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THE PARLIAMENT OF THE COMMONWEALTH OF AUSTRALIA

PARLIAMENTARY STANDING COMMITTEE ON PUBLIC WORKS

R E P O R T

relating to the

REDEVELOPMENT OF AUSTRALIAN ANTARCTIC BASES

(Fifth Report of 1981)

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PUBLIC WORKS COMMITTEE ACT 1969

ORDER UNDER SUB-SECTION 18(4)

I, SIR ZELMAN COWEN, the Governor-General of the Commonwealth of Australia, acting with the advice of the Federal Executive Council, in pursuance of Sub-Section 18(4) of the Public Works Committee Act 1969, hereby, by this Order, declare that the public work described in the schedule be referred to the Parliamentary Standing Committee on Public Works for consideration and report.

SCHEDULE

REDEVELOPMENT OF AUSTRALIAN ANTARCTIC BASES

Given under my Hand and the Great Seal of Australia on 29 January 1981

L.S.

ZELMAN COWEN

Governor-General

By His Excellency's Command

(Signed) D.T. McVeigh

Minister of State for Housing and Construction

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C O N T E N T S

PARLIAMENTARY STANDING COMMITTEE ON PUBLIC WORKS

REDEVELOPMENT OF AUSTRALIAN ANTARCTIC BASES

R E P O R T

On 29 January 1981, His Excellency the Governor-General in Council referred to the Parliamentary Standing Committee on Public Works for consideration and report to Parliament the proposed redevelopment of Australian Antarctic Bases.

THE REFERENCE

1. The proposal is for the progressive replacement of buildings and the provision of facilities needed to support current research programs in Australia's Antarctic Territory. The redevelopment will be carried out over a ten-year period and will involve the replacement of accommodation at Casey, Mawson and Davis bases which is substandard and where maintenance is no longer economical or practicable.

2. The estimated cost of the proposal when referred to the Committee was $58.14 million. This comprises $35.0 million from the Civil Works vote as advised by the Department of Housing and Construction and $23.14 million from the Department of Science and Technology. The latter figure includes estimates for plant and equipment, logistic support and shipping.

THE COMMITTEE'S INVESTIGATION

3. The Committee received written submissions and drawings from the Departments of Science and Technology and Housing and Construction and took evidence from their representatives at public hearings in Melbourne on 18 and 19 March, in Adelaide on 4 May and in Canberra on 5 May 1981. The Committee sought a

submission from the Department of Foreign Affairs and took evidence in Melbourne from a departmental representative.

4. In response to its advertisement in the National Press on 6 February 1981, the Committee received submissions from a number of organisations including the Australian Conservation Foundation, Bureau of Mineral Resources, Bureau of Meteorology, the ANARE Club, the Habitat Group, Department of Architecture, Melbourne University and took evidence from their representatives in Melbourne on 19 March 1981. A representative of the Antarctic Research Policy Advisory Committee (ARPAC) also gave evidence.

5. The Committee wrote to the 300 former expenditioners who had served at the Australian stations in Antarctica over the last three years inviting their views on the proposal. A number contacted the Committee and three former expeditioners gave evidence in Melbourne on 19 March 1981.

6. On 4 May 1981 a Sectional Committee met in Adelaide and took evidence from a further three former expeditioners, as well as representatives of the Mawson Institute for Antarctic Research and the South Australian Museum. On 5 May 1981, the Committee concluded its hearing following evidence from another former expeditioner and the recall of departmental witnesses.

7. Prior to the hearings the Committee travelled to New Zealand and thence by United States ski-equipped Hercules aircraft to McMurdo and Casey stations in Antarctica. The Committee inspected the Australian station at Casey, the United States McMurdo Station and the nearby New Zealand Scott Base. The Committee believes the four day visit to Antarctica and the inspection of the three stations was invaluable in enabling members to obtain a first hand appreciation of conditions and life in that area. The inspection of the three stations, particularly Casey, enabled the Committee members to establish

benchmarks against which their assessment of the proposed work at the three Australian stations is more meaningful and authoritative than would otherwise have been the case.

8. The Committee's proceedings will be printed as Minutes of Evidence.

BACKGROUND

9. Geography The Antarctic Continent is a large land mass centred approximately on the South Geographic Pole. It has an area of almost thirteen and a half million square kilometres. Australia, which has an area of around eight million square kilometres, and Antarctica, are the only two Continents of the world which lie entirely within the Southern Hemisphere.

10. Antarctica has been described as the white frontier of Australia and is unique among the world's Continents in that it is almost entirely covered by an ice sheet. At its highest point, the ice is over four kilometres above sea level and beneath it there is a hidden landscape of mountains, valleys and plains. The estimated average thickness of the continental ice sheet is about 1800 metres. The high plateau of Antarctica is the world's largest and driest desert.

11. In most coastal regions, the mean annual temperature is around minus 12 degrees celsius to minus 60 degrees celsius at 4000 metres above sea level.

12. Flora and fauna species are few with penguins, seals, birds, algae and lichens being the most common.

13. Summer on the Antarctic Continent lasts from late November through to early February. Some coastal areas of Antarctica often experience winds which exceed hurricane force (120 kilometres per hour) for several days at a time, maximum

wind gusts being more than 250 kilometres per hour.

14. Australian Involvement Australia's title in Antarctica is the outcome of acts of discovery and an Imperial Conference in 1926, when Australia was invited to co-operate with Britain in securing its presence in Antarctica and to assume control over certain areas. The discussions were given urgency by a campaign for action from the Australian scientific community led by Professor Sir Douglas Mawson. The final outcome was the British, Australian and New Zealand Antarctic Research Expedition (BANZARE) of 1929-30 and 1930-31 led by Sir Douglas Mawson. Britain provided the "Discovery" and New Zealand also contributed.

15. During that expedition British sovereignty was proclaimed at seven localities and two years later the Australian Antarctic Territory was proclaimed by an Order in Council. After the passage of the Australian Antarctic Territory Acceptance Act through Federal Parliament, sovereignty came into force on 24 August 1936.

16. The Australian Antarctic Territory (AAT) lies south of latitude 60 degrees and between 45 degrees and 160 degrees east and is divided into two areas by the wedge of Adelie Land claimed by France. To the east of Australian Antarctic Territory is the New Zealand Territory, the Ross Dependency, and further west is the British Antarctic Territory.

17. In the late 1940s and early 1950s world attention again turned to Antarctica. In 1947 the Commonwealth Government established the Australian National Antarctic Research Expedition (ANARE). Stations were established at Macquarie and Heard Islands in the same year. In 1949 the Antarctic Division of the Department of External Affairs was established to continue scientific programs at Heard and Macquarie Islands and to establish a station of the Antarctic Continent. The latter

objective was realised in 1954 with the establishment of Mawson which is now the longest permanently occupied station in Antarctica.

18. International scientific collaboration was heightened during the International Geophysical Year (IGY) in 1957 when Australia and eleven other nations embarked on an ambitious program of scientific discovery and research. The second Australian station, Davis, was established on the Antarctic continent to support the Australian contribution to the IGY. Following the IGY Australia and eleven other nations signed the Antarctic Treaty in 1959. The treaty establishes the foundation for the present international regime of cooperation in Australia.

19. In 1959 the United States vacated its station at Wilkes and a small contingent of Australians moved into the facilities and established the third Australian station in the AAT. By the beginning of the 1960s Australia thus had four stations in the region, three on the Antarctic continent Mawson, Davis and Wilkes and one on the Sub-Antarctic Macquarie Island. Wilkes became permanently buried by snow drifts and was abandoned and replaced by Casey built during 1965-69 on a nearby site.

20. Importance of Antarctica Antarctica is important to Australia and the rest of the world because:

- the ice sheet is a major factor in the heat balances of the Earth, and in global atmospheric and oceanic circulations;
- meteorological data from Antarctica aid in understanding global weather patterns;
- the area has extensive marine living resources. Whales and seals have already been exploited and krill, squid and fish are beginning to attract attention as nations look for new sources of protein from the sea;
- it may also have substantial mineral resources; and

- its relative freedom from pollution makes the Antarctic a valuable reference for comparison of global pollution levels.

21. Station Function The Australian stations at Casey, Davis and Mawson accommodate and provide support to personnel from the Antarctic Division and other government agencies as well as universities. Research programs vary in length.

22. Research in a number of broad disciplines is carried out at the stations. These are meteorology, terrestrial biology (including limnology), marine biology, glaciology, cosmic ray physics, upper atmosphere physics, geology, geophysics, surveying, mapping and medical research.

23. All three stations operate as weather observatories and have upper atmosphere physics programs. Both Mawson and Casey support glaciology programs; at Mawson this involves studies of the sea-ice effects on climate and oceanography; at Casey it involves inland traverses using tracked vehicles. Davis supports biology studies of the nearby Vestfold Hills and Mawson is used as a staging and support station for summer inland field surveys of the Prince Charles Mountains and Enderby Land areas.

THE NEED

24. Policy Reviews During the mid 1970s a number of policy reviews both within the Department of Science and open to the public were launched by the government. The first occurred in February 1974 when Sir Hugh Ennor, Secretary of the Department of Science appointed the Advisory Committee on Antarctic Programmes (ACAP) to carry out a review of past and future research activities centred on Antarctica. The Committee, chaired by Sir Frederick White, presented its report in December 1974. The ACAP report recommended that a planning committee be established to undertake an annual review of the

program, to determine future programs and the relative priorities of competing demands on available resources.

25. The second policy review commenced in March 1974 when the Minister for Science released a discussion paper which sought comments from the public, past and present expeditioners, research workers and the academic community on a paper entitled "Towards New Perspectives for Australian Scientific Research in Antarctica". (Parliamentary Paper 34/1975)

26. During 1977 the Government gave approval for Australia's Antarctic scientific program to be extended to include Antarctic marine science. Administration and coordination of this would lie with the Antarctic Division. Planning for the Antarctic marine science activities commenced with a seminar, conducted by the Department of Science, attended by invited specialists and representatives of other agencies with interests in marine science, held in Canberra 1 - 2 February 1978.

27. During the summer of 1980/81 the tangible result of this extension of activities was reflected in Australian involvement in the international program of 'Biological Investigation of Marine Antarctic Systems and Stocks'. (BIOMASS) The aim of the program is to gain an understanding of the structure and function of the Antarctic marine ecosystem as a basis for future conservation and management of living resources. The need for such involvement was heightened following Australia signing the Convention on Antarctic Marine Living Resources in 1980.

28. In February 1979 the Prime Minister announced the establishment of the Antarctic Research Policy Advisory Committee (ARPAC), its membership consisting of top level industrial and academic research interests together with relevant departments as observers. The function of ARPAC was to

advise the government inter alia:

> '...on priority areas for scientific and technological research of the potential resources of the Antarctic and sub-Antarctic, with an emphasis on increasing Australia's knowledge and expertise of both mineral and living marine resources and the possible environmental effects of resource exploitation; and,
>
> ...on the scientific merit and adequacy of the Australian research effort in the Antarctic and sub-Antarctic, on the organisational arrangements for implementing that research effort and, in particular, on the role to be played in this effort by the Antarctic Division of the Department of Science and the Environment'.

29. The Committee's report was tabled in Parliament in March 1980 (Parliamentary Paper 65/1980). The report drew particularly on the ACAP reports of 1974, the "New Perspectives Paper" of March 1975, the Marine Science Seminar papers and on a paper prepared by the Australian National Committee for Antarctic Research (ANCAR) of the Australian Academy of Science.

30. It is not intended to canvas all 18 recommendations made by the Committee. The recommendations establish an administrative and policy framework for the continuation of scientific research in Antarctica stemming from and consistent with Australia's overall Antarctic policy which is directed towards:

- maintenance of sovereignty over the AAT;
- strengthening of the Antarctic Treaty and the use of its consultative framework; and,
- maintenance of a balanced scientific program as a contribution to world science and in support of Australian sovereignty and the Antarctic Treaty system.

31. ARPAC recommended that Australia have a high quality research program in Antarctica directed towards:

- the living and mineral resources of the Antarctic and the environmental effects of their exploitation;
- the effect of the Antarctic on climate, weather and oceanic circulations in the Southern Ocean area, particularly as these relate to Australia; and taking advantage of the special opportunities as afforded by the uniqueness of the Antarctic.

32. ARPAC also recommended that the replacement of existing station buildings continue and that additional shipping capacity be provided to allow that program to proceed without reducing the logistic support for the scientific program.

33. In summary, a continuing Australian presence in Antarctica stems from three factors. First, Australia's assertion of sovereignty over the AAT which derives from discovery and formal taking of possession by the United Kingdom followed by a continuous display of Australian occupation and administration after passage of the Australian Antarctic Territory Acceptance Act of 1933. In evidence it was stated for as long as it remains our national policy that we have sovereignty over the AAT, in international terms it is important that we should exercise it and can be seen to exercise it to an appropriate degree in technological terms. Our presence and our stations are evidence of our assertion of sovereignty.

34. Secondly, as a signatory to the Antarctic Treaty Australia takes part in regular meetings of the Antarctic Treaty Consultative Parties where international collaboration on scientific and environmental issues and more recently resources matters are discussed. The successful conclusion by the 13 Consultative Parties and the Federal Republic of Germany and the German Democratic Republic of the Convention on the Conservation

of Antarctic Marine Living Resources, in Canberra in May 1980, is an important achievement in that it represents a testing ground for the ability of the Antarctic Treaty to provide a framework for the discussion of and solution to resource issues. Australia by its Consultative Party status, is a force in these discussions.

35. Thirdly, as a nation with stations which provide support for scientific research in Antarctica, our standing as a participant in Antarctic Affairs both within the formal Antarctic Treaty forum and with the international scientific community, depends on the quality of research and related activities such as contributing to international projects. In evidence it was suggested it is necessary for Australia's stations to be of adequate standard in order to maintain its activities in comparison with other countries as well as to raise the quality of Antarctic research. World interest in Antarctic resources is increasing and there could be serious consequences for our present policies and for consideration of future options if the level and quality of our Antarctic activity were seen to be declining. The three stations, the facilities they offer and the nature of scientific research they can support are vital to Australia's Antarctic policy.

36. Committee's Conclusion A continuing presence by Australia in the Australian Antarctic Territory is required to maintain its role as an effective Antarctic Treaty partner, to assert its sovereignty and to permit scientific research of a high quality to be carried out.

37. Existing Facilities Since the establishment of the Mawson Station in 1954 there has been an evolution in the design of buildings. Early designs were significantly constrained by the sizes of relief ships, the availability of construction manpower and machinery, the duration of the short summer and the need to carry out continuing scientific work. Prefabrication of

relatively small and easily erected structures was for many years seen as the most effective design and construction solution within the constraints imposed by transportation and climate.

38. Early designs comprised prefabricated timber framed panels filled with rigid foam insulation and sheeted with aluminium. The panels were assembled and post tensioned by tie rods and the completed buildings were anchored by steel wire rope guys fixed to the rock. These buildings, typically 24 feet by 12 feet, could be quickly constructed with external panels erected in a day.

39. The relatively modest sizes of buildings erected at Australian stations, dictated by logistic and construction limitations, has meant over the years numerous small buildings have been erected, internal space for habitation, work and recreation is small, and there is a large surface to volume ratio. Design and construction philosophies, based on lightweight prefabrication, compromised physical comfort and durability.

40. Living accommodation, or "dongas", consist of small cubicles approximately 1.8 metres by 2.0 metres separated from a central passage by a curtain. These are the 'homes' of expeditioners for at least 12 months or more in an environment that can tax even the most even temperament. The dongas internal fittings are rudimentary and offer little privacy and comfort.

41. By the mid 1970s buildings at all stations were showing marked deterioration with failures occurring in joints and panels. The most common fault was leaks in panel joints. The effects of leaks on internal wiring created safety problems and the lack of effective water vapour barriers caused internal rusting. At Mawson and Casey non-protected steel is heavily

rusted and at Davis strong winds carry surface grit which removes paint from buildings in a short space of time.

42. Because of the post tensioned load bearing panel design it is not possible to replace deteriorated panels without dismantling entire structures. Internal load bearing panels likewise cannot be removed to increase internal spaces.

43. Casey was constructed between 1966 and 1969 to a unique design. To avoid the problem of snow drift, which had caused the nearby Wilkes station to be abandoned, the new station consisted of a row of 13 individual buildings, elevated 3 metres above the ground on scaffolding and set at right angles to the prevailing wind. The buildings were connected by a 200 metre corridor made from galvanised iron with a curved wall on the windward side to assist airflow above and below the structure thereby reducing snow drift. Both the passageway and the buildings are showing marked deterioration caused by salt corrosion. Evidence suggests that the configuration based on a link passageway has produced adverse psychological effects. Because of its elevation on scaffolding the entire structure vibrates during blizzards and strong winds. The facilities offered to expeditioners are primitive.

44. The Committee is of the opinion that while the design and construction of the existing stations may have been influenced by a number of constraints, more attention should have been given to design and construction by the Departments responsible and consideration to design improvements should have been given earlier.

45. Structures have deteriorated to such a state where continuous maintenance is no longer economically practical. The Department of Housing and Construction indicated the outside limit of the use of existing facilities is ten years. However on the basis of safety and comfort this is likely to be less.

46. In summary, buildings at Australian Antarctic stations have deteriorated and are not fulfilling the functions for which they were designed. It is not possible to further repair and maintain these structures and it is inadvisable to replace them with similar structures. Morale, efficiency and safety have been affected.

47. There are constant power shortages at all stations. At present both Mawson and Casey have two 160kVA generators and two 80kVA emergency units and Davis has two 80kVA generators and two 40kVA emergency units. Demand for power exceeds generation capacity, especially during winter and it is often necessary to use emergency generators or ration supplies. Since most station activities such as communications, heating, cooking and other scientific and construction activities require reliable power, shortages can be disruptive, affecting output and morale and safety.

48. The problem of waste disposal is heightened in an environment where biodegrading of organic matter is virtually non-existent and where non-combustible material cannot be easily disposed. Sewage is at present either burned or discharged into the sea. Other organic matter and non-combustibles are either buried in trenches or hidden from view. Both disposal methods may in the long term cause environmental problems, for example Antarctic fauna coming into contact with contaminated organic matter, or toxic chemicals becoming meshed in food chains.

49. Committee's Conclusion Unless buildings and facilities at Australia's Antarctic stations at Casey, Davis and Mawson are replaced government policy for a continued Australian presence in the Australian Antarctic Territory cannot be achieved.

THE PROPOSAL

50. The proposal is to rebuild Australia's Antarctic stations over the next ten years in accordance with master plans, utilising the increased construction and logistic resources, and a new building design affording greater durability and improved standards of working and living accommodation. Some buildings have been completed or are under construction because they were funded and programed ahead of government approval for the complete rebuilding program. Details of individual components of the rebuilding program are at Appendix 1.

51. Construction activity in Antarctica has been influenced in the past by a number of constraints. For example access to the stations by sea is limited to the period from mid- December to mid-March and weather conditions and day length between April and October limit building activities that can be performed out of doors. Construction manpower is limited by accommodation available at stations and on board the resupply ships.

52 The proposal is made possible by overcoming these largely logistic limitations by the chartering of a third resupply ship, the Nanok S which has significantly increased the volume of construction material that can be shipped to the stations and to a lesser extent the number of berths available for additional personnel.

53. Number of Personnel The personnel capacity of facilities proposed will be as follows:

	CASEY	DAVIS	MAWSON
Winter	33	24	33
Additional Summer	5	6	5
Total	38	30	38

54. Master Planning From 1975/76 defective buildings have been replaced on an ad hoc basis. It was recognised that effective layout planning of reticulated services and structures, building design and construction scheduling could best be achieved by integrated master planning, by planning each station as a unit rather than a collection of disparate structures which required replacement sooner or later. Accordingly master plans for the redevelopment of the three stations, made possible by the development of a new building system and reflecting a number of layout, building design and construction principles, were developed. The layout proposed for each station is shown in the drawings and may be summarised as follows:

	Proposed Buildings and Facilities	Completed or under Construction
Mawson	17	7
Davis	15	6
Casey	16	4

55. The following principles are basic to the master plans:

- building orientation to ensure snow drift, occurring on short windward and leeward building sides, not to interfere with main entrances and exits;

- living and sleeping quarters located adjacent to each other and linked by an elevated corridor to avoid drift accumulation;

- the absence of covered walkways between living/sleeping quarters and work areas;

- the use of larger buildings to reduce the surface area to volume ratio, thereby reducing heat loss;

- the use of steel frames in the design of buildings capable of meeting high wind loadings without the need for external guying;

- external insulated panels;

- reticulated services located in heat traced pipes on above ground supports;

- water storage and pumps in heated buildings;

- minimum site development of building sites;

- minimum disturbance to existing buildings during the rebuilding;

- a dual system of electricity generators;

- improved means of liquid and solid waste treatment and disposal;

- a separate building for active recreation;

- fire detection and suppression system for all buildings.

56. Building System A new building system that substantially departs from the smaller, lightweight and less durable structures built before 1976 has been developed and is common to all structures involved in the proposal. The system, which has undergone some field testing in Antarctica, has the advantages of permitting the construction of larger structures and of being capable of prefabrication in Australia, readily packed for shipment to Antarctica and capable of erection to the lock up stage by a small workforce.

57. The building system comprises substantial steel portal frames located on concrete foundations anchored to the rock. The frames will be provided at 2400 mm centres with sections for purlins and girts and will be designed to withstand the substantial wind loads with no assistance from cladding panels. Concrete will come in dry mix bags and covered with insulated bags during curing.

58. The external cladding panels will comprise standard cool room panels, a polystyrene foam core clad on both sides by prefinished sheet steel. External panel faces will be prefinished with polyester paint in a range of bright colours. At Davis, because of the grit blasting, external panels will be treated with a hypalon rubber compound. Panels will be attached to the frame by steel bolts and joints will be covered on the outside with a steel top hat section, filled with polyurethane foam insulation, sealed with silicone and screwed to the panel. On the inside, joints will be sealed to prevent water vapour entering, by a special aluminium extrusion fitted between panels and girts. Foundations will be concrete pedestals, piers or slabs. Internal lining will be double-layer gypsum plaster board and will be attached on internal girts and purlins.

59. Windows will be triple glazed and fitted into external panels during prefabrication. External panes will be laminated reflective glass and inner panes will be clear glass.

60. Doors will be modified cool room units having special latches, gaskets and electric self limiting heat-traced cable to prevent freezing of the door seals.

61 The expected life of buildings constructed using this system is 30 years.

62. Committee's Conclusion The new building system is a big improvement on the previous system and appears satisfactory.

THE SITES

63. The locations of the three stations on the Antarctic continent at Mawson, Davis and Casey are the result of historical, geographic and cost factors. As a general rule the locations of stations were determined by ease of access to resupply ships, the presence of suitable building sites and their potential for supporting scientific work based either directly at the station or in adjacent areas. The stations are roughly equi-distant.

64. The mean range of temperature experienced at Mawson, Davis and Casey is +5 degrees Celsius to minus 40 degrees Celsius. On the coast, where the Australian stations are located, the mean annual temperature is minus 17 degrees Celsius. Each station experiences strong winds. Mawson receives wind speeds up to 280 kilometres per hour and local katabatic winds of 30 to 40 kilometres occur there on most days. Casey and Davis receive wind speeds between 180 and 280 kilometres per hour.

65. The number of days per year winds exceed 120 kilometres per hour at the stations is summarised below:

	Mawson	Davis	Casey
120 kilometres per hour	50	32	39
200 kilometres per hour	3	3	1

66. The proposal is for the redevelopment of the stations at or near their present locations. Individual buildings will be orientated to minimise the effect of snow drift on entrances and exits. The siting and separation distances of buildings was influenced by local building conditions, available flat land, the presence of existing buildings, fire risk and psychological factors.

67. Mawson Mawson was the first Australian station to be established on the Antarctic continent. It is situated on an ice-free rock exposure which forms a natural harbour on its northern side. Mawson is located directly beneath the auroral oval, which makes the site ideal for upper atmosphere physics research. The presence offshore of sea ice during winter permits sea ice glaciology to be carried out.

68. The site has good conditions for building construction by Antarctic standards - ice-free rock of which a limited portion is sufficiently flat for building purposes. The proposed new buildings will occupy sites at present occupied by some old buildings as well as new sites. Buildings will be sited in two lines running north-south.

69. The site is suitable for resupply by ship. Cargo will be transferred from ship to shore by barge and LARC as in the past. The bunded fuel storage tanks, located some distance from the main complex, will be near the water's edge to facilitate trans-shipment by pipeline.

70. Davis Davis was established in 1957 for Australia's participation in the International Geophysical Year. It occupies an ice-free area on the edge of the Vestfold Hills on the coast of Princess Elizabeth Land. The Vestfold Hills are an ice-free area with loose rock and gravel deposited by the retreating ice cap which is now 20 Km upwind of the station. During periods of high wind, air-borne grit sand blasts exposed surfaces and special measures to reduce the effect of this are included in the design of buildings. The sites for the new buildings are located south-east of the existing buildings. The site is capable of being levelled more easily than Mawson.

71. Feasibility studies have shown that it is possible to construct an all weather airfield in the vicinity of the station.

72. Casey Casey is situated on the Bailey peninsula, a generally ice free exposure on the coast of Wilkes Land, which is almost due south of Perth. The original Casey station was on a projection northward from the main peninsula resulting in the station being affected by salt spray. The new site is south-west and will be less affected by salt spray. The site comprises moraine deposits with rock outcrops in a landscape of low hills separated by shallow valleys filled with ice. Resupply ships anchor offshore and cargo is discharged by LARC or barge. Casey is the only Australian station at which large aircraft can land. Aircraft such as ski-equipped Hercules can land at the ice airfield at Lanyon Junction, 18 kilometres inland. The proximity of the Law Dome to the station makes it ideal for carrying out land-based glaciology.

73. Committee's Conclusion The sites selected for the redeveloped stations at Mawson, Davis and Casey are suitable.

BUILDINGS

74. Sleeping/Medical and Living Quarters These will be located in two double-storey buildings located next to each other and linked by an elevated walkway. The sleeping/medical building will house all sleeping quarters, ablution and laundry facilities as well as the station medical facility. The adjacent living quarters building will house the mess, kitchen, some recreation areas and a library. Both the lounge and the mess will have high ceilings.

75. Each wintering expeditioner will have single room accommodation of 9.5 square metres with a bed, desk, chair, semi lounge chair and wardrobe. Curtains used to provide privacy in existing dongas will be replaced by doors. Each room will have a window fitted with a blind. Summer personnel will be accommodated in the same size room with two beds, one wardrobe, couch, chair and writing table. Bathrooms, toilets, laundry and

drying facilities will be located in the central service core.

76. The living quarters building will have a high ceiling lounge which has been designed to give relief from the effects of indoor confinement during the winter months. The proposal includes a large double bay window. Space for billiards and the storage of beverages will be included in the ground floor area. The mezzanine floor will have a film/music room and a library. Areas likely to generate some noise are located so as their impact is minimised on silent areas such as the library.

77. The dining area, located on the ground floor adjacent to the lounge, also has a high ceiling with windows providing sunlight. The kitchen, fitted with commercial type equipment, will be located under the mezzanine floor area and will have pantries and storage areas.

78. The design of the Casey sleeping, medical and domestic quarters was changed from the two building style described above to a single building during the Committee's investigation. The new design will improve external and internal access and reduce surface areas thereby reducing heat loss. Cement fire walls will compartmentalise the building to prevent the spread of fire.

79. Physical recreation activities will be provided for by an indoor sports building sized to allow for tennis or squash and team games. Exercise machines and gymnasium equipment will be accommodated.

80. Operational and Logistic Support Medical facilities will be located on one half of the ground floor of the sleeping building. Facilities to be provided will include a consulting room/office, an examination room, laboratory with fume cupboard, work benches, a sterilizer, an emergency theatre, a hospital ward and a special bathroom for the treatment of hyperthermia.

81. It is proposed to have communications and meteorological facilities and workshops in a separate operations building. This building will also have a general office for the officer-in-charge and a conference room. Separate small transmitter buildings with some workshop and storage space will be provided at each base.

82. Each base will have a large bulk stores building and bulk stores items will be kept at ambient temperatures. Items which suffer if frozen will be held in heated spaces.

83. Flammable liquids will be kept in a separate store, bulk fuel oils will be stored in tank farms and drum fuels will be stored in a separate area in the open. Tank farms will be bunded to ensure spillages are contained. Vehicles will be housed in an unheated shelter during winter.

84. A workshop building will house carpenters, plumbers, electricians and mechanics. Each trade will have a discreet work area with its own entrances and exits. Heating will be provided for the servicing of vehicles.

85. Scientific Facilities Much of the scientific work carried out will be serviced by logistic and operational facilities. New science laboratory buildings will be constructed at Casey and Davis for a variety of research activities. The recently completed aeronomy building at Mawson will be extended to provide workshop facilities for the physical research activities in this building.

ENGINEERING AND SUPPORT SERVICES

86. The proposal includes substantial upgrading of all engineering services to provide adequate power generation, heating, water and sewage and waste disposal. These services will be provided from centralised equipment and reticulated

between buildings on cable ladders and pipes mounted on structural supports about one metre above ground. Their elevation is primarily due to the difficulty of excavating a trench in rock and the requirment for easy access for maintenance. The cable ladders themselves will be shallow troughs designed to permit easy inspection and to prevent cables from sagging.

87. Power This will be provided from two identical self-contained and physically separated power houses each containing three 125 kVA diesel alternators with space for a fourth. Each power house will be able to supply total station requirements. This duplication is a significant improvement on previous arrangements in which emergency generator capacity was about half the capacity of the main station. It will enable each station to function normally without power disruptions in the event of a breakdown.

88. Power will be reticulated at 415 volts by a ring main connecting each building to both power houses. In the event of a breakdown of a power station or a fault in the reticulation system, power can be maintained to all buildings by using the ring main system. In the event of a total power failure, considered to be remote, portable generators can be linked to those buildings requiring power.

89. Piped Water Water for heating and domestic use and fire fighting as well as waste water will also be reticulated in insulated pipes around each site using the same cable ladder reticulation system. A heat trace system will be installed between the insulation and pipes and will only be used when the temperature of pipes falls to a predetermined low level.

90. Heating The proposal makes substantial use of recycled heat given off by diesel generators in the power houses. About half of the peak load heat requirements will be

generated by this method. An oil fired boiler to supplement the waste heat when necessary is also proposed. Hot water for heating will be reticulated.

91. Other Engineering Works The following facilities and features will be provided at all stations:

- Bulk fuel storage capable of holding two years consumption - these tanks will be bunded to localise accidental spillage and fuel will be transferred from ship to shore by hose and from bulk fuel tanks to insulated settling tanks near each power station by insulated pipework;

- A road system connecting all buildings;

- Additional footpaths with blizzard lines for frequently used routes between buildings;

- Light bollards joined by blizzard lines to provide for safe movement during poor weather and in winter darkness;

- Helipads for use by ships' helicopters during summer;

- External loading and storage areas to assist with unloading and backloading;

- A 20 tonne gantry crane to handle seatainers used for transporting resupply materials by sea;

- An oil fired incinerator for burning combustible solid waste and a garbage compactor and associated bins for storing waste to be returned to Australia.

92. Water Much time is presently spent in water

collection and cartage. In summer, melt lakes close to Davis and Mawson provide sufficient water but this must be carted to tanks at various buildings. In winter free water is not available and ice and snow has to be melted.

93. The proposal is to pump and reticulate water from the melt lakes at Mawson and Davis throughout the year. This will be done by pumping hot water from a boiler in the water supply buildings to a "heat bell" which will melt the ice as it sinks under its own weight. Once sufficient water is available the boiler will be shut down and the circulating pump reversed, water will be drawn into the bell to the water supply building from where it will be pumped to the tanks.

94. At Casey a melt lake near the new site for the redeveloped station contains free water throughout the year and this will be pumped to a tank house and reticulated in the same manner as Mawson and Davis.

95. Sewage and Waste Disposal An integrated and unique system of sewage and waste disposal is included in the proposal to minimise the effects of discharge on the local environment. The main component of the system is a biological treatment plant, the first to be installed in Antarctica. Each building will have its waste water, including sewage, collected in a tank, pumped to the biological treatment plant and, after treatment, discharged to the sea through a heated drain at an area remote from the station.

96. Toxic and biologically disruptive wastes produced for example by photographic and laboratory activities will have non-biodegradable material removed, recycled or neutralised before discharge into the treatment plant.

97. Solid waste material will be burned on site in an incinerator or compacted for backloading to Australia on relie'

ships for disposal. It is worth mentioning here that after the redevelopment program is completed most existing facilities will be demolished and shipped back to Australia for disposal.

98. Waste oil from the desludging of fuel tanks and from vehicles will also be returned to Australia for disposal. Fuel handling systems themselves will be modified to ensure that strict handling procedures minimise the accidental release of fuels.

99. The Committee believes the proposed sewage and waste treatment facilities will significantly reduce the total impact of maintaining a presence in Antarctica.

100. Fire Protection and Detection System The potentially disastrous consequences of fire causing the loss of any facility at the stations has necessitated the inclusion of features designed to minimise fire risk and for rapid detection and suppression of fire.

101. The design of all buildings will include the use of fire resistant materials in all occupied space, the compartmentalising of buildings and emergency escape routes to permit evacuation of personnel at all times of the year. It also includes the provision of extensive fire detection and suppression systems.

102. Occupied and heated buildings, except areas containing electrical and radio equipment, will be provided with sprinkler systems connected to a central water storage tank. Areas containing electrical and radio equipment will be protected by gaseous flooding as will be the central unheated store. In addition, hose reels and portable fire extinguishers will be provided in all heated buildings.

103. Manual fire alarm call points and alarms associated

with detection and suppression systems will be monitored at a central point.

104. Communications Communication between buildings will be by an automatic telephone system. A public address system will also be installed to alert personnel in the event of emergency.

105. Central Supervisory System The integrity of the entire reticulation system which includes the heat-trace system, piped water temperatures and electricity load will be monitored. The main monitor will be in the operations building with mimic panels in the sleeping/medical quarters and living quarters. The following services will be monitored:

- hot water-flow temperature and pressure
- building space temperature
- ring main air temperature
- power supply status
- availability of power in each building
- pumps
- heat traces in service pipes
- blizzard line lighting

106. Scale of Proposal During the public hearings some witnesses criticised the proposal on a number of grounds - the buildings are too large, the services system is too complex to function reliably in the harsh environment, the additional construction personnel involved places a secondary emphasis on continuing scientific activities.

107. Overall, the buildings give an improved surface area volume ratio which reduces the impact of drift and heat l If the same level of comfort, utility and durability were achieved using smaller structures, additional building ma and building effort would be required. The Committee

these arguments and believes the proposed buildings generally reflect a trend towards more robust, larger and durable structures being followed by other countries such as the United States and New Zealand.

108. It does not necessarily follow that the "savings" created by constructing smaller structures could be channelled into scientific activities. The overall level of expenditure on capital works has been set by government in accordance with national priorities and any savings in building are not necessarily redeployed to scientific activities.

109. In regard to the reticulated services system the Committee believes sufficient monitoring, fail safe and backup provisions are included in the design to permit stations to adequately function in the event of disruptions to primary reticulated services sources and systems.

110. The rebuilding proposal, programmed over ten years, has been made possible by the chartering of the "Nanok S". Extra construction personnel can be transported by using the additional berths made available without disrupting the level of scientific activity.

111. Covered Walkways The decision to separate sleeping/living accommodation from work areas was deliberately made following an assessment of the relative merits of having buildings joined by covered walkways thereby obviating the need for expeditioneers to venture outside. Building separation was seen as providing regular relief from the artificial enclosed spaces in buildings to the realities of Antarctica, thereby creating a sense of distance within the small station area.

112. The Committee notes that blizzard lines and light bollards are included in the design to minimise the dangers to personnel moving between buildings during winter darkness and

inclement weather.

113. Committee's Conclusion The design and layout of the proposed facilities appears satisfactory. The Committee recommends construction of the work in this reference.

ENVIRONMENTAL FACTORS

114. During the public hearings a number of witnesses said they believed the Administrative Procedures of the Environment Protection (Impact of Proposals) Act were not followed. Departmental witnesses tabled documents and gave evidence that the Procedures were followed and that the environmental effects of the rebuilding program had been assessed by relevant agencies.

115. The redevelopment proposal received Government approval in principle in May 1980. Earlier, in March 1980 Notices of Intention to rebuild the three stations were submitted to the Environment Division of the then Department of Science and the Environment. This was followed by several meetings between officers of the Antarctic Division and the Environment Division of the Department of Science and the Department of Housing and Construction which resulted in the inclusion of all requirements of the Environment Division in the redevelopment proposal. In November 1980, following a change in responsibilities of Departments administering the relevant legislation, the Department of Home Affairs and the Environment advised the Department of Science and Technology that the Minister for Home Affairs and the Environment had determined that an Environmental Impact Statement would not be required for the redevelopment proposal. Nevertheless, the Departments of Science and Technology and Housing and Construction prepared a lengthy background paper, dated March 1981, which identifies likely areas of impacts and their extent caused by the redevelopment and the continued presence of personnel at the three stations.

116. The proposal includes substantially improved facilities for solid and liquid waste disposal. The proposal also includes provision for the compaction and backloading to Australia of waste that cannot be burned or treated. This will include building material and waste oil. These facilities and means of waste disposal will reduce the immediate and long term impact of the rebuilding program and a continued presence.

117. Some concern was expressed that the moss bed adjacent to the melt lake near the site for the proposed sleeping and living quarters at Casey could be damaged during and after construction. The Committee notes that a number of measures aimed at limiting the impact of building and activity and proximate human habitation of the moss bed will be implemented. These include the erection of a fence around the moss bed, the prohibition of access, a ban on concrete batching when the wind is from the direction of the batching plant blowing towards the moss bed and that no effluent or pollutants will be introduced to the melt lake or its surrounding areas.

118. The Committee is satisfied that the requirements of the Administrative Procedures of the Environment Protection (Impact of Proposals) Act have been fulfilled and that significant regard has been given in the proposal to reduce the impact of construction and a continuing human presence on the environment.

MONITORING OF REBUILDING PROGRAM

119. During the public hearing the question of the habitability and psychological impact of designs was raised by a number of witnesses. They felt that perhaps too much emphasis was being placed on the structures themselves without addressing the question of the reactions of their inhabitants. The Committee notes that the Antarctic Division has engaged the Melbourne University Program in Antarctic Studies Habitat Group to prepare a report on the user reaction to buildings provided

in the redevelopment program. The initial study will involve interviewing recent expeditioners as a basis for

- evaluating the attitudes of building users with particular reference to the psychological requirements of remote isolated groups;

- reporting on the feasibility of implementing a long term study to provide further information for future planning and designs as the redevelopment proceeds;

120. The Committee commends the Antarctic Division for initiating this far sighted study. The Committee strongly suggests that any development in this regard be included in the Annual Reports of the Antarctic Division.

HYDROPONICS

121. During its inspection of Casey station the Committee was shown a healthy crop of vegetables being grown hydroponically in a special building module. Evidence was given by a number of witnesses that hydroponics boosts morale as well as providing a recreation outlet during the long winter months. The Committee feels provision for hydroponics should be made in the design of the living quarters building at the three stations.

OTHER COUNTRIES REBUILDING ACTIVITIES

122. The Committee was able to see at first hand new buildings and construction methods being employed at the United States McMurdo Station and the nearby New Zealand Scott Base. Both countries have adopted the principle of master planning and designing larger two storey structures. Both stations use central diesel generators for power, and above gro

reticulation of services. Generally, the approach to construction is very similar to that proposed for the Australian stations.

123. Other countries have or are establishing new stations or progressively upgrading existing ones. Designs vary greatly from small simple structures to fully integrated below ice stations and they reflect financial, logistic and climatic considerations and national aspirations. Expenditure levels cannot be meaningfully compared with Australian expenditure since very often capital costs are absorbed within operating costs.

OTHER OBSERVATIONS

124. The Committee was given the unique opportunity for a group of Parliamentarians to visit Antarctica and inspect facilities and to talk to personnel at the Australian Station at Casey, the United States McMurdo Station and the New Zealand Scott Base. A number of issues outside the scope of the Committee's purview emerged from these inspections, the discussions and during the Committee's enquiry. These are summarised below and the Committee believes that Parliament should be made aware of them.

125. Transport Under present arrangements three vessels, the "Thala Dan", "Nella Dan" and "Nanok S" are chartered annually for 430 days of which 263 days are for actual resupply and research in Antarctica. The cost of chartering these vessels in 1980/81 was $4.711 million. The Antarctic Division has been given the responsibility of conducting Antarctic marine science and to this end the "Nella Dan" has been modified to permit Australian scientists to take part in the First International Biomass Experiment. Even with the modifications that have been made to the Nella Dan, and with the addition of the Nanok S, only a limited amount of marine science can be

done. Because the thrust of Antarctic research is changing from terrestrial based studies to research into living marine resources and because of the future uncertainties of the availability and cost of resupply ships, the Committee believes the government should give favourable consideration to the acquisition of a multi-purpose resupply and research vessel. It is understood the design parameters and costings for such a vessel are presently being formulated and evaluated.

126. Air transport in support of Australian scientific programs is limited to the use of small single engined helicopters, carried on resupply vessels, during the summer. These helicopters have a limited range and payload. Large aircraft such as ski-equipped Hercules can land on the ice runway at Lanyon Junction near Casey. At present under arrangements with the United States Government National Science Foundation, there is an annual flight to Casey from the United States station at McMurdo Sound in return for a number of RAAF flights from Christchurch to McMurdo. The Committee believes that facilities for air travel to and within Antarctica should be examined as a matter of urgency.

127. Fourth Continental Station The question of the number of stations to support scientific research was raised during the public hearing in the context of reinforcing Australia's sovereignty and in the context of establishing the relative importance of existing stations. It was pointed out Australian sovereignty extends over the eastern sector (between 142 and 160 degrees East) without a permanent presence there. The Committee notes the Soviet Union has four stations in the AAT one of which is in the eastern sector. The eastern sector is important geologically and access using present transport is difficult. The Committee supports the policy of successive Australian Governments in the expansion of further stations in Antarctica but priority should be given to the establishment of the next base in the eastern sector. The introduction of a

Australian owned resupply/research vessel with an ice-breaking capability would overcome the practical difficulty of creating access.

128. Priorities for Research The allocation of priorities for Antarctic research is clearly the function of ARPAC which in its report to the Government recommended "that the Antarctic Division be developed with a view to becoming a centre of excellence in Southern Ocean marine biology as the major thrust of its research program..." The Committee believes there may be scope for this research being conducted from land based stations as well as from ships and suggests that the Antarctic Division further investigates this.

129. Wages and Conditions The number of tradesmen applying for positions has declined over the past three years. The decline may be attributable to a general lack of interest by competent tradesmen to spend a year in Antarctica when relative wages and conditions applying at less remote locations in Australia are more attractive. The Committee believes the recruiting base could be enlarged by the government agreeing to the granting of a special Antarctic service tax concession to all expeditioners.

130. Beginning in 1982 the Department of Housing and Construction will employ "construction tradesmen" responsible for carrying out the rebuilding program and the Antarctic Division will have maintenance tradesmen at each station. Both groups receive a zone allowance and an allowance in lieu of overtime. The Public Service Board has indicated that the Department of Housing and Construction tradesmen should receive 80 per cent of the allowance in lieu of overtime, Antarctic Division tradesmen receiving the full amount. The Committee believes this creates an invidious anomaly which should be rectified. All tradesmen, indeed all expeditioners employed by the Commonwealth, should be given the same relative

entitlements.

131. Public Relations The Committee believes the rebuilding program and the continuing scientific research should be publicised against the background of Australia's long involvement in Antarctic exploration and scientific research.

132. Business Involvement The Committee sees scope for more business involvement in the rebuilding program as well as in the continuing presence of Australian personnel in Antarctica. It is not intended to suggest commercialisation of our presence but rather that Australian manufacturing industry be given the opportunity of testing and evaluating equipment, foodstuffs, and technical expertise. Equipment could cover the entire gamut of requirements ranging from, for example, gymnasium equipment to specialised scientific instruments. The Committee sees the continuing Australian presence in Australia as a national commitment, an endeavour in which industry has a very real and vital role to contribute.

133. Communications Under present arrangments expeditioners are expected to pay for all private radio telephone calls to Australia. The Committee believes this to be harsh and recommends each expeditioner be entitled to make one private, three minute radio telephone to his immediate family per week provided official traffic permits.

134. Wharves Unloading operations at the three stations are relatively lengthy and often dangerous. To facilitate the movement of cargo the Committee believes the practicability of constructing wharves or other methods be investigated and assessed.

PROGRAM

135. Details of the scope of the redevelopment program are given at Appendix 1. The program allows for construction activities extending over a ten year period culminating by the end of summer 1990, and is based on an assessment of constraints such as climatic conditions, accommodation, transport, and performance achieved in buildings already erected.

136. The program also reflects an assessment of building priorities made by the Antarctic Division. The Committee believes the recreation buildings at Mawson and Davis, scheduled for 1984/85 should nevertheless be included in the 1986/87 program year.

137. Committee's Conclusion The proposed redevelopment program is satisfactory with the exception of the recreation buildings for Mawson and Davis which should be rescheduled in the 1986/87 program year.

ESTIMATE OF COST

138. The estimated cost for the program of the redevelopment of Casey Davis and Mawson is $58.14 million. This comprises $35.0m from the Civil Works Vote and $23.14 million from the Department of Science and Technology. The latter cost includes estimates for plant and equipment, logistic support and shipping.

RECOMMENDATIONS AND CONCLUSIONS

139. The summary of recommendations and conclusions of the Committee is set out below. Alongside each is shown the paragraph in the report to which it refers.

		Paragraph
1.	A CONTINUING PRESENCE BY AUSTRALIA IN THE AUSTRALIAN ANTARCTIC TERRITORY IS REQUIRED TO MAINTAIN ITS ROLE AS AN EFFECTIVE ANTARCTIC TREATY PARTNER, TO ASSERT ITS SOVEREIGNITY AND TO PERMIT SCIENTIFIC RESEARCH OF A HIGH QUALITY TO BE CARRIED OUT.	36
2.	UNLESS BUILDINGS AND FACILITIES AT AUSTRALIA'S ANTARCTIC STATIONS AT CASEY, DAVIS AND MAWSON ARE REPLACED, GOVERNMENT POLICY FOR A CONTINUED AUSTRALIAN PRESENCE IN THE AUSTRALIAN ANTARCTIC TERRITORY CANNOT BE ACHIEVED.	49
3.	THE NEW BUILDING SYSTEM IS A BIG IMPROVEMENT ON THE PREVIOUS SYSTEM AND APPEARS SATISFACTORY	62
4.	THE SITES SELECTED FOR THE REDEVELOPED STATIONS AT MAWSON, DAVIS AND CASEY ARE SUITABLE.	73
5.	THE DESIGN AND LAYOUT OF THE PROPOSED FACILITIES APPEARS SATISFACTORY.	113
6.	THE COMMITTEE RECOMMENDS THE CONSTRUCTION OF THE WORK IN THIS REFERENCE.	113
7.	THE PROPOSED REDEVELOPMENT PROGRAM IS SATISFACTORY WITH THE EXCEPTION OF THE RECREATION BUILDINGS FOR MAWSON AND DAVIS WHICH SHOULD BE RESCHEDULED IN	

THE 1986/87 PROGRAM YEAR. 137

8. THE ESTIMATED COST OF THE PROPOSED REDEVELOPMENT OF CASEY, DAVIS AND MAWSON IS $35 MILLION FROM THE CIVIL WORKS VOTE 138

(M.H. BUNGEY)
Chairman

Parliamentary Standing Committee
on Public Works,
Parliament House,
CANBERRA

5 June 1981.

APPENDIX 1

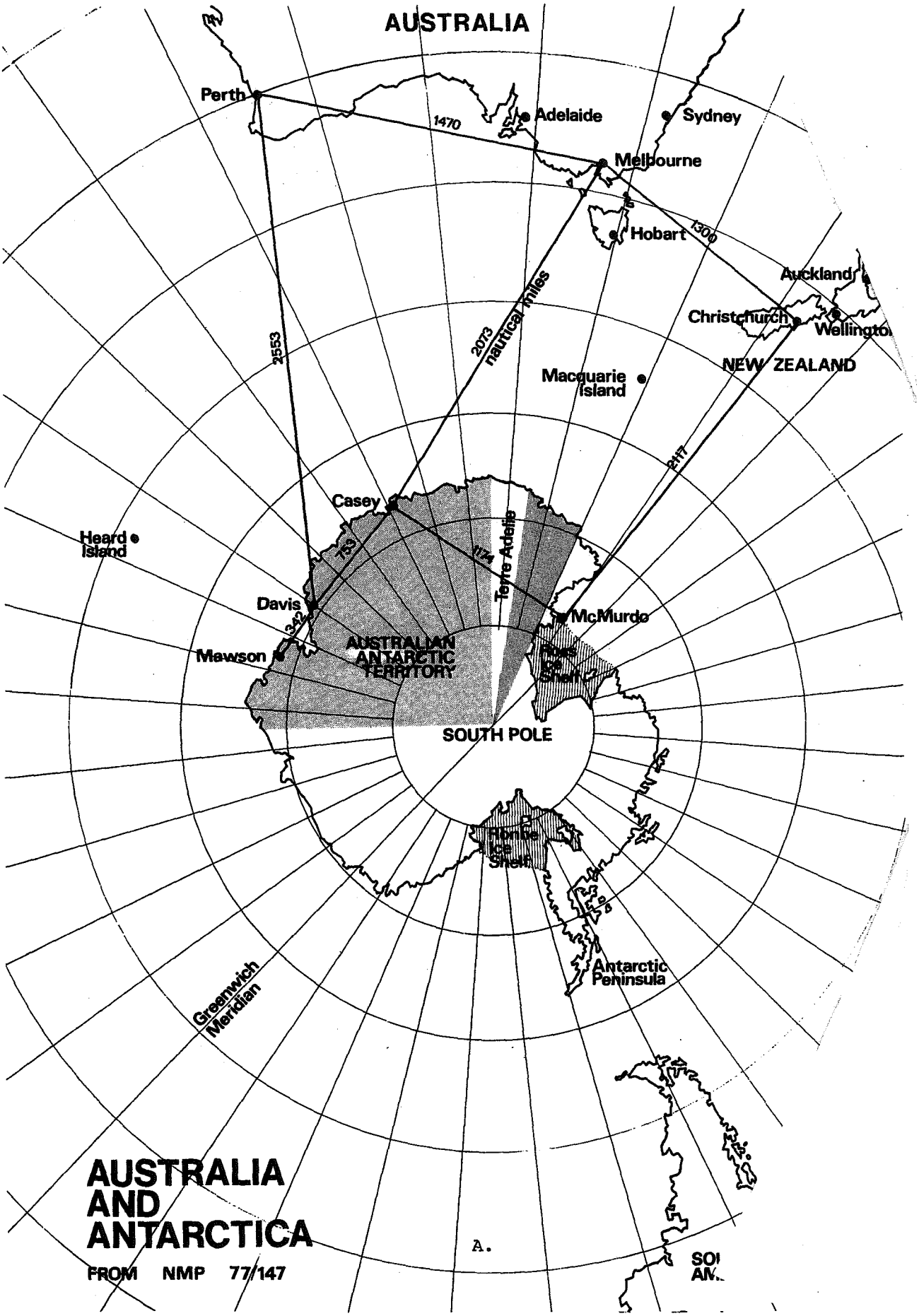
DETAILS OF SCOPE OF PROPOSAL

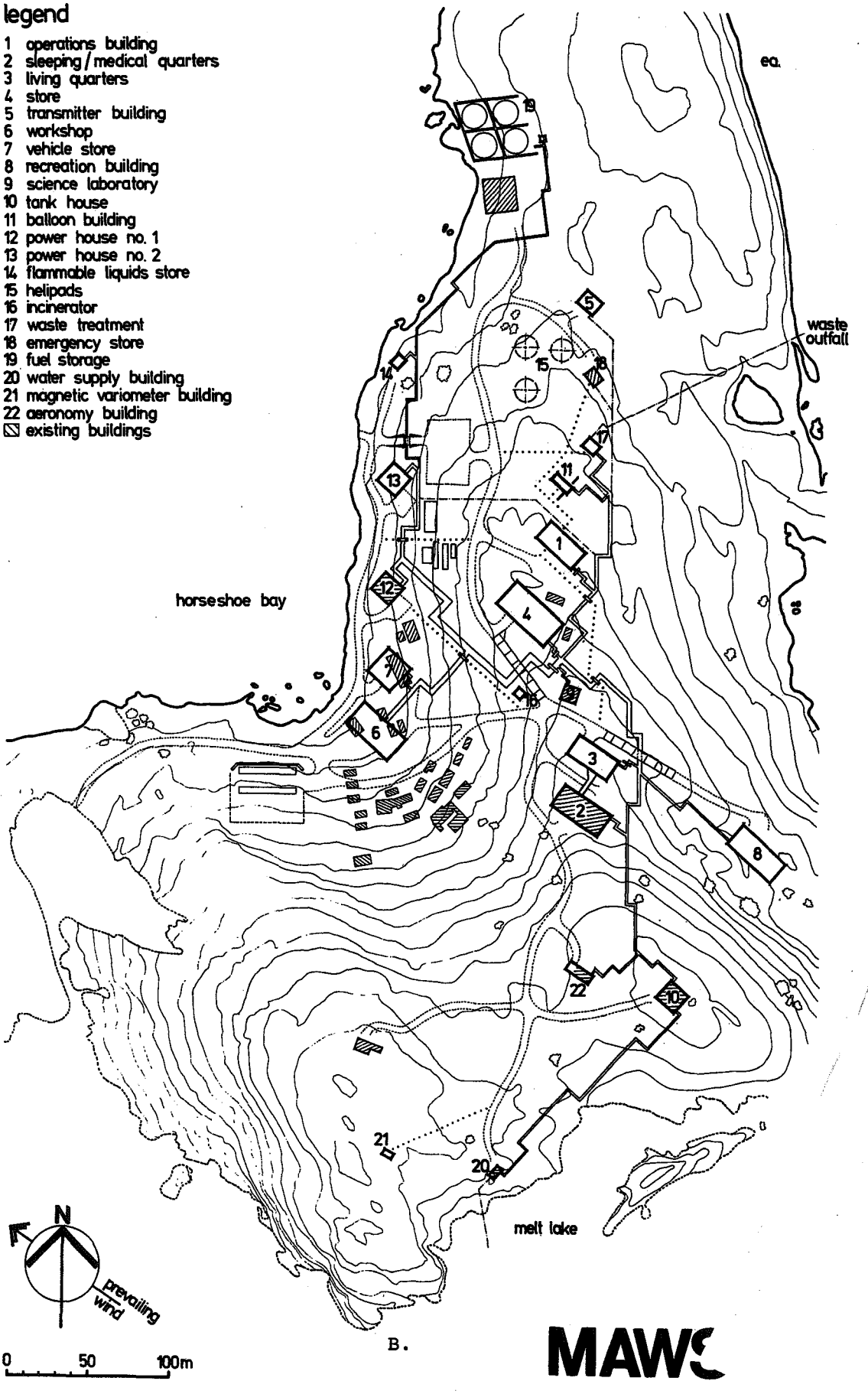
Buildings and other facilities already commenced and those proposed for each station are summarised in the following tabulation:-

Legend: o Projects already committed
● Projects included in P.W.C. Proposal

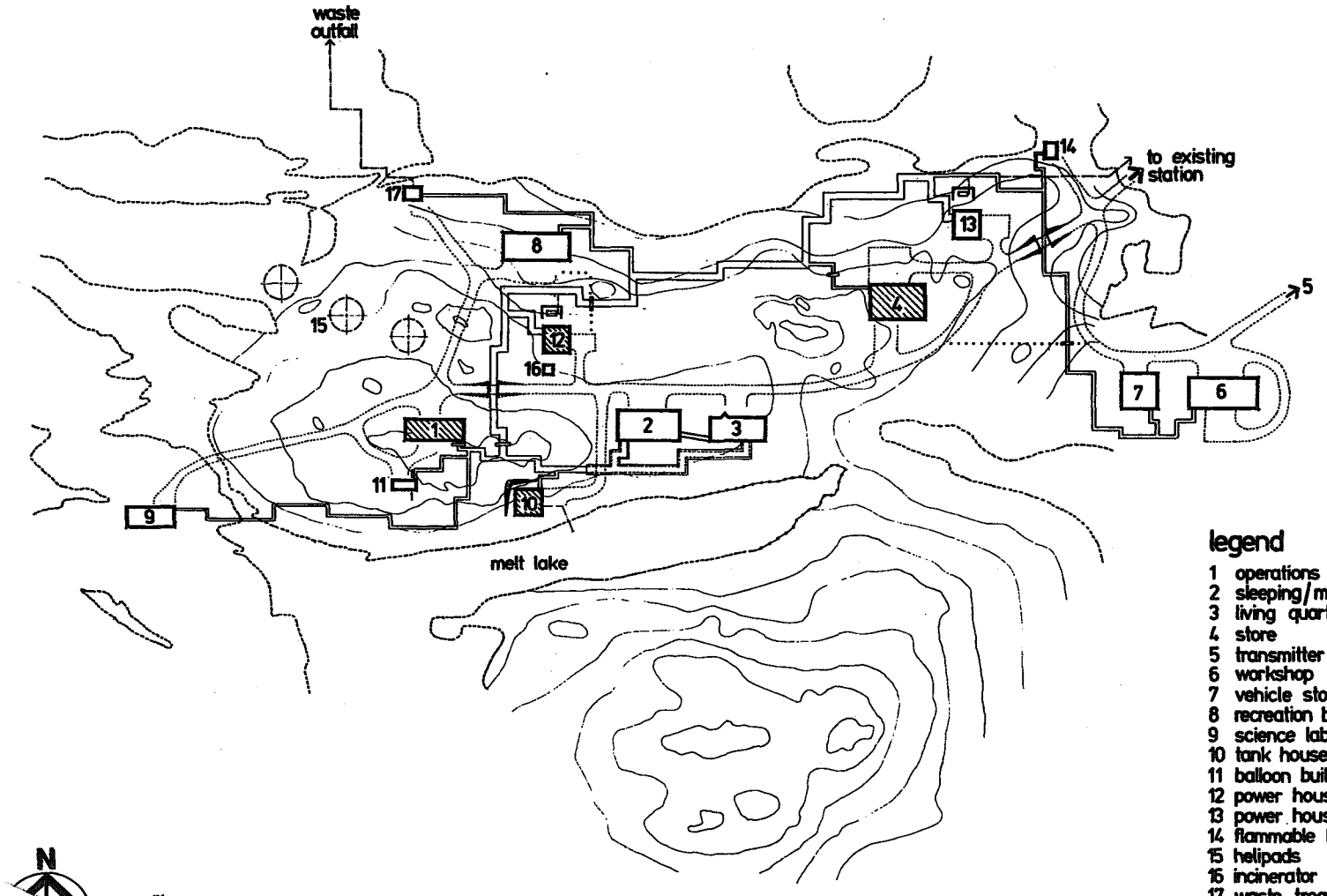
	MAWSON	DAVIS	CASEY
Sleeping Quarters	o	●	●
Living Quarters	●	o	●
Operations building	●	●	o
Store	●	●	o
Workshop	●	o	●
Powerhouse 1	o	o	o
Powerhouse 2	●	●	●
Storage Dam	-	●	-
Tank House/Services building	o	o	o
Water supply building	o	o	inc in Tank house
Waste Treatment building	●	inc in services bldg	●
Balloon building	●	●	●
Magnetic Variometer building	●	-	-
Aeronomy building	o	-	-
Aeronomy workshop	●	-	-
Cargo handling facility	●	●	●
Recreation building	●	●	●
Transmitter building	●	●	●
Science laboratory	o	●	●

	MAWSON	DAVIS	CASEY
Vehicle store	●	●	●
Flammable liquids store	●	●	●
External engineering services	o	o	●
Bulk fuel handling facilities	●	●	●
Garbage Disposal system	●	●	●
Associated station facilities (inc. provision of roads, footpaths, helipads, external lighting, external storage and unloading areas, blizzard lines, telephones, public address system)	●	●	●


AUSTRALIA
Perth
Adelaide
Sydney
Melbourne
Hobart
1470
1300
2553
2073
nautical miles
Auckland
Christchurch
Wellington
NEW ZEALAND
Macquarie Island
2417
Casey
Heard Island
759
174
Terre Adelie
Davis
McMurdo
342
Mawson
AUSTRALIAN ANTARCTIC TERRITORY
Ross Ice Shelf
SOUTH POLE
Ronne Ice Shelf
Antarctic Peninsula
Greenwich Meridian
AUSTRALIA AND ANTARCTICA
FROM NMP 77/147
A.
SOUTH AMERICA


legend
1 operations building
2 sleeping / medical quarters
3 living quarters
4 store
5 transmitter building
6 workshop
7 vehicle store
8 recreation building
9 science laboratory
10 tank house
11 balloon building
12 power house no. 1
13 power house no. 2
14 flammable liquids store
15 helipads
16 incinerator
17 waste treatment
18 emergency store
19 fuel storage
20 water supply building
21 magnetic variometer building
22 aeronomy building
existing buildings
horseshoe bay
waste outfall
melt lake
N
prevailing wind
0
50
100m

B.



legend

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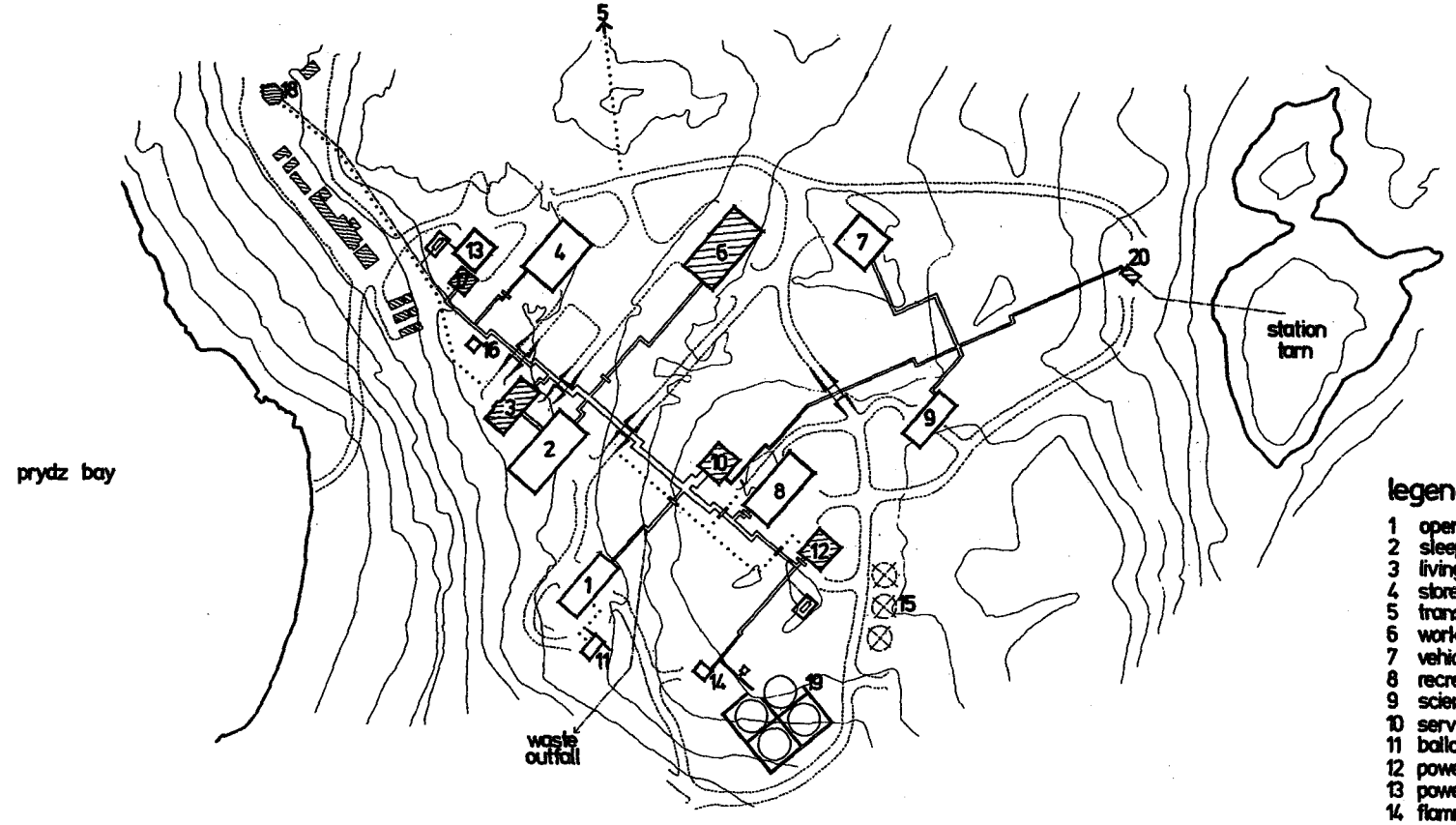
5 transmitter building
6 workshop
7 vehicle store
8 recreation building
9 science laboratory
10 tank house
11 balloon building
12 power house no. 1
13 power house no. 2
14 flammable liquids store
15 helipads
16 incinerator
17 waste treatment building
▨ existing buildings

CASEY



legend

1 operations building
2 sleeping/medical quarters
3 living quarters
4 store
5 transmitter building
6 workshop
7 vehicle store
8 recreation building
9 science laboratory
10 services building
11 balloon building
12 power house no. 1
13 power house no. 2
14 flammable liquids store
15 helipads
16 incinerator
17 existing power house
18 emergency store
19 fuel storage
20 water supply building
existing buildings

D.

DAVIS