in intra-continental biosecurity as identified by the Council of Managers of National Antarctic Programs. The application of measures will focus on preventing transfers between biologically distinct areas.	
Mitigation measures are to include: i. obligations on aviation contractors to undertake regular cleaning of aircraft (i.e. vacuuming, emptying of seat pockets, removal of visible signs of soil etc.) ii. the supply of appropriate materials to facilitate aircraft and equipment cleaning between bioregions iii. the supply of insecticides to stations	There were no specific obligations on contractors however some biosecurity practices were incorporated in contractors' procedures.
Fuel management standard operating procedures are to be regularly reviewed and updated as required.	
Fuel spill contingency plans are to be maintained for sites where fuel is routinely handled or stored in bulk. Plans will be regularly reviewed and updated as required.	
Expeditioners are to receive competency-assessed training appropriate to the level of their involvement in fuel management activities.	
Expeditioners' training is to reference standard operating procedures and where applicable, the content of fuel spill contingency plans and the location and use of fuel spill response equipment.	
Clean-up equipment is to be supplied in quantities and of a type appropriate to the location, risks and volume of fuel held.	
Spotters are to be used when there is a need to use vehicles to clear snow from around fuel storage areas.	Two separate incidences of the puncture of 200 L drums by vehicles occurred – at Davis and Wilkins in 2018.
Samples taken from drums and aircraft tanks, however small, are to be containerised after their assessment.	
Designated areas are to be used for refueling on stations.	
If fuel is lost: i. all reasonable steps are required to be taken to contain and clean-up the impacted environment (other than where the impacts of clean up action are likely to be greater than leaving the fuel in situ) ii. the spill is required to be managed in accordance with plans consistent with COMNAP-identified best practice standards and procedures iii. local action is required to be taken as soon as possible after the incident occurring	
Any new aviation fuel containments of >~1000 L are to be double-skinned and/or bunded.	Not applicable between 2015-20.
Unbunded containments >~1000 L are to be decommissioned and repatriated by the end of the 2017-18 season.	Not applicable – no unbunded containments are in place.
The use of heavy vehicles is prohibited in the vicinity of bulk fuel containment areas (other than where needed to remove or relocate units).	
Containments are to be subject to a regular testing and inspection regime.	

Fuel drums are to be co-located in designated areas at stations; at Mawson, drums are to be stored to minimise any spillage or drum failure resulting in run-off into Horseshoe Harbour.	
Station stockpiles are to be made visible through the use of brightly coloured barricades and canes as appropriate, and/or be located in areas where vehicles do not routinely operate.	
The bottom row of stockpiles are to be held in position with wedges or fabricated drum stands to prevent collapse as stacks are created.	
Stockpiles are to be managed such that drums of the same year of manufacture are grouped and the oldest fuel can be used first.	
Fuel drums are to be colour-coded in a way that ensures their year of manufacture is readily distinguishable.	
Periodic checks are to be made of drum stocks' soundness.	
Used drums are to have their bungs re-inserted.	
A register of Australian fuel caches is to be maintained in real time, and include GPS co-ordinates, and the number and age of full and empty drums.	
The removal of old aviation fuel from ASPAs is to be prioritised, and no new aviation fuel depots are allowed to be established in ASPAs.	
New caches are only able to be established following a documented assessment of: i. the environmental values of the proposed site and surrounding area ii. the features of the local landscape, with particular emphasis on slope, aspect, water flows, susceptibility to high winds and heavy snowfalls, and proximity to lakes, vegetation and wildlife iii. any particular challenges for clean-up actions presented by the location, landscape, and surrounding area (e.g. the area's accessibility and its susceptibility to damage from machinery or recovery equipment) iv. the prospects that exist for the timely removal of drums once emptied or expired Significant risks, if identified, are to be referred to the relevant delegate under the *AT(EP) Act.*	
Caches on ice and snow are to be marked using bamboo canes, wands or similar.	Partial compliance.
Caches are to be secured to prevent their wind dispersal, while facilitating their removal.	
Drums are to be stored on their sides to prevent water being drawn inside and the fuel becoming unacceptable for aviation.	
Resources are to be allocated to ensure that unused drums are removed from field caches within six years of the drums' manufacture or depoting.	Drums >6 years old remain in the field (at Turk Glacier and Beaver Lake).
Cargo handling equipment and methods are to be fit for purpose.	
The potential need for cargo to be jettisoned is to be taken into account in route planning; overflying lakes and other especially vulnerable areas is required to be actively avoided.	
No more than 8 full drums are to be sling-loaded per sortie, and overflying lakes and water courses will be avoided wherever practicable.	Partial compliance with respect to lake over-flight.
The discovery of any caches, artefacts etc. that may pre-date 1958 are to be identified as among incidents to be reported to the AAD's HO.	

Aircraft are to maintain a buffer zone around historic sites and monuments that have international Antarctic community recognition.	
Unmanned aircraft operations are to be undertaken in a manner consistent with CASA administered regulations insofar as they can be applied in the Antarctic context.	
In addition to, or in concert with the above, unmanned aircraft operations are to: i. be scheduled, routed and approved by station and voyage leaders using the processes in place for planning conventional aircraft operations ii. only be undertaken by appropriately experienced/qualified individuals, in concert with an observer/look-out iii. only be undertaken where a strong command and control link can be maintained iv. not be undertaken where they could intersect the flight paths of other aircraft, i.e. within a radius of 3 nm (5.5 km) of Wilkins, SLAs and other sites where aircraft may be operating or parked. v. comply with the wildlife separation distances applicable to single engine aircraft (unless closer approaches are specifically authorised by a permit) vi. be discontinued if they are observed to modify animal behaviour (unless a permit has been obtained that specifically authorises wildlife disturbance) vii. not occur when weather forecasts are poor, or in conditions of poor visibility or darkness or near-darkness viii. not be flown under conditions where icing may form without proper anti-ice/de-icing function ix. be undertaken in a manner that minimises the sound emitted x. generally necessitate the development of retrieval plans should systems fail xi. not be undertaken in the vicinity of foreign facilities without the approval of the relevant national program operator xii. not be undertaken within 30 m of historic sites and monuments, as appropriate to maintaining a buffer in the event of an unplanned landing xiii. not be undertaken in an ASPA unless specifically authorised by a permit xiv. be subject to a record keeping process that is available for inspection xv. undergo separate environmental impact assessment if they involve aircraft that will not be recovered	
Domestic flights are to be scheduled and routed so as to minimise the potential need for unplanned safety-related actions that could impact on the environment.	
Waste management requirements are to be communicated to station personnel simply and effectively.	
Waste generated on board international flights is to be retained on board for discharge at airports outside Antarctica.	
Waste generated onboard domestic flights and at Wilkins and SLAs is to be handled via established processes that, as a minimum, comply with the waste management annex to the Madrid Protocol. To this end: i. the preferred approach is to be total removal from Antarctica ii. waste is to be recycled or re-used where possible iii. waste is to be stored in a way that prevents its wind dispersal and wildlife access iv. grey water generated at SLAs < 50 km from a station is to be returned to station for treatment (but in the absence of a treatment plant at Davis, grey water from the Davis SLA may, if free of food particles, be transported to and released at the coast, wherever possible away from wildlife and in an area from where it will rapidly disperse)	

Inventories are to be maintained of the location and nature of equipment, fuel, waste etc. left in the field on account of unplanned operational circumstances.	
To avoid pollution: cargo is not permitted to be pre-positioned at SLAs if it cannot be properly secured or containerised within existing infrastructure.	
Overnighting aircraft at Mawson is to be avoided on account of the potential for aircraft destruction by extreme katabatic winds.	
The siting of new aviation infrastructure is to factor the likely severity of impacts to the site and its values should mitigation measures fail.	Not applicable between 2015-20.
No new aviation-related infrastructure is to be built in areas where mosses and lichens are found.	Not applicable between 2015-20.
No aviation support vehicles are to be parked in areas where mosses and lichens are evident.	
Disintegrating bamboo canes are to be regularly retrieved from vehicle routes.	

AAD (1994). *Initial environmental evaluation of the proposal to use long-range helicopters to support Australia's Antarctic program*.

AAD (2003). *Initial environmental evaluation: Air transport system. Implementation and operation of an ongoing air transport system including intercontinental flights between the Australian and Antarctic continents and intra-continental flights between Antarctic stations*.

AAD (2007). *Initial environmental evaluation: Air transport system – Development and operation of an ongoing air transport system including inter-continental flights between the Australian and Antarctic continents and intra-continental flights between Antarctic stations*. https://documents.ats.aq/EIA/01155enAir%20Transport%20IEE%20Variation%20Final%20Sep%202007.pdf

AAD (2010). *Australian Antarctic science strategic plan 2011–12 to 2020–21*. http://www.antarctica.gov.au/__data/assets/pdf_file/0019/27307/AASSP_final-published-version_Apr-2011.pdf

AAD (2012). *Australian Antarctic Division strategic directions 2012-2022*.

AAD (2015). *Environmental impact assessment – Australian Antarctic program aviation operations 2015-2020*. https://documents.ats.aq/EIA/01727enAviation%20Initial%20Environmental%20Evaluation%20(IEE)%20-%202015-2020%20-%20final.PDF

AAD (2016). *Initial environmental evaluation – geotechnical site investigations and environmental baseline sampling in the Vestfold Hills 2016/17 – Project 5097*. Antarctic Modernisation Program, November 2016. https://documents.ats.aq/EIA/01819enIEE_Australia_geotechnical_investigations_environmental_sampling_Vestfold_Hills_2016.pdf.

AAD (2018a). 'Building Antarctica's first paved runway' (18 May 2018). https://www.antarctica.gov.au/news/2018/building-antarcticas-first-paved-runway/; accessed 19 May 2020.

AAD (2018b). 'New Davis runway' (18 May 2018). http://www.antarctica.gov.au/living-and-working/travel-and-logistics/aviation/New-Davis-Runway; accessed 13 August 2019.

AAD (2020a). 'Davis aerodrome project – future science opportunities.' https://www.antarctica.gov.au/site/assets/files/54470/future_science_opportunities_synthesis_report_final.pdf.

AAD (2020b). 'EPBC Act referral – 2019/8594 – Davis Aerodrome Project' and 'Davis Aerodrome Project extended referral submission' (16 December 2019). http://epbcnotices.environment.gov.au/_entity/annotation/21cd824e-4f42-ea11-b0a8-00505684324c/a71d58ad-4cba-48b6-8dab-f3091fc31cd5?t=1590124021991; accessed 1 February 2020.

AAD (2020c). 'Next steps for proposed Antarctic aerodrome decided. 'https://www.antarctica.gov.au/news/2020/next-steps-for-proposed-antarctic-aerodrome-decided/; accessed 19 May 2020.

Antarctic Treaty Secretariat (2004). *Guidelines for the operation of aircraft near concentrations of birds in Antarctica.* https://documents.ats.aq/recatt/Att224_e.pdf.

Antarctic Treaty Secretariat (2014). 'Larsemann Hills East Antarctica – Antarctic Specially Managed Area Management Plan.' https://www.ats.aq/devph/en/apa-database; accessed 1 February 2020.

Antarctic Treaty Secretariat (2016). 'Management Plan for Antarctic Specially Protected Area No. 167 – Hawker Island, Princess Elizabeth Land.' https://www.ats.aq/devph/en/apa-database; accessed 1 February 2020.

Antarctic Treaty Secretariat (2014). 'Management Plan for Antarctic Specially Protected Area No. 169 – Amanda Bay, Ingrid Christensen Coast, Princess Elizabeth Land, East Antarctica.' https://www.ats.aq/devph/en/apa-database; accessed 1 February 2020.

Australia (2006). Fuel spill management in Antarctica: recent advances in first response and remediation. Information Paper 45. Antarctic Treaty Consultative Meeting XXIX, Edinburgh, Scotland.

Aviation Environment Federation (undated). What are an airport's impacts? https://www.aef.org.uk/uploads/PlanningGuide2.pdf.

Blanchette, R.A., Held, B.W., Jurgens, J.A., Aislabie, J., Duncan, S. and Farrell, R.L. (2004). Environmental pollutants from the Scott and Shackleton expeditions during the 'Heroic Age' of Antarctic exploration. *Polar Record 40*(213):143-151.

Boutron, C.F. and Wolff, E.W. (1989). Heavy metal and sulphur emissions to the atmosphere from human activities in Antarctica. *Atmospheric Environment 23*(8):1669-1675.

Brooks, S.T., Jabour, J., van den Hoff, J. and Bergstrom, D.M. (2019). Our footprint on Antarctica competes with nature for rare ice-free land. *Nature Sustainability 2*:185-190.

Burns, R. (2001). *Just tell them I survived! Women in Antarctica*. Allen Unwin. 232 pp.

Burton-Johnson, A., Black, M., Fretwell, P.T. and Kaluza-Gilbert, J. (2016). An automated methodology for differentiating rock from snow, clouds and sea in Antarctica from Landsat 8 imagery: a new rock outcrop map and area estimation for the entire Antarctic continent. *The Cryosphere 10*:1665-1677.

COMNAP (2005). *Practical guidelines for development and designing environmental monitoring programmes in Antarctica.* Council of Managers of National Antarctic Programs / Antarctic Environment Officers Network.

COMNAP (2008). *COMNAP fuel manual*. Council of Managers of National Antarctic Programs Secretariat, Hobart. 28 pp.

COMNAP (2014). *Antarctic flight information manual.* Council of Managers of National Antarctic Programs Secretariat, Christchurch.

COMNAP and SCAR (2000*). COMNAP–SCAR Antarctic environmental monitoring handbook.* Council of Managers of National Antarctic Programs Secretariat, Hobart. 76 pp.

Campbell, I.B., Claridge, G.G.C. and Balks, M.R. (1998). Short- and long-term impacts of human disturbances on snow-free surfaces in Antarctica. *Polar Record 34*:15-24.

Chown, S.L., Huiskes, A.H.L., Gremmen, N.J.M., Lee, J.E., Terauds, A., Crosbie, K.,Frenot, Y., Hughes, K.A., Imura, S., Kiefer, K., Lebouvier, M., Raymond, B.,Tsujimoto, M., Ware, C., Van de Vijver, B. and Bergstrom, D.M. (2012). Continent-wide risk assessment for the establishment of non-indigenous species in Antarctica. *Proceedings of the National Academy of Science USA 109*:4938-4943.

Chupin, I. (1997). Human impact and breeding success in southern giant petrel *Macronectes giganteus* on King George Island (South Shetland Islands). *Korean Journal of Polar Research 8*(1,2):113-116.

Committee for Environmental Protection (2014). *Clean up manual.* Antarctic Treaty Secretariat. https://documents.ats.aq/recatt/att540_e.pdf.

Commonwealth of Australia (2017). *Australian national guidelines for whale and dolphin watching 2017*. Australian Government Department of the Environment, Canberra. 23 pp.

Corporan, E., Quick, A. and DeWitt, M.J. (2008). Characterization of particulate matter and gaseous emissions of a C-130H aircraft. *Journal of the Air and Waste Management Association 58(4):474-483.*

Cowan, D.A. and Tow, L.A. (2004). Endangered Antarctic environments. *Annual Review of Microbiology 58*:611-690.

Department of the Environment (2013). *Matters of national environmental significance. Significant impact guidelines 1.1 Environment Protection and Biodiversity Conservation Act 1999*. Australian Government Department of the Environment, Canberra. 35 pp.

Department of the Environment (2014). *Annual Report 2013-14*. Australian Government Department of the Environment, Canberra.

DEWHA (2008). *National Pollutant Inventory – emission estimation technique manual for airports.* Australian Government Department of the Environment, Water, Heritage and the Arts, Canberra. 66 pp.

Dewitt, M.J., Klingshirn, C.D. and Anneken, D. (2010). *Alternative fuel tests on a C-17 aircraft: emissions characteristics*. Air Force Research Laboratory Propulsion Directorate, Wright-Patterson Airforce Base, Ohio. 33 pp.

EPA (2000). 'Aircraft contrails factsheet.' US Environmental Protection Agency, Washington DC. 6 pp.

Drenthen, M. and Keulartz, J. (2014). (Eds). *Environmental aesthetics.* Fordham University Press, New York. 252 pp.

Eurocopter (2009). 'Eurocopter AS350 B3 technical data.' http://www.eurocopter.com.

Frenot, Y., Chown, S.L., Whinam, J., Selkirk, P.M., Convey, P., Skotnicki, M. and Bergstrom, D.M. (2005). Biological invasions in the Antarctic: extent, impacts and implications. *Biological Reviews 80*:45–72.

Harris, C.M. (2005). Aircraft operations near concentrations of birds in Antarctica: the development of practical guidelines. *Biological Conservation 125*:309-322.

Harris, C.M., Lorenz, K., Fishpool, L.D.C., Lascelles, B., Cooper, J., Croxall, J.P., Emmerson, L.M., Fraser, W.R., Fijn, R., Jouventin, P., LaRue, M.A., Le Maho, Y., Lynch, H.J., Naveen, R., Patterson-

Fraser, D.L., Peter, H.-U., Poncet, S., Phillips, R.A., Southwell, C.J., van Franeker, J.A., Weimerskirch, H., Wienecke, B. and Woehler, E.J. (2015). *Important Bird Areas in Antarctica 2015 Summary.* BirdLife International and Environmental Research & Assessment Ltd., Cambridge. 313 pp. http://pal.lternet.edu/docs/bibliography/Public/515lterc.pdf

Houghton, M., McQuillan, P.B., Bergstrom, D.M., Frost, L., van den Hoff, J. and Shaw, J. (2014). Pathways of alien invertebrate transfer to the Antarctic region. *Polar Biology*; published online.

Hughes, K.A. and Convey, P. (2010). The protection of Antarctic terrestrial ecosystems from inter- and intra-continental transfer of non-indigenous species by human activities: a review of current systems and practices. *Global Environmental Change 20*:96-112.

Hughes, K.A., Cary, S.C., Cowan, D.A., Lovejoy, C., Vincent, W.F. and Wilmotte, V.A. (2013). Pristine Antarctica: threats and protection. *Antarctic Science 25*(1):1.

Jouventin, P., Stahl, J.C., Weimerskirch, H. and Mougin, J.L. (1984). The seabirds of the French Subantarctic Islands and Adélie Land, their status and conservation. I.C.B.P. Technical Publication. Status and Conservation of the World Seabirds, Cambridge 2:609-625.

Klekociuk, A. and Wienecke, B. (2016). Antarctic environment: Australian Antarctic Program's station environment: Contaminated sites and pollution. In: *Australia state of the environment 2016*, Australian Government Department of the Environment and Energy, Canberra. https://soe.environment.gov.au/theme/antarctic-environment/topic/2016/australian-antarctic-programs-station-environment-0.

Klekociuk, A. and Wienecke, B. (2017). *Australia State of the Environment 2016: Antarctic environment, independent report to the Australian Government Minister for the Environment and Energy.* Australian Government Department of the Environment and Energy, Canberra.

Manci, K.M., Gladwin, D.N., Villella, R. and Cavendish, M.G. (1998). *Effects of aircraft noise and sonic booms on domestic animals and wildlife: a literature synthesis.* U.S. Air Force and National Ecology Research Center.

Marchant, S. and Higgins, P.J. (1990) *Handbook of Australian, New Zealand and Antarctic Birds*. Royal Australasian Ornithologists Union and Oxford University Press, Melbourne. 1400 pp.

Marchant, H.J., Lugg, D.J. and Quilty, P.G. (Eds). *Australian Antarctic science: the first 50 years of ANARE.* Australian Antarctic Division, Kingston. 622 pp.

Masiol, M. and Harrison, R.M. (2008). Aircraft engine exhaust emissions and other airport-related contributions to ambient air pollution: a review. *Atmospheric Environment 95*:409-455.

Morgan, F., Barker, G., Briggs, C., Price, R. and Keys, H. (2007). *Environmental Domains of Antarctica Version 2.0 Final Report.* Landcare Research New Zealand Ltd. 89 pp.

NSF Office of Polar Programs (2014). *Activity: Operate airfield facilities at McMurdo station, Antarctica.* National Science Foundation, Arlington, Virginia. 20 pp.

Pertierra, L.R., Hughes, K.A., Vega, G.C. and Olalla-Tarraga, M.A. (2017). High resolution spatial mapping of human footprint across Antarctica and its implications for the strategic conservation of avifauna. *PLoS ONE 12*(1):e0168280. Doi:10.1371/journal.pone.0168280.

Pickard, J. (Ed.). (1986). *Antarctic oasis: Terrestrial environments and history of the Vestfold Hills.* Academic Press, Sydney.

Potter, S. (2009). Protecting Antarctica from non-indigenous species: the imperatives and the impediments. In: Leary, D. (Ed.). *Yearbook of Polar Law.* Martinus Nijhoff Publishers, Leiden. Pp. 383-399.

Press, A.J. (2014). *20 year Australian Antarctic strategic plan* (report released October 2014). http://20yearplan.antarctica.gov.au/final-report. 72 pp.

Rounsevell, D. and Binns, D. (1991). Mass deaths of King penguins (*Aptenodytes patagonicus*) at Lusitania Bay, Macquarie Island. *Aurora* 10(4):8-10.

SCAR (1985). *Man's impact on the Antarctic environment: a procedure for evaluating impacts from scientific and logistic activities.* SCAR, Scott Polar Research Institute, Cambridge. 56 pp.

SCAR Panel of Experts on Waste Disposal (1989). *Waste disposal in the Antarctic.* Australian Antarctic Division. 53 pp.

Selkirk, P.M. (2002). Antarctic and sub-Antarctic terrestrial biology, present, past and future. In: Marchant, H.J., Lugg, D.J. and Quilty, P.G. (Eds). *Australian Antarctic science: the first 50 years of ANARE.* Australian Antarctic Division, Kingston. Pp. 225-236.

Shaw, J.D., Terauds, A., Riddle, M.J., Possingham, H.P. and Chown, S.L. (2014). Antarctica's protected areas are inadequate, unrepresentative, and at risk. *PLOS Biology 12*(6):1-5.

State of the Environment Committee (2011). *Australia State of the Environment 2011. Independent report to the Australian Government Minister for Sustainability, Environment, Water, Population and Communities.* Australian Government DSEWPaC, Canberra.

Terauds, A., Chown, S.L., Morgan, F., Peat, H.J., Watts, D.J., Keys, H., Convey, P. and Bergstrom, D.M. (2012). Conservation biogeography of the Antarctic. *Diversity and Distributions 18*:726-241.

Terauds, A. and Lee, J. R. (2016). Antarctic biogeography revisited: updating the Antarctic Conservation Biogeographic Regions. *Diversity and Distributions* 22:836–840.

Tin, T., Fleming, Z.L, Hughes, K.A., Ainley, D.G., Coney, P., Moreno, C.A., Pfeiffer, S., Scott, J. and Snape, I. (2008). Impacts of local human activities on the Antarctic environment. *Antarctic Science 21*:3-33.

Van Franeker, J. and Bell, P.J. (1988). Plastic ingestion by petrels breeding in Antarctica. *Marine Pollution Bulletin 19(*12):672-674.

Vaught, J.M., Johnsen, S.E.J., Parks, W.M. and Johnson, R.L. (1971). *Collection and assessment of aircraft emissions base-line data – turboprop engines.* EPA Office of Air Programs, Michigan. 69 pp.

Procedures, studies etc. held by the AAD

AAD Environmental Management System (EMS) 19th Management Review.

'AAD risk management guidelines 2018-20' (April 2018)

'AAD standard operating procedure – Operations manual (Volume 5) – Aviation standard operating procedures' (10 September 2019)

'Antarctic air transport scoping study,' J. Shevlin and J. Johnson, Antarctic Air Transport Task Force, AAD (July 1999)

‘Antarctic air services – noise emissions for CN 212 and Falcon 900EX at Antarctic landing areas.’ Report by The Ambidji Group Pty Ltd, Melbourne (August 2003)

‘Aspects and impacts – Antarctic and Southern Ocean: Aviation operations’ (13 November 2013)

‘Aviation facilities operation standard operating procedure 2019-20’ (6 August 2019)

‘Environmental management plan for Wilkins Aerodrome and aircraft operations 2019/20’ (July 2019)

‘Environmental management plan for Australian Antarctic intra-continental aviation operations and facilities 2019/20’ (1 July 2019)

‘Environmental policy on unmanned aerial systems (drones) in Antarctica’ (July/August 2018)

Antarctic Field manual (September 2018)

Flight paths to avoid wildlife in East Antarctica (September 2014)

Flight path guidelines – avoiding wildlife in East Antarctica (October 2019)

‘Fuel spills – review and analysis from 1980s to March 2013’ (13 May 2013)

‘Intra-continental aviation manual’ (May 2019)

‘Intra-continental aviation operations & facilities management environmental management plan’ (March 2019)

‘Use of poultry products’ (24 July 2017)

‘Wilkins Aerodrome manual’ (3 May 2019)

Reports prepared by M. Gasparon under AAD-UQ Contract No. 07/768 ((2008, 2009, 2010)

Databases

Antarctic Treaty Secretariat – Antarctic Protected Areas
http://www.ats.aq/devPH/apa/ep_protected.aspx?lang=e

Antarctic Treaty Secretariat – Environmental Impact Assessment
http://www.ats.aq/devAS/ep_eia_list.aspx?lang=e

Antarctic Treaty Secretariat – Exchange Information
http://www.ats.aq/e/ie.htm

Australian Antarctic Data Centre – Map Catalogue
https://www1.data.antarctica.gov.au/aadc/mapcat/

Australian Antarctic Data Centre – State of the Environment Reporting
https://www1.data.antarctica.gov.au/aadc/soe/

Australian Antarctic Division – Incident, Hazard and Improvement Suggestions reporting system (AAD intranet)

Australian Government Department of the Environment – Species Profile and Threats Database
http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl

BirdLife International – Data Zone
http://www.birdlife.org/datazone/home

Instruments etc.

Antarctic Treaty (Environment Protection) Act 1980

Antarctic Treaty (Environment Protection) (Environmental Impact Assessment) Regulations 1993

Antarctic Treaty (Environmental Protection) (Waste Management) Regulations 1994

Environment Protection and Biodiversity Conservation Act 1999

Environment Protection and Biodiversity Conservation Regulations 2000

Protocol on Environmental Protection to the Antarctic Treaty *including:*
Annex I – Environmental Impact Assessment
Annex II – Conservation of Antarctic Flora and Fauna
Annex III – Waste Disposal and Waste Management
Annex V – Area Protection and Management

Definitions, abbreviations and acronyms

AAD	Australian Antarctic Division (being part of the Department of Agriculture, Water and the Environment
AADC	Australian Antarctic Data Centre
AAP	Australian Antarctic Program
AAS	Australian Antarctic Science (project)
AAT	Australian Antarctic Territory, as established by the *Australian Antarctic Territory Acceptance Act 1933*
ACBR	Antarctic Conservation Biogeographic Regions – being areas of biodiversity so labelled by Terauds *et al.* (2012)
ADF	Australian Defence Force
AGL	above ground level
AGSO	air–ground support officer
ASL	above sea level
ASMA	Antarctic Specially Managed Area – as designated by Antarctic Treaty Parties
ASPA	Antarctic Specially Protected Area – as designated by Antarctic Treaty Parties
AT(EP) Act	*Antarctic Treaty (Environment Protection) Act* 1980 – being Australian legislation
ATK	aviation turbine kerosene, specifically F-34 AVTUR with fuel system icing inhibitor (FSII)
ATS	Antarctic Treaty system
AWS	automatic weather station
BOM	Bureau of Meteorology
CASA	Civil Aviation Safety Authority (and an aircraft)
CEE	comprehensive environmental evaluation, being the environmental impact assessment documentation required under the *AT(EP) Act* for proposed activities that may have a more than minor or transitory impact on the Antarctic environment
CEP	Committee for Environmental Protection – being a group tasked with providing advice and formulating recommendations to Antarctic Treaty Parties in connection with the implementation of the Madrid Protocol
CHINARE	Chinese National Antarctic Research Expeditions
COMNAP	Council of Managers of National Antarctic Programs
disinsection	insecticide spraying for quarantine purposes
domestic flights	flights within Antarctica
EIA	environmental impact assessment
EMP	environmental management plan
EMS	environmental management system
EPBC Act	*Environment Protection and Biodiversity Conservation Act* 1999 – being Australian legislation
ETA	Expeditioners, Transport and Accommodation – being an AAD logistics database
field operations	operations remote from Casey, Davis or Mawson

footprint	ground surface modified, disturbed or impacted by infrastructure and their associated support and logistics activities (and that is rarely measured in a uniform manner)
heavy vehicles	vehicles > 20 t
HO	Head Office i.e. Australian Antarctic Division, Kingston
HSM	a historic site or monument that has been given special status within the Antarctic Treaty system
IEE	initial environmental evaluation, being the environmental impact assessment documentation required under the *AT(EP) Act* for proposed activities that may have a minor or transitory impact on the Antarctic environment
IHIS	Incidents, Hazards and Improvement Suggestions – being an AAD database in which environmental and safety incidents are required to be recorded
impact	a change in the values or resources attributable to a human activity; it is the consequences of an agent of change, not the agent itself
international flights	flights between the Antarctic continent and places outside of Antarctica, including flights between Australia and AAT
IUCN	International Union for the Conservation of Nature
KIAS	knots indicated air speed
landing site	unprepared surface on which aircraft are potentially landed
large fixed-wing aircraft	fixed-wing aircraft exceeding twin engines
Madrid Protocol	Protocol on Environmental Protection to the Antarctic Treaty (signed in Madrid)
MECC	mobile, expandable, container, configuration – trademark name for a re-deployable shelter that is often also referred to as a Weatherhaven, after its manufacturer
meromictic lake	A lake in which the water column is stratified into layers of varying density ranging from freshwater to hypersaline
mitigation	the use of practice, procedure or technology to minimise or prevent impacts associated with proposed activities
oasis	a substantially sized ice-free area separated from the ice sheet and having a positive radiation balance
PA	preliminary assessment (of environmental impacts)
PAPI	precision approach path indicators
RENL	runway end lighting
SAB	special Antarctic blend being a station-used diesel
SAR	search and rescue
SCAR	Scientific Committee for Antarctic Research
skiway	site for landing large ski equipped aircraft (> 60 t maximum take-off weight)
SLA	ski landing area, being a site that has been prepared for the receipt of multiple flights (and as distinct from a landing site or a skiway) SLAs are operated as 'certain other landing areas' (MOS Part 139) under the CASA's regulatory framework
SOE	state of the environment [reporting processes]
SOP	standard operating procedure

transit passengers	personnel transferring between domestic and international flights in and out of Wilkins, and for whom accommodation is provided at Wilkins in preference to Casey
unprepared [landing site/area]	a location that a pilot determines to be suitable for landing
USAP	United States Antarctic Program, as managed by the US National Science Foundation
ULP	unleaded petrol
Wilkins	Wilkins Aerodrome, a 'Code 3C' facility under CASA regulations, and for the purposes of this document, the runway plus the infrastructure etc. in support
UAS	unmanned aerial systems (drones, unmanned aircraft, remotely operated or piloted aircraft) – in the context of this EIA, other than a unit that is used for sport and recreation