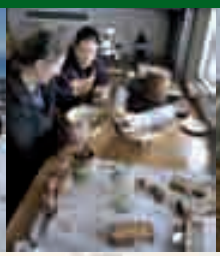
THE MAWSON'S HUTS FOUNDATION

Mawson's Huts Foundation

2008–09 Expedition Report





MAWSON'S HUTS CONSERVATION EXPEDITION 2008/09

EXPEDITION REPORT

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MAWSON'S HUTS EXPEDITION 2008/09

1. Executive Summary

The 2008/09 Mawson's Huts Foundation expedition team boarded the *Marina Svetaeva* on the afternoon of 12 December, departed Hobart on 13 December and returned on 28 January 2009 on *L'Astrolabe* after a very successful expedition.

The team travelled to Cape Denison via Macquarie Island, a detour that allowed us to inspect the remains of the AAE's wireless relay station on North Head. Unfortunately very little physical evidence remains of AAE activities at this site. The *Marina Svetaeva* left Macquarie Island on 17 December and arrived off Cape Denison on 20 December after a very smooth trip south. Strong winds delayed landing until 22 December, when helicopters were used to deploy the expedition team, supplies and equipment. This was a smooth operation which saw the team safely ensconced in the Sorensen Hut in the early hours of 23 December.

After a period of settling in and establishing the camp and associated infrastructure, work began in earnest on the works program. The main aim of the planned works, the completion of the conservation laboratory and treatment of artefacts, was the initial focus of activity. A variety of preliminary work and logistic constraints determined the order of these initial works – vents had to be installed in the new rooms (accommodation and laboratory) and because of storage issues, both the new accommodation room and the laboratory had to be fitted out before the laboratory could be used for artefact treatments. After about 2 weeks the laboratory was available for use by the team's conservators, with all equipment, chemicals and fittings installed.

While the heritage carpentry team was working on the buildings, many other activities were undertaken, including:

- Documentation of the condition of the Absolute Magnetic and Transit Huts, the Magnetograph House, the Main Hut, Memorial Cross and plaque and the replica proclamation plaque.
- Documentation of snow ingress in the workshop and Main Hut.
- Removal of snow and ice from the interior of the Main Hut – hoar frost from accessible walls and ceilings, compacted snow and solid ice from Murphy's bunk, the bunks along the eastern and southern walls and from the area above Mawson's cubicle.
- Ground penetrating radar surveys of the area near Boat Harbour where the air tractor was thought to be located and of the lakes in the Cape Denison area.
- Excavation of the first area identified as a possible location for the air tractor.
- Documentation and downloading of data from the environmental and vibration monitoring systems and reprogramming of the stand-alone data loggers. The satellite communications system was removed.
- Collection of mould, food and corrosion samples for analysis and determination of moisture contents for structural timbers and lining boards in the Living Quarters of the Main Hut.

Snow continues to enter the workshop via leaks in the northern workshop wall and a small amount also enters from the south-eastern corner of the workshop. High levels of snow in the southern veranda has continued to seal the building and prevented

further ingress along the southern wall of the living quarters in the main hut. While this heavy snow coverage prevented additional snow ingress during the period 2006 – 2008 it also prevented the team from undertaking remedial work to seal areas that are known entry points for drift snow and from over-cladding the southern veranda wall.

The removal of snow and ice from the various areas exposed a number of interesting artefacts and details including Murphy's initials, 'H.D.M. 1912' and the words 'wireless 1913' on the walls of the north-east corner bunk.

As soon as the laboratory was available for use by the materials conservation team artefacts, excavated in 1978 by the Ledingham AAD team, were taken from the workshop to the new facilities and treated. Treated objects were then packed and returned to the workshop where they will eventually be reinstated in their original positions (once snow and ice has been removed and shelves and other fittings repaired). Objects treated included everyday items such as an assortment of enamel wares, boxes of matches, a dog collar and chain, broken hockey stick and numerous food cans and tools. The laboratory functioned well and will be a boon to conservation activities at the site.

Heritage carpentry work completed included the following:

- Documentation of internal fittings and shelving units that are in need of repair and taking of representative bracket samples for replication in preparation for future reinstatement of broken and dislodged shelving.
- Manufacture of a temporary support for a shelf in the living quarters that was in danger of collapsing, a supporting framework to protect fragile boards on the workshop observatory roof and fixing of a strap holding the acetylene generation plant.
- Reinstatement and fixing of timbers to the Transit Hut, using an adhesive/screw combination.

Other activities undertaken included:

- Extensive photographic and video documentation of all activities for media releases, documentary preparation and for promotional material for the Mawson's Huts Foundation.
- Grandmother, one of Mawson's huskies, stored in a temporary ice tomb in the workshop was examined and found to be in a stable condition, neither smelling nor showing any visible signs of further deterioration since his last examination.
- Identification, documentation and recovery of the remains of the third seat from the air tractor and its move from the rocks in Boat Harbour to the laboratory for analysis and conservation treatment.
- The use of ground penetrating radar to examine the sub snow/ice profiles inside the living quarters and to determine the bottom profiles of melt lakes in the Cape Denison area. This former testing was undertaken in an effort to determine the nature and extent of buried artefacts, information that would be useful in guiding future excavations. The latter testing, undertaken on behalf of the AAD, was carried out in order to evaluate this technology as a possible means of mapping lakes in other areas such as the Vestfold Hills.
- Re-booting of the automatic weather station located on Anemometer Hill.

The team also hosted visits to the site by expeditioners from the *Orion* (2 visits), the *Marina Svetaeva* and the *MS Bremen.* Passengers from the *Bremen* were given tours through the hut.

Some objectives of the works program were not achieved. Despite a rigorous examination of historic and modern photographs, in order to determine transects which could pinpoint its location, and the use of ground penetrating radar, the fuselage of Mawson's air tractor was not located. Two test trenches were dug, the first to a depth of approximately 1.4m, the second to a depth of 2.7 m. There was no sign of the missing fuselage in either area. The radar signals, thought to be due to the fuselage turned out to be caused by compacted snow and ice of differing densities.

While data was able to be downloaded from the Campbell Scientific/Australian Museum environmental monitoring system, the failure of both batteries meant that the system could not be set up to collect data for the coming year. Environmental data will be provided by the system of Tiny Tag loggers installed in different microenvironments in the workshop and living quarters.

The web camera was not installed on the Granholm hut. Testing of the unit was unsuccessful, with transmitted images not being received in Australia. The equipment was returned to Australia for further testing, with a view to including its installation in the 2009/10 works plan.

A level survey was completed between Mawson's original benchmark and the new adjacent AAD benchmark and a plaster cast was made of Mawson's benchmark. Unfortunately unreliable data prevented successful completion of a levelling survey between Mawson's benchmark and the new AAD benchmark on the eastern side of Boat Harbour. Rough conditions also prevented data being downloaded from the tide gauge in Boat Harbour.

This report recommends that future work at the site be directed towards:

- Prioritisation of artefacts for conservation treatment and continuation of an active materials conservation program to stabilise corroding and deteriorating artefacts.
- Monitoring and remediation work in areas of snow ingress with particular attention to wall/ceiling junctions.
- Over-cladding of the northern wall of the workshop in the short term and of south wall of the Main Hut in the longer term.
- Removal of more snow and ice to reveal interior spaces and artefacts, including that on the floors of both the workshop and living quarters of the Main Hut.
- Continuation of the monitoring program.
- The development of a formal interpretation plan to guide conservation processes for the interior of the Main Hut (artefacts and fittings such as shelves etc) and to take account the eventuality of full exposure of the floor (and associated artefacts) in both the workshop and the living quarters.
- Re-fixing of detached timbers and loose timbers to the transit hut, absolute magnetic hut and magnetograph house.

With respect to the logistics of future expeditions it is strongly recommended that expeditions continue to occur over the summer period (December/January) and that helicopter operations be used whenever possible. The former is essential to reduce downtime due to poor weather conditions and the latter primarily for operational efficiency.

In conclusion it is important to comment on the range of activities undertaken by the Mawson's Huts team this year. There needs to be a careful examination of work priorities and rigorous planning to ensure that programs that may be considered peripheral to the main conservation focus do not reduce the amount of time and resources available for key conservation programs. Examples this year include the web cam project and aspects of the ground penetrating radar surveys and tide gauge work. While these are important projects in themselves, they impacted considerably on the amount of time that the heritage carpenters, among others, had available to undertake conservation tasks in and around the huts. Specific resources, including dedicated personnel, should be allocated to these projects to ensure that they do not impact negatively on important conservation works and they should be programmed in such a way that they do not impede conservation programs. It may be necessary for instance, to attempt to complete one additional non-conservation-related project per year in order to maintain the focus on conservation-related outcomes and to ensure that these are achieved.

2. FIELD LEADER'S REPORT by Dr Ian Godfrey

2.1 Introduction

I preface this report by stating how honoured I was to take on the role of Field Leader for the 2008/09 expedition. It was a very strong team with a broad mix of talents and personalities, but importantly, all with tolerance and understanding of working in a small group in an extreme, isolated environment. While not wishing to single out individuals, it is important to acknowledge at this early stage the critical role that Pete McCabe played. As Deputy Leader, his professionalism and easy-going style were invaluable to the overall success of this expedition.

As usual, with Rob Easther coordinating the overall project, the pre-departure preparations, planning, logistics and team selection went very smoothly. Prior to the arrival in Hobart of other expedition team members, Pete McCabe, Marty Passingham and Michelle Berry put in a lot of hard work, with great assistance from Australian Antarctic Division staff, in particular Dave McCormack and Jan Adolph. The thought and effort put into these preparations put the expedition on a very sound footing from the start.

The expedition report as a whole describes all aspects of the expedition with limited discussion of collected data and associated research investigations. This section, the Field Leader's Report, gives an overview of the whole project from the leader's perspective only. Individual members of the expedition team have commented on their specialist fields, with their reports included later in this document. While the observations, conclusions and recommendations recorded in individual team members' reports stand alone, there will obviously be some overlap between the specialist reports and the Field Leader's Report. Many of the recommendations made at the end of this section of the overall report are based on comments from all members of the expedition team. The recommendations in this section are not comprehensive however.

Before commenting on the many aspects of the expedition it is important to formally compliment the team on their achievements, their professionalism and their ability to live and work together, while maintaining good humour, understanding and tolerance at all times. It was probably the most balanced team that I have had the pleasure of working with.

It is also very important to thank David Jensen, Greg Holland and Rob Easther of the Mawson's Huts Foundation for their strong support before, during and after the expedition. It is both a privilege and an honour to be part of such a select group, the Mawson's Huts Expedition team. Also acknowledged is the fine service provided by the Davis Meteorology team, who supplied us with daily forecasts for the duration of our stay. This service is invaluable and gave us the luxury of being able to plan our activities, including our retrieval at the conclusion of the expedition.

2.2 Expedition Team:

2.2.1 Team composition

Rob Easther	Expedition Manager (Hobart-based)
Ian Godfrey	Field Leader, conservation scientist
Peter McCabe	Deputy Field Leader, carpenter
Megan Absolon	Conservator

Michelle Berry	Conservator
Peter Boyer	Journalist, camp manager
Ben Burdett	Carpenter
Chris Henderson	Doctor, communications, radar operator
David London	Documentary film maker, photographer

Left to right: Peter Boyer, Pete McCabe, Ben Burdett, Michelle Berry, Ian Godfrey, Megan Absolon, Chris Henderson, David London

2.2.2 Antarctic experience

It was an experienced team, with only one Antarctic 'novice' amongst them, a factor that, combined with a lack of big egos and a good mix of tolerance and good humour, undoubtedly contributed to the success of the expedition.

Ian Godfrey	11th Antarctic trip, 4th to Cape Denison
Pete McCabe	3rd Antarctic trip, 2nd to Cape Denison
Megan Absolon	2nd Antarctic trip, 1st to Cape Denison
Michelle Berry	2nd trip to Cape Denison
Peter Boyer	2nd Antarctic trip, 1st to Cape Denison
Ben Burdett	2nd Antarctic trip, 1st to Cape Denison
Chris Henderson	2nd Antarctic trip, 1st to Cape Denison
David London	1st Antarctic trip

2.2.3 Team performance

As stated above all members of the field party worked together extremely well to achieve the main goals of the conservation works plan. While team members had clearly defined roles, all were prepared to assist others without hesitation. Examples of this were many and varied, with a few listed below:

- While Peter Boyer worked very hard to keep the camp running smoothly and baked wonderful bread daily, all members of the team regularly shared the

evening cooking duties to take some of the pressure from Peter and give him time for his other duties.

- Chris Henderson needed assistance with the physical recording of the ground penetrating radar data – this help was readily provided by Megan, Ben and Peter Boyer.
- Likewise, the tide gauge program and associated levelling surveys, coordinated by Pete McCabe, required a team approach – help was always willing provided.
- Domestic duties were shared without the need for rosters with all team members willingly washing/drying dishes, emptying slops and wastes, refuelling generators etc.

2.3 The Conservation Works Program:

2.3.1 Overview

The major achievements are as described in the Executive Summary, in the detailed reports of individual team members that follow this section and as further summarised below:

- Completion of the internal fit-out of the laboratory and bunk room at the Sorensen Hut
- Conservation treatment of 88 artefacts (ex 1978 workshop excavation).
- Documentation of the condition of the absolute magnetic and transit huts, the magnetograph house, the main hut, memorial cross and plaque and the replica proclamation plaque.
- Documentation of snow ingress in the workshop and living quarters in the main hut.
- Removal of snow and ice from the interior of the living quarters in the main hut.
- Excavations to determine the location of the air tractor (unsuccessful).
- Documentation and downloading of data from the environmental and vibration monitoring systems and reprogramming of the same.
- Collection of mould, food and corrosion samples for analysis; determination of moisture contents for structural timbers and lining boards in the living quarters of the Main Hut; timber thickness measurements on external timbers.
- Documentation of internal fittings and shelving units in need of repair in the main hut.
- Manufacture of a temporary support for a shelf in the main hut and of a supporting framework to protect fragile boards on the workshop observatory roof; fixing of a strap holding the acetylene generation plant.
- Reinstatement and fixing of timbers to the transit hut.
- Extensive photographic and video documentation of all activities for media releases, documentary preparation and for promotional material for the Mawson's Huts Foundation.
- Ground penetrating radar surveys –of the lakes in the Cape Denison area, the ice floor in the living quarters and in areas where the air tractor's fuselage was thought to be.
- Exhumation and examination of Grandmother, one of Mawson's huskies.
- Identification, documentation and recovery of the remains of the third seat from the air tractor.

A few objectives of the Works Plan were not achieved during the expedition. These are summarised below:

- Work could not be undertaken to seal leaks at the southern wall/ceiling junction (living quarters) or to over clad the southern wall.
- No attempt was made to seal leaks on the northern workshop wall because of the large amount of intervention required and the intrusive nature of the patching that was needed.
- The air tractor, the fuselage of Mawson's plane, was not located despite excavations in two locations.
- The web camera was not installed on the Granholm hut.
- The Campbell Scientific/Australian Museum environmental monitoring system could not be set up to collect data for the coming year.
- A levelling survey was not completed between Mawson's benchmark and the new AAD benchmark near Boat Harbour.
- Data was not able to be downloaded from the tide gauge in Boat Harbour.

2.3.2 Adherence to the program

The clear priorities in the works plan and delineation of expeditioners' duties meant that there was little deviation from the overall program during the expedition. Although the main focus was to complete the fitting out of the new accommodation and laboratory spaces to allow for conservation treatments of artefacts to commence, many tasks were tackled concurrently.

As stated previously, the high snow coverage prevented work to seal breaches in the external skin of the building, in particular the ceiling/wall junction on the south wall of the living quarters and to over clad the south wall of the main hut.

Although the works plan specified that work should be done to seal points of snow ingress, no work was done on the northern wall of the workshop, despite this being an obvious area of such ingress and despite the team having access to much of this wall. Rather than tackle the problem via the traditional method of cover battens and compressive sealing strips, a process that would have been visually intrusive and damaging to the original fabric, it was decided to take no action. Instead it is strongly recommended that the whole wall be over-clad, using the method applied to the roof of the main hut.

The air tractor tail was not repatriated to Australia. Lack of time to prepare a suitable container and the opinion that the tail could be conserved in the new laboratory led to a decision to leave the tail in the workshop until its long-term location is decided.

2.4 Resources and Training

The expedition team was very well resourced with very regard to clothing (probably a little too much to choose from), food, good quality tools, electrical equipment, spares (except for spare chains for the chain saws), gas heaters, computers, cameras and communication equipment.

As the pre-departure time was very limited, no training was provided with respect to helicopter operations or quad/generator servicing and maintenance. Fortunately the skill and experience of the carpentry team compensated for this. It is recommended however, that these aspects be built into future pre-departure programs as the skills of individual expeditioners will vary from year to year.

The delivery of new mattresses and sleeping bags was extremely timely as many of those stored at the Sorensen hut were wet, covered in snow or frozen in place due to

drift snow ingress in the new corridor over the winter period. Care needs to be taken with packing on departure to ensure that mattresses, woollen underlays and sleeping bags are protected from both snow ingress and leaks from the roof panels. This occurrence, as with the 2006 expedition, highlights the importance of deploying the team at the same time as their cargo. This team was given the option of being put ashore in marginal conditions without cargo, a situation that would have led to extremely uncomfortable sleeping arrangements had the option been taken up. The situation of unusable bedding also reinforces the importance of taking sleeping bags for all expeditioners each trip, with those at Cape Denison available as spares.

2.5 Compliance with Environment Protection and Biodiversity Conservation Act 1999:

All activities were conducted in accordance with the requirements of the Environmental Protection and Biodiversity Act 1999 and the Mawson's Huts Historic Site Conservation Management Plan 2007-12[1] and the Field Leader's brief. They were also consistent with Australia's obligations under the Antarctic Treaty 1959 and the Protocol on Environmental Protection to the Antarctic Treaty 1991 (the Madrid Protocol).

Kitchen and other wastes and timber off-cuts were bagged and returned to Australia (RTA) for disposal, human wastes (urine and faeces) and grey water were disposed of into the sea according to protocols developed prior to the expedition. Recyclable wastes were bagged separately and RTA'd for processing. All operations were conducted so that there was no interference with wildlife and the environment in general.

Work programs involving the use of power tools and quad operations were conducted so as to minimise disturbance to the animal species that inhabit Cape Denison over the spring/summer period. Thus breeding colonies of Adelie penguins, storm and snow petrels, South Polar skuas and resting Weddell seals were unaffected by the team's operations during the expedition.

The work undertaken also had no effect on soil and vegetation at the site. The high snow coverage ensured that rocks and associated lichens were generally well protected. Exposed boulders and rocks were not in areas in which work operations were conducted and were therefore unaffected by these activities.

No melt streams developed for the duration of the expedition and, apart from water gathering, no activities impinged on the melt water lakes present at Cape Denison. There was therefore, no contamination of the marine environment via transportation of pollutants from the land to the sea via summer melt streams.

Refuelling of the quad bikes was undertaken at the Sorensen Hut while refuelling of generators took place at both the Sorensen Hut and occasionally near Mawson's main hut during chain saw operations. The refuelling locations were neither in the catchment areas of lakes or melt streams, nor at the ice edge. There were no spillages of fuel at either location and therefore no potential contamination of melt streams, lakes or the ocean.

2.6 Logistics:

2.6.1 Pre-departure preparation and planning

Apart from input into the Works Plan, I had minimal involvement in pre-departure planning and preparation. Pre-departure planning and packing had been very well coordinated prior to my arrival in Hobart however, with Rob Easther leading this aspect of the expedition, with assistance from Pete McCabe, Michelle Berry, former expeditioner Marty Passingham and Antarctic Division staff. This ensured that most arrangements had been taken care of well in advance.

Pre-departure briefings in the final few days were not as detailed as in previous expeditions and there was less time spent discussing operational requirements, the works plan and policy matters. While this wasn't so much of an issue for those who had worked at Cape Denison before, a longer lead time is highly recommended for future trips so that all significant issues can be thoroughly canvassed, including an orientation to the Sorensen Hut and surrounds for those members of the team who will be visiting Cape Denison for the first time. A longer lead time will take some of the pressure off team members immediately prior to departure and ensure that all are as well briefed as possible.

2.6.2 Shipping operations

The expedition team travelled to Cape Denison, via Macquarie Island, aboard the tourist ship, *Marina Svetaeva*. Strong winds prevented our deployment for approximately 2 days, after which time we were flown the short distance from the ship to our final destination.

Accommodation on the *Marina Svetaeva* was very good, with spacious cabins, good facilities and very good quality meals. Storage of personal and professional effects were an issue in one cabin, primarily due to the large amount of camera and communications equipment that had to be kept close at hand, but the very good sailing conditions meant that there were no problems with equipment moving about during the voyage.

Greg Mortimer, the Expedition Leader on the *Marina Svetaeva* and the crew were most friendly and extremely cooperative, attempting to facilitate our operations as much as they could. As mentioned earlier in this report, Greg offered to get our team on shore, in somewhat marginal conditions, but without our cargo, so as to give us the opportunity to get our camp established before the bulk of the cargo was delivered. Fortunately this offer was not taken up and, as we later discovered, this would not have been to our advantage because of the somewhat parlous state of most of the bedding stored in the Sorensen Hut.

The trip with the *Marina Svetaeva* was mutually beneficial. Our team benefited by travelling on a very comfortable ship and by being able to interact personally and professionally with the passengers, all of whom had a passion or at least a strong interest in Mawson and things Antarctic. We shared our experiences and knowledge via a series of illustrated presentations while on board, something that seemed to be much appreciated by the passengers.

We were picked up by the *L'Astrolabe* and spent a night at Dumont d'Urville before heading to Hobart. Cargo operations went smoothly from Cape Denison and the trip back was a typical Southern Ocean cruise – a mixture of good sailing and some rocking and rolling! The relationship with the French has developed into a very good

one, building on that which was so well established by Pete McCabe and his team in 2007/08. Unfortunately a failure in communications complicated the release of our unaccompanied cargo in Hobart. Steps have been taken in the planning process to ensure that a similar occurrence is not repeated on future expeditions.

2.6.3 Helicopter operations

Briefings were held with the expedition team and the pilots prior to helicopter operations commencing and all were made aware of expectations, requirements and flight paths. As is often the case, plans were made and then altered at the last minute as the circumstances changed! In this instance the order of passengers altered when it became clear that passengers from the ship were to be deployed at the same time as the helicopter operations.

Pete McCabe, David London and Angus McDonald ended up taking the first flight in, the aims being for Pete to remove skylights from the main hut, Angus and David to get some video and photos of the flight in and for Angus to be able to spend some time in the hut before the arrival of the bulk of the passengers. Peter Boyer was the last to leave the ship, accompanied by the bulk of the hand luggage, carried as an internal load, with the lot, including Peter being disgorged at the designated helicopter landing site in the hut valley.

Cargo operations commenced almost immediately after the last of the expedition team was dropped off at Cape Denison, with Pete McCabe and Ben coordinating these activities. All cage pallets were delivered close to the Sorensen hut, via use of a long lead line, with no noticeable disturbance to the Adelie rookeries to the north of the hut. Concurrently ice and snow was cleared from the blizz tail along the northern veranda of the Sorensen, quads were put into service and the Sorensen was de-winterised.

The use of cord to tie Nally tub lids was again justified, with no lids being lost during the unloading of cargo from the cage pallets.

Helicopter operations for the return journey with the *L'Astrolabe* also went very smoothly. Again, last minute alterations to flight arrangements (time of pick up, what could be taken in the helicopter etc) required the team to adjust very quickly to changing situations, something that everyone took in their stride. Crew from the *L'Astrolabe* took care of all of the cargo operations, with the expedition team taken directly to the ship, along with important hand luggage, prior to the cage pallets being hoisted aboard.

The location of the designated helicopter landing site in the hut valley is somewhat problematic. The site is rarely level and is some distance from the Sorensen hut, adding considerable time to pre-departure operations as cage pallets must be moved to this location and then repacked. It is a strange situation for it to be OK to deliver cage pallets directly to the Sorensen Hut on arrival but then not OK for them to be picked up from there. As cargo delivered directly to the Sorensen hut appears to have had no noticeable effect on nearby wildlife, it seems logical that the pick up of RTA material also occur from this site. It is recommended therefore, that the location of the designated landing site and the associated flight paths be reconsidered. If the area immediately adjacent to the Sorensen hut is deemed unsuitable, an alternative location may be slightly to the south of Alga Lake. This area is however, occasionally subject to sastrugi formation.

2.6.4 Field camp:

In line with Antarctic tradition, the Sorensen Hut probably should now be renamed the Sorensen Hilton. With the completion of the accommodation room, the corridor and even a shower unit, there is ample space to accommodate (and clean) 6 expeditioners and their personal gear, with another 2 in the Apple. Gear can be stored on shelves or under the bunks, removing a lot of the clutter from the dining room.

The dining/working area still becomes very crowded however, if most of the team needs space to work using computers or other equipment. A temporary shelf was installed along the eastern wall for power boards, leads and battery chargers. This helped to remove some of the clutter from the bench top. Further shelving may help to ease some of the congestion associated with what seems to be the ever-increasing amount of electronic equipment used on these expeditions.

Over the past few seasons considerable changes in equipment and operating procedures have seen marked improvements in comfort levels for expeditioners. Chairs with backs, good quality gas heaters (another one would be useful, as would an oil or ceramic-style heater be for the heating of the laboratory), conversion of the bunks in the kitchen to storage areas, provision of a shower, the establishment of a reliable and safe electrical system etc are but some of the improvements. The addition of a small microwave oven was also much appreciated, especially for heating up leftovers for lunch!

Peter Boyer did a very good job as Camp Manager, ensuring that the kitchen was kept in a good state and that we had copious supplies of water and freshly baked bread. Cooking duties were shared by most of the team, with some wonderful meals being prepared.

Listed below are a few comments that should be considered prior to the next expedition:

- A new latch/handle should be fitted to the inside of the main door of the Sorensen to allow it to be closed quietly and without having to slam it shut (see Carpenters' Report).
- Toilet operations need to be reviewed in light of our experience with chemical toilets. The latter work well, with less smell (although I have a personal liking for the smell of baby powder) and less of a visual impact – however they fill more quickly, requiring more frequent emptying and this latter operation is not pretty (nor recommended) in windy conditions. The possible environmental impact of both systems (plastic-lined bags and the chemical toilets) needs to be evaluated and a recommended procedure adopted for this most basic of our needs (possibly with a fall-back position!). The procedure naturally should take into account the predominantly windy conditions that prevail at this site.
- The Apple should be refurbished - reduce flaking from the interior, fix the inner door handle (see the Carpenters' Report) and door seal and replace rusting bolts.
- Tent dwelling must always be an option however, giving expeditioners the opportunity to have some privacy and space, should it become necessary over the period of an expedition.

2.6.5 Field equipment:

The quads and trailer are essential for efficient operations at Cape Denison. The quads worked extremely well during the early part of the season. They all started first time and provided a reliable means of getting quickly around the site. One of the quads developed starting problems (see the Carpenters' Report for more details) and will require attention next season.

The Spirit of Denison sled again was used extensively to transport heavy loads, cage pallets in particular. One of the timbers framing the sled has broken and needs to be either reinforced or replaced early next season. Manufacture of a bridal arrangement will also improve its handling (again, see the Carpenters' Report).

Generally good weather meant that the generators were not subjected to extensive periods of blizzard-like conditions and thus the new arrangements were not fully tested. While there is a blizz box for the large generator, there is no box for the smaller generator. As this is a more economical unit, a box should be available for this generator so that it can be used, whatever the conditions, when the power of the larger unit is not required.

It is recommended that fuel decanters be provided that match the capacity of the generator tanks. These can be filled in the lee of the building, ready for use, when the generator runs out of fuel. This will inevitably reduce the time spent refuelling and substantially reduce the possibility of fuel spills that are more likely when refuelling from 20 litre containers in often windy conditions.

The gas bottle rack built under the kitchen of the Sorensen was difficult to access. A build-up of snow and ice had frozen in the gas lead as well as a number of cylinders. As a result the gas bottles were relocated and strapped together at the southern end of the western veranda. While the bottles will not move when there is a large number of them, a wooden rail should be screwed to the veranda to prevent any wind-induced movement along the veranda.

Although problems were experienced with the wireless email system, external communications were generally very good. Chris did a great job in keeping all of our computers connected, despite the many incarnations of the wireless set up. The satellite phone system again proved its worth, allowing the team to keep in touch with family and friends and the connection of an external aerial via the vent in the laboratory allowed calls to be made in private. Our only problem was an initial failure to remove the call forwarding function from the satellite phone, something that prevented us from receiving incoming calls for a number of days.

The VHF radios worked well around the site allowing the team to keep in touch at all times, very good from safety and contact perspectives.

2.7 Occupational Safety and Health:

The age and experience of the team meant that there was no risk-taking behaviour or actions, apart from occasional fun rides on the Spirit of Denison sled when transporting pallets and equipment!

Good quality clothing was provided by the AAD and the provision of both Sorells and Glacier boots allowed these to be alternated for drying, giving additional comfort to all. The large range of quality clothing provided gave the team options to deal with

weather changes experienced during the expedition, with changes in levels of physical exertion and personal preferences.

Responsible behaviour and good hygiene practices ensured that there were no major health or safety issues. Alcohol gel, Aquim or similar, was very effective as a hand wash and is highly recommended for all future trips as is the provision of large numbers of baby wipes (or similar).

2.8 Tourist Activity:

Both the *Spirit of Enderby* and the *Orion* visited Mawson's Huts in the days immediately preceding our arrival at Cape Denison. Passengers from the *Spirit of Enderby* entered the hut on an apparently delightfully calm day, but those from the Orion toured the area but did not take tours through the hut because of the inclement weather and the possible need to evacuate at short notice.

The *Orion* returned on two more occasions, the first on New Years Day and the second as we were preparing to leave on the *L'Astrolabe* (20 January 2009). Passengers and crew from the *Marina Svetaeva* toured the huts while the MHF team was establishing its camp (22 December), with Estelle Lazer from the ship, conducting most of the tours. The MHF team also hosted a visit to the site by the *MS Bremen*, with Ian and Peter Boyer conducting tours in the main hut. A large number of calendars were sold to the tourists. Sale of tourist material to ships, with which the MHF does not have a formal relationship, is potentially lucrative, subject of course to the passengers actually being able to get ashore.

Visit to Cape Denison by tourists from the Orion (photograph by David London)

All tours were conducted in accordance with the AAD guidelines and the tourists complied with instructions regarding access to the hut and with respect to the maintenance of appropriate distances from native fauna. While small areas of the artefact scatter to the north of the main hut were exposed, visitors respected the area and walked around the exposed areas.

2.9 Recommended Future Works:

As mentioned in the Executive summary, it is important to carefully examine all aspects of the works plan to ensure that projects are not included that impact on core conservation activities. One example of extremely worthwhile, but not core conservation work, is the tide gauge project. Its impact on heritage carpentry work is commented on in the Carpenters' Report. As both French and Australian teams are measuring the same thing in Boat Harbour, it seems logical that these experts should collaborate more closely on this project. This should then reduce the impact of this project on the time available for conservation activities.

Sealing the main hut and the artefact conservation program should be the highest priority projects in the coming years. These and a variety of other tasks that should be tackled in the lead up to the centenary of Mawson's expedition are listed below (in no particular order of priority).

2.9.1. Conservation of artefacts:

Artefacts previously excavated (AAD 1978 expedition etc), those exposed on shelves and floors and those that will be exposed during future ice and snow excavations must be stabilised and conserved for reinstatement in the main hut, using the facilities of the newly established conservation laboratory in the Sorensen hut. Artefact conservation should be a prime focus of future MHF activities at Cape Denison.

Artefacts should only be repatriated to Australia for conservation treatment if they cannot be satisfactorily conserved at the on-site Sorensen laboratory.

Documentation of the 88 artefacts treated in this, the first season of operations in the conservation laboratory, was as thorough as it could be. Links need to be established with the existing AAD database to ensure that all relevant information is recorded and linked to appropriate records - data and photographs from the 2007/08 and the 2008/09 seasons need to be entered into the AAD Cape Denison Artefact database.

- It is recommended that processes and guidelines be established in conjunction with the AAD to assist the ease of hand over of the data and photographs in future seasons
- It is also recommended that investigation is made into the possibility of storing condition reports for the buildings and other reports as digital files in the Cape Denison artefact database as a means of archiving as well as providing access to the growing number of reports concerning Mawson's Huts.

Guidelines should be prepared for laboratory practices and procedures to ensure that work flow is optimized, wastes are managed appropriately and that all operations comply with OH&S standards. These should be based on appropriate Australian standards.

2.9.2 Reduction of snow and melt-water ingress:

While the roofs of the workshop and living quarters now prevent snow ingress via these routes, it is known that snow still penetrates the building at other points. To reduce this build up, to maintain the spaces revealed in the interior and to protect and conserve internal artefacts and structures, future work at the site should involve the following:

- Recording of recent snow/ice ingress.
- Investigation of possible sources of ingress with special attention to the wall/ceiling connections in both the workshop and the living quarters.
- Removal of all recent accumulations (unless these are to be left to prevent further ingress).
- Over-cladding of the northern wall of the workshop using the approach adopted for the roof of the main hut (breathable membrane, tongue and groove timbers). More detail is provided in point 2.9.3 below.
- Wall and roof/ceiling junctions in the workshop and the living quarters should also be sealed, with highest priority given to external surfaces, using accepted techniques of cover battens and compressive sealing strips.
- Protection of artefacts in areas where future ingress may occur.
- Monitoring of future ingress using black plastic sheets.
- Investigation of the option of freeing both doors to the entry of the Workshop in order to provide a better seal to this area. This investigation should include an assessment of the risk of snow or melt-water restricting the opening and closing of these doors. See the Mawson's Huts Historic Site Works Plan 2006[2] for a more complete discussion of this aspect of future works. This option should be discussed in light of the recommendation to remove snow and ice from the floor areas in the workshop and living quarters (see later).

2.9.3 Over-cladding of the north wall of the workshop

The northern wall of the workshop is the only external wall that is not protected by a veranda. It does not have any battens attached to the original cladding. Although this surface is not exposed to the harshest abrasion by wind-borne snow and ice particles, it has deteriorated to the point where large gaps are present in the tongue and groove cladding. From inside the workshop, beams of light are clearly visible in at least three places. Patching, using compressive strips and battens would be visibly intrusive and damaging to the original fabric. It is therefore strongly recommended that the wall is over-clad using a similar approach to that applied to the roof of the Main Hut (breathable membrane, tongue and groove timbers). If this recommendation is endorsed, a heritage architect must be consulted to ensure that the work is done in the least visually-intrusive manner.

2.9.4 Ice removal/artefact excavation in the main hut:

Continued ice removal will reveal more of the internal spaces, significant fabric and artefacts inside the Main Hut. It has been demonstrated that the removal of substantial amounts of snow and ice from the workshop and living quarters has not affected the internal environments of these spaces thus far. It has been recommended that a 600 mm layer of ice be retained on the floor of both areas. It is difficult to justify this recommendation on the grounds previously given; that is, maintenance of an appropriate physical mass assisting in the holding down of the structure and protection of embedded artefacts and those that will inevitably be found at floor level.

The presence of large amounts of snow and ice in the verandas should continue to provide a sufficiently large mass to anchor the building to the bedrock. During winter, when the building is most at risk due to strong winds, the building is protected by the build up of snow in and around the verandas and the development of a snow ramp on the southern wall which deflects winds over the roof.

It is recommended therefore that, once the buildings have been effectively sealed, ice and compacted snow is removed from the floors in the workshop and the living quarters. This recommendation is consistent with the current management plan, *Mawson's Huts and Mawson's Huts Historic Site: Management Plan 2007-2012*[1] in which the following statement is made:

"…. it is desirable to reveal significant fabric and spaces by removing snow and ice from the internal rooms of the Main Hut to restore it to its original configuration" (p95).

This recommendation is simply an acceleration of what will happen naturally should the building remain sealed, without further ingress of snow. Research conducted at Wilkes over the period 1995-2003 has clearly demonstrated that if snow ingress is stopped, snow and ice in a building will slowly disappear over time (Ambrose and Godfrey, paper in preparation[3]).

As continued ice and snow excavation is likely to reveal previously undocumented artefacts, archaeological and conservation input is required during this process. Ice and snow removal must only take place under the guidance of a conservator and/or archaeologist and among other things should take into account the following:

- Employment of an appropriate mix of techniques to safely release embedded artefacts (see below).
- Monitoring of the internal environment during ice removal procedures.
- Thorough archaeological and conservation documentation of exposed and excavated artefacts (descriptions, location, condition etc).
- Ice removal must not proceed in an area if there is any risk of damage to embedded artefacts. The snow/ice should be left to naturally ablate, a process that has been observed elsewhere in similar situations[3].

Techniques that have been used with success elsewhere include percussion hammer drills with a chisel bit (eg Dynadrill - highly recommended for most areas but must not be used near embedded glass), manual tools including ice saws, ice picks, chisels etc, solar melting and artificial heat sources including hot air guns and hot water. Note that the choice of technique and equipment will be determined by the nature of the snow/ice to be removed, the nature of any embedded artefacts and the potential risks to artefacts and the building fabric. Any ice excavation technique must be endorsed and supervised by a conservator or archaeologist before it is applied. Naked flames cannot be used in any internal spaces.

2.9.5 Over-cladding of the south wall of the main hut:

Over-cladding of the south wall of the main hut is deemed necessary because some of the boards on this wall are abraded to the point that they are on the verge of failure, cover battens attached to this wall are being lost and importantly, openings in the south wall contribute to the ablation of the snow bank that has built up in the veranda. This snow bank is considered important because it provides a buffer to the internal hut environment and a thermal mass to the whole building.

2.9.6 Continuation of the monitoring program:

The monitoring program is designed to provide information that guides conservation management decisions. It is important that the program continues. Currently the following parameters are being monitored:

- Temperature and relative humidity
- Vibration of structural components
- Corrosion of ferrous objects

Monitoring of temperature and relative humidity, in correlation with corrosion studies, provides clear evidence of any changes that may occur, or have occurred, in the internal environment as a result of changes to the external fabric or because of ice removal from interior spaces. As anecdotal evidence, primarily the build-up of hoar frost in the main hut, indicates that there have been changes in moisture migration in the building, it is important to record the internal conditions so that current data can be compared with that measured prior to over-cladding of the living quarters in 2006.

Vibration data, obtained from data loggers attached to structural timbers in both the workshop and the living quarters provides important information regarding any movement of the building during high wind periods. This is important in light of continued ice removal from the internal spaces which some consider may impact on the structural integrity of the building.

2.9.7 Development of an interpretation plan for the interior of the main hut:

In order to formalize and clearly define how the interior of the main hut is to be interpreted it is important that an Interpretation Plan is drawn up for the building. It is generally accepted that the interior of the main hut will not be restored to a state that resembles the more 'museum-like' interiors of Shackleton or Scott's huts and numerous statements have been made regarding interpretation and conservation. In the document *Mawson's Huts and Mawson's Huts Historic Site: Management Plan 2007-2012*[1] for instance, the following statements are made:

"…. it is desirable to reveal significant fabric and spaces by removing snow and ice from the internal rooms of the Main Hut to restore it to its original configuration" (p 92).

"Significant fabric should be conserved in its original context, and exceptionally significant objects should be treated to prolong their lifespan (preferably on site, and returned to their original location…)…the external scatters should not be re-arranged for display (p 95).

It is important to define, in one place, how the interior of the hut is to be interpreted and to state this unambiguously. The plan should also take into account the likely eventuality of full exposure of the floor (and associated artefacts) in both the workshop and the living quarters with consideration of how interior access is then to be managed.

Future conservation work will necessarily be guided by this plan and interpretation will be simplified. For instance, the above statement re restoring the hut to its 'original condition' is open to interpretation itself. Is the original condition that which prevailed during the period that Mawson and his team were living in the hut, as it was when they left the building in 1914 or as it was after Mawson's BANZARE visit when more items were removed from the interior of the hut?

Once decisions have been made regarding interpretation of the interior of the main hut, based obviously on significance assessments, the implications for internal conservation and restoration processes will be clearer. The following recommendation for future conservation work for instance, is based on the

assumption that interpretation of the interior will not include a component designed to show the 'passage of time' aspect, particularly that associated with the damage done to internal structures by snow and ice over time. This recommendation for future conservation work should only be followed therefore once an Interpretation Plan has been prepared and endorsed.

2.9.8 Reinstatement of damaged internal fittings:

It is recommended that where it is clear that internal fittings have been damaged by snow ingress or ice build up, that the fittings be conserved and reinstated (if possible), subject to this complying with the endorsed Interpretation Plan for the interior.

This recommendation applies particularly to shelves, many of which have been damaged by accumulated snow and ice buildups. Care is needed with this work as many damaged shelves still hold artefacts embedded in ice and snow (eg above Mertz's bunk, in the workshop etc).

Damaged and sloping shelving in the south east corner of the workshop

It is also recommended that the platform in the living quarters be reinstated. Now that there is little risk of snow ingress via the roof, reinstatement of the platform will return that part of the living quarters to its original configuration, while concurrently protecting sensitive books and other artefacts from the damaging impacts of direct sunlight when the skylights are removed during summer.

2.9.9 Documentation and repairs to the transit and absolute magnetic huts and the magnetograph house:

These buildings should be inspected each year and stabilization work, including the re-attachment of dislodged timbers, undertaken as needed.

The transit hut, in particular is in a very bad state, with a significant number of timbers lost over the past few years (see the Materials Conservation Report).

2.9.10 Improvements within the visual protection zone:

In order to improve the aesthetics of the visual protection zone the following recommendations are made:

- Relocate the timber stack, currently buried south of the Main Hut, to the newly established timber storage area near the Sorensen Hut.
- Paint all of the surfaces of the Granholm Hut in the same colours and style as the other sides so that the whole structure will blend into its rocky background regardless of the viewing aspect.

Although painting of most of the Granholm Hut has allowed it to blend very nicely into the background, it still stands out when viewed from Azimuth Hill and from the entrance to Boat Harbour. Completion of its painting will further minimize its impact on the heritage values of the Mawson's Huts Historic Site.

2.10 Recommendations for Future Expedition Planning:

Recommendations specific to the 2008 expedition are outlined below. Most of these are elaborated on, and additional recommendations made, in other sections of the overall report.

2.10.1 Pre-departure planning and preparation

Packing:

- Daypacks, including sleeping bags, must be available to expeditioners at all times, particularly for travel when disembarking.
- Pallets must be loaded in reverse order of priority to ensure that high priority goods and equipment are accessible for the earliest possible fly-off.

Catering:

It is not considered necessary to return consumables based on "best by" dates as the Antarctic environment keeps food well beyond recommended dates.

Kitchen equipment:

See the Camp Report and Appendices for catering and equipment recommendations.

Training:

- Courses in small engine operation and maintenance, quad servicing/trouble-shooting and the basics of gas/electrical appliances (for the upkeep of stoves, heaters and electrical equipment)
- Some of the team members should either possess Senior First Aid or wilderness first aid level qualifications or be given that level of training so that there is some back up for the designated medical officer.
- Depending on the background of the expedition team and the nature of ship to shore operations, team members should be given basic instructions with respect to helicopter cargo operations in the field. Awareness and response to helicopter operations could be improved. Helicopter procedure and instruction from the *Marina Cvetaeva* crew was comprehensive and the operations appeared to run smoothly on the day. Our uplift from Cape Denison however was not so streamlined. Some were not familiar with ground procedures,

especially when dealing with unrestrained cargo. A briefing should be held on the day of uplift with all team members alert to cargo restraint and group positioning upon sight of incoming chopper.

2.10.2 Ship to shore operations:

- It is strongly recommended that helicopter operations be used whenever possible.

2.10.3 Sorensen hut and camp:

An overview should be given on arrival to ensure that each member of the team is familiar with essential operations of the Sorensen field camp, such as: power supply (the ins and outs), refuelling generators and quads, how to turn the oven on and change the gas, phone and internet connections, shower use, water procurement, waste management etc.

Apple Hut:

Although it has been suggested that the Apple would benefit from built-in beds, this may limit its use for storage at the end of a season and also as an alternative emergency accommodation for more than 2 people. The team this season found it suitable for two people with mattresses on the floor. Work needed includes:

- Replacement of many of the rusted internal bolts.
- Provision of a new door seal.
- An internal door handle is required.
- Recoating of the internal surface is needed as the current insulation is starting to flake away. This could be done just before departure so it could still be used for accommodation for the bulk of the season and available for the next season without the wait for drying of solvents etc.

Electrical/lighting system

- See the recommendations in Chris Henderson's report (Sorensen Hut Electrical Supply).

Generators and blizz boxes:

- Refuelling needs to be simplified, by either arranging it so that the generator can be connected to a larger capacity external fuel tank (outboard hose?) or having a filler tank with a capacity that matches that of the generators.
- Blizz box needs to be supplied for the smaller generator.

General amenity

- Semi-permeable blinds should be installed on the laboratory windows to reduce the very bright, afternoon light.

2.10.4 Communications and electronic equipment:

There were some problems with the MHF laptops. The following actions will improve the situation:

- remove old profiles and unregistered programs
- install virus protection
- install a registered and current version of Microsoft Office suite

2.10.5 Quads

- See the Carpenters' Report for details of recommendations

2.10.6 Medical

- A local area SAR plan needs to be written and procedures understood for future teams at Cape Denison.
- Medical briefings are recommended on the journey to the site – hypothermia, basic first aid etc.

2.10.7 Tools and equipment:

- Replacement chains and chain repair kits should be purchased for the saws on site.
- Either a ceramic panel or oil-filled heater should be purchased for the laboratory (no naked flames because of solvents).
- Nikon SB400 Speed light flash unit is needed for artefact photographic documentation.
- A substantial list of chemicals and minor equipment needed for the laboratory is listed in Appendix 3.
- Battery is needed for the Campbell Scientific/Australian Museum environmental logging system.

3. MATERIALS CONSERVATION REPORT

By Megan Absolon, Michelle Berry and Ian Godfrey

3.1 Introduction:

Prior to arriving at Cape Denison the expedition team was fortunate to be able to call at Macquarie Island and to clamber up North Head to inspect the remains of the site of the AAE wireless relay station. A description of this visit follows the introduction.

Once at Cape Denison and while the laboratory was being completed and fitted out, conservation work focussed on three main areas – monitoring, sampling and ice excavation. While these were the main foci of initial activities they will be reported on later as the most significant aspect of this year's work program was the commissioning of the Conservation Laboratory and the successful treatment of 88 artefacts in the two weeks available after the laboratory was commissioned.

3.2 Macquarie Island – AAE Wireless Station:

The expedition team visited the site of the AAE wireless station on North Head, Macquarie Island. Very little physical evidence remains of the station. The remains of a radio mast and very small corroded lengths of iron cables are all that remain in one area. No remains were found of the second mast. Similarly, an inspection of the sites of the engine and wireless huts revealed little other than some (possibly) structural timbers and wires. Tussock grass has slowly encapsulated this site, covering features, such as dressed stone foundations, that were previously described in 2003[4]. The time available on the island did not allow for a thorough inspection to be made.

Remains of wireless mast

Engine hut site, AAE wireless – North Head, Macquarie Island

3.3 Artefact Treatment Summary/Laboratory Operation

The laboratory was outfitted and all equipment unpacked. The laboratory functioned well for the treatment processing of objects from the main hut. Laboratory functions, practices and equipment needs will no doubt be further refined in upcoming seasons. Conservation treatments focused on the objects excavated by the ANARE expedition in 1978, as identified in last years report. Work undertaken generally followed the sequence outlined immediately below:

- Packing for transport in the hut
- Transportation to the lab from the hut

- Cataloguing (entering the object into the database and filling in the required fields)
- Identification and before treatment photography
- Conservation treatment
- Applying catalogue numbers to objects
- After treatment photography
- Packing for storage
- Return to the hut for storage

Packing and transportation

Objects were selected from the box of artefacts excavated by the 1978 Ledingham expedition. These were wrapped in bubble wrap, packed in a Nally bin and the lid tied down. The bin was placed in the Nally bin strapped to the back of the quad bike and driven slowly back to the Sorensen, carefully avoiding the worst of the sastrugi.

Cataloguing

An Excel copy of the Mawson's Huts artefact database, provided by the Australian Antarctic Division, was used to document the conservation treatment of artefacts. Several new fields were established in this copy of the database including:

- Conservator - name of conservator who carried out the treatment
- Condition - description of the condition of the object prior to treatment
- Treatment carried out - description of the conservation treatment used
- Treatment justification - used if necessary, to explain the reasons for the type of treatment carried out
- Photography - the photographs taken
- Analysis - the types of analysis (if any) that were carried out
- Products used - the materials and products used during the conservation treatment

Artefacts that were exposed during ice excavation were recorded in the database and where artefacts had been previously recorded, new information was included.

Identification and before treatment photography:

Each object was photographed before treatment to identify it along with its catalogue number and to assist in the recording of its condition prior to treatment. Images were saved as jpg and raw digital files. Each file used a standard naming schema – the catalogue number followed by either before (BT) or after treatment (AT) eg. 2511BT.jpg, 2511AT.jpg.

The flash unit purchased for photography proved to be too large for the space. A personal Nikon SB400 Speed light flash unit was used instead. The flash units were returned to Australia for refund and it is recommended that a small flash unit such as the Nikon SB800 be purchased to replace them.

Conservation treatments:

Eighty eight objects were treated in the conservation lab this year, consisting mainly of mechanical and chemical treatments of metal objects and a small number of paper treatments. Additional chemicals and equipment have been identified for next year's expedition, something that will increase the range of possible treatments. More

details of conservation treatments are given at the end of this section of the report.

Applying catalogue numbers:

Catalogue numbers were applied to each of the treated objects to identify them, to enable tracking, management and research. Standard conservation labelling techniques were used for this task.

Packing for storage:

Due to the build up snow and the damage to the shelving in the workshop, the artefacts treated this year could not be replaced in the positions from which they had been excavated in 1978. Instead they were packed for storage in readiness for reinstatement. Each conserved object was wrapped in bubble wrap and packed in a Nally bin, with a list of artefact numbers written on the outside of each bin.

The collection management of artefacts has now reached a critical stage. Data and photographs from this season and from last season now need to be entered into the Cape Denison Artefact database. It is recommended that processes and guidelines be established in conjunction with the Australian Antarctic Division to assist the ease of hand over of the data and photographs in future seasons. It is also recommended that investigation is made into the possibility of storing condition reports for the buildings and other reports as digital files in the Cape Denison artefact database as a means of archiving as well as providing access to the growing number of reports concerning Mawson's Huts.

3.4 Artefact Treatment Details:

The conservation treatments carried out in the 2008/2009 season were guided by the policies established by the Mawson's Huts Historic Site Management Plan 2007-2012[1]. Treatments were designed to ensure that evidence of past use by the AAE was preserved as a record of their experiences.

The program this year focused on the contents of the box of objects excavated from the workshop in 1978 by Rod Ledingham and his team. These objects were identified in last year's Conservation Report as in poor condition due to storage in the wooden box and were identified as a priority for conservation treatment. Objects from this box were processed through the conservation laboratory with the work following the sequence outlined above. The majority of the objects were metal and metal composites or glass with a few paper items including the remains of a dried apple wrapped in paper.

Metal treatments:

The metal objects, which were predominantly iron, were treated by removing loose corrosion, treating the metal surface with a metal inhibitor and coating with either a wax or resin layer to protect the surface from the high relative humidity inside the huts. An example of one of the metal treatments carried out is a hammer excavated from the workshop. Although the wooden handle of the hammer was in good condition, the iron head had suffered from extensive surface corrosion. Conservation treatment consisted of removal of loose surface corrosion, followed by stabilisation of the iron surface with tannic acid and coating with polyethylene wax. The photos show before and after treatment results.

Hammer before treatment

Hammer after treatment

Cans and contents:

One of the issues identified in the 2007 Conservation report[5] was that associated with the conservation treatment of cans still containing food or other substances, particularly those which were liquid at room temperature or contained substantial amounts of water. Only one such can was treated in the lab this season. The can, with a paper Horlicks Malted Milk label, was moved to the lab for treatment and after thawing, was found to contain linseed oil. Fortunately the can did not have any holes or punctures and the contents did not leak after thawing. The paper label was reattached and the contents were left intact before the can was frozen and returned to the hut; freezing prior to transport prevented spillage on the journey back.

Historically this can also provides evidence of the support that Mawson received from companies such as Horlicks. The label is inscribed "*Put up in tin cans expressly for the use of the Australasian Antarctic Expedition 1911 – 1912*".

Can of Horlicks Malted Milk containing linseed oil

Where possible, cans that still contain original materials need to remain frozen during their treatment so that there is no loss or leakage of the contents as they thaw, something that may result in the exposure of expeditioners to risks such as deteriorating food.

Damage due to past excavation techniques:

Some of the metal objects from the workshop had suffered impact damage from a chisel during excavation and in most cases it was not possible to reduce this damage, as the metal was resistant to being reformed. The following image shows an enamel dish whose foot had been deformed by a chisel's impact.

Enamel dish with chisel marks on the foot

Enamelware and evidence of use:

Many of the enamel objects still showed evidence of the use to which they had been put after they had been retired from the kitchen and moved to the workshop. The surfaces of much of the enamelware were covered in grease and oil residues. Treatment of these objects focused on the stabilisation of areas of exposed metal while leaving the oil and grease residues intact. The following image shows the grease residues on the outside of a large enamelware jug.

Enamel jug with intact oil residues after conservation treatment

Most of the enamelware objects did not change appearance as a result of the conservation treatments and remain an intact record of the changes and adaptations made by the members of the AAE expedition during the two years at Cape Denison. The following images show an enamel plate with heavy grease residues, corrosion staining of the enamel and metal corrosion where the enamel has been chipped off. The grease residues and corrosion stains were left intact while the areas of corroding metal were spot treated with tannic acid and coated with Paraloid B72 resin.

Enamel plate before treatment

Enamel plate after treatment

Glass objects:

The glass objects were not overly cleaned as the residues visible on the exterior and interior were as a result of their use by the expedition. The following images show an example of a lightly cleaned glass jar.

Glass jar containing a feather before treatment

Glass jar after very light cleaning

Paper conservation treatments:

Few paper based objects were found among the Ledingham objects, with the exception of two cardboard matchboxes and a fragment of a newspaper from 1912. The matchboxes had collapsed due to the failure of the original adhesive and the boxes had sprung apart. Treatment consisted of reassembling the boxes and re-adhering the failed joins so that the boxes were once again structurally sound.

Matchbox before treatment

Matchbox after treatment

One of the many interesting objects discovered this year was a corroding tin. Surface cleaning revealed a label, which showed that it had once contained 'skinning powder' supplied by a Furrier in London. This powder would probably have been used to preserve the skin specimens collected by the AAE. This object also highlights some of the risks involved with this collection. In the 19th and early 20th century, skinning powders used to preserve skins were often based on arsenic compounds.

Skinning powder tin

Detail of skinning powder tin label

Conservation program:

This was the first year of conservation treatment of objects from Mawson's Huts at Cape Denison. It was therefore the first opportunity to test the assumptions made in previous years as to how the work would be carried out.

Although the laboratory is small by Australian standards, efficient use of the space, adoption of standard procedures and an established workflow means the lab can successfully accommodate three conservators working in the space.

It is most important to quarantine laboratory space for conservation purposes only in the coming years. Space is at a premium in the confines of the field hut and it is understandable that other members of the team would want to use some of the lab space. Laboratory space will also be at a premium however and will need to be respected, despite the sometimes limited space in the main living area of the Sorensen Hut.

The treatments carried out this year highlighted the need for a small range of additional chemicals and equipment to increase the range of treatments possible. In particular, the addition of phosphoric acid-based metal inhibitors will provide an alternative to the tannic acid metal treatments and therefore a choice as to the types of colour changes available for the treatment of iron objects. The addition of semi permeable blinds for the windows in the lab, to reduce glare and the installation of an electric heater (without a naked flame) in the lab will increase the usability of the lab.

The program this year was successful in setting up the laboratory space and testing and establishing a workflow, which enabled the processing of eighty-eight objects in a comparatively short space of time. Considering the remoteness, the difficult conditions under which the lab has been established and the work carried out this season, it is a remarkably successful facility. The lab has all the functionalities of many conservation laboratories in Australia, aside from being a little cold in the mornings!

All electronic equipment left at the site was winterised for protection against ingress or melt water damage by being placed in a large esky containing silica gel.

Recommendations:

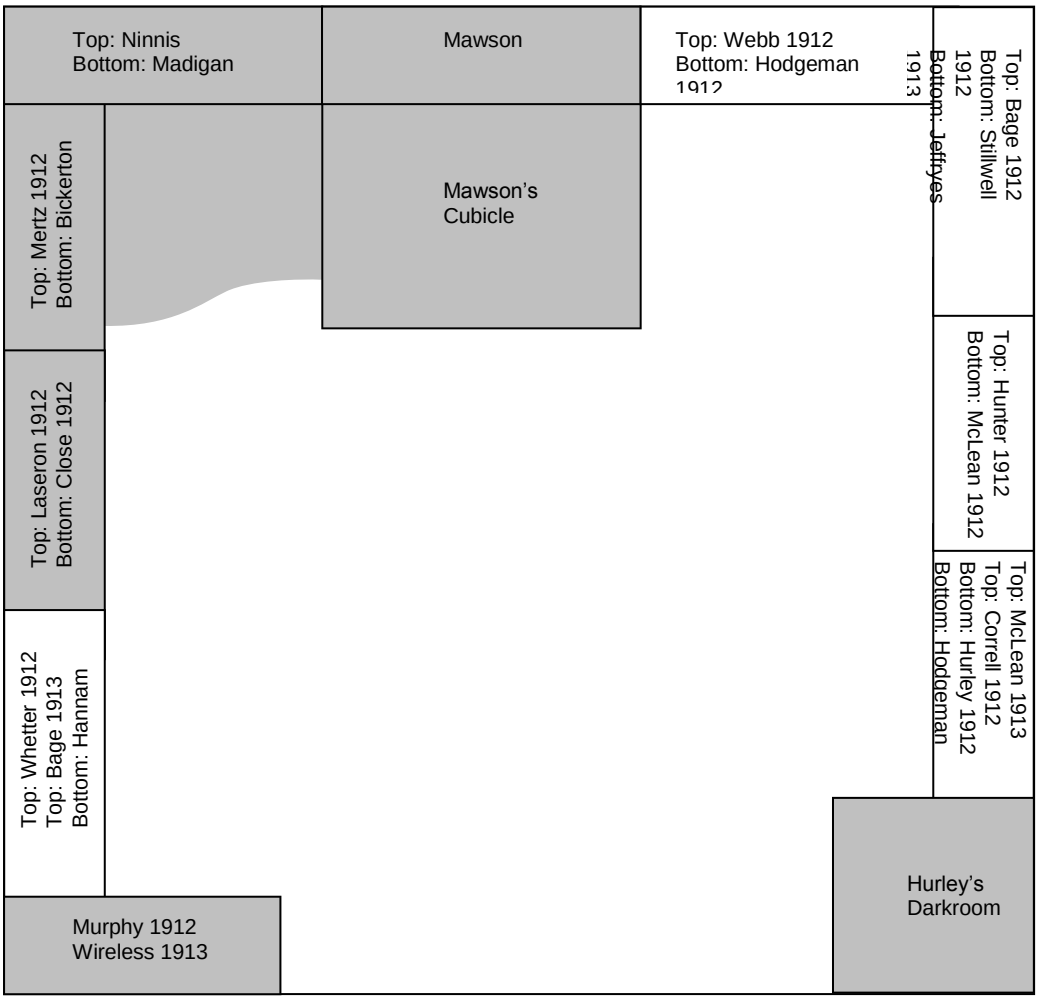
- Standardise the photographic set-up to ensure before and after treatment photographs are more easily compared
- Install semi permeable blinds in the laboratory
- Ensure that the laboratory space is reserved for the treatment of the artefacts
- Install a heater inside the laboratory
- Write up procedures for photography and workflow
- Prepare a policy on cataloguing of artefacts, particularly those exposed during excavation and guidelines as to when catalogue numbers will be physically applied to artefacts.
- Establish processes and guidelines, in conjunction with the Australian Antarctic Division, to assist the ease of hand over of the data and photographs in future seasons.
- Investigate the possibility of storing condition reports for the buildings and other reports as digital files in the Cape Denison artefact database as a means of archiving as well as providing access to the growing number of reports concerning Mawson's Huts.

- Purchase additional equipment as identified in Appendix 4.

3.5 Ice Removal/Excavation:

Hoar frost was removed, using plastic scrapers, from ceilings, bunks and shelf areas where possible. Care was taken not to remove frost from the top of shelves where objects were present or from paper objects. For the most part, the frost broke away easily.

Following frost removal, ice was removed from the following areas in the Main Hut (see the figure below): Mawson's cubicle (floor and the roof space above the cubicle), Hyde Park Corner (floor, Mertz and Ninnis' bunks), Laseron's bunk, Murphy's bunk and a small amount from above Hurley's darkroom. Tools used for ice excavation included cold chisels, paint scrapers, hammers, brushes and jemmy bars. A pneumatic hammer drill was used to break up hard ice from the floor area in Hyde Park Corner.



Bunk map - areas of ice excavation (shaded)

Mawson's cubicle floor:

The floor in Mawson's cubicle consisted mostly of hard clear ice (melt ice) which formed a dome in the centre. This created a difficult platform to stand on in order to removal hoar frost and for positioning of the ladder when needed. Ice was removed therefore, mainly from the centre of the floor to create an even surface. This was done carefully using a cold chisel and hammer. Mawson's chair was freed from the ice and placed on the bunk during the ice removal period. A large can was excavated from beside the bed. There are many small items on the floor along the walled sections, including scientific glass tubes and fragments, tar paper, matches, general fluff, dirt and straw. These items remain on the floor. For ease of entry into the cubicle a stair was cut into the drop off.

Floor ice before ice removal (photo: David London)

Floor ice levelled

The creation of a step, while enhancing access for conservators, will now make for easier movement in and out of Mawson's cubicle for all visitors to the hut, including tourists if not adequately supervised. This may be problematic for the following reasons:

- It is a small room to manoeuvre in, particularly when people are in bulky clothing that they are not used to wearing.
- Items from Mawson's cubicle may seem more desirable to souvenir. Most tourists are respectful of the heritage site but artefact loss is inevitable. (Future collection management procedures will be vital in tracking movement of objects in the Hut.)
- The small glassware items on the floor are likely to be crushed underfoot.

It is very important therefore, that all visitors are given clear instructions that they are not to enter either Mawson's cubicle or Hurley's darkroom. Tour guides have to remain vigilant to ensure that this instruction is complied with.

Ceiling above Mawson's cubicle:

A large amount of compacted snow and hard ice was removed from the ceiling above Mawson's cubicle. Several artefacts were uncovered during this process, including a pair of boots, two glass bottles, two copper alloy cylinders, a wooden box with Dr Mawson's name printed on the side, a metal box, assorted strips of tar paper, straw and a badly corroded iron 'trough' (see below). While documented, these objects were not added to the objects' database this season.

Above Mawson's cubicle - pre-ice excavation

Above Mawson's cubicle - post ice excavation

There is a risk of more ingress in this area because the wall and ceiling junctions have not been sealed. A large amount of snow in the southern veranda currently prevents any ingress of drift snow. This area needs to be continually monitored until such time as access to the veranda wall/ceiling junction allows sealing work to be undertaken. This is a priority as soon as there is sufficient ablation in the southern veranda.

Hyde Park Corner floor:

The floor ice level in Hyde Park Corner extended at the same height from the kitchen area and dropped down (~ 200mm) to floor level approximately 500mm from the southern bunks and up to 800mm from the eastern bunks. For ease of ladder access for ice excavation of the Hyde Park Corner bunks and the top of Mawson's cubicle, floor ice was removed from this corner. The ice floor was lowered to ~ 50-80mm above the floor and taken back roughly in line with the northern wall of Mawson's cubicle. Some lengths of tar paper were excavated in the process and placed on the floor near Bickerton's bunk (see images below).

Hyde Park Corner floor ice before removal (photo David London)

Hyde Park Corner floor ice after levelling

Murphy's bunk:

The bulk of hard ice has now been removed from Murphy's bunk, with the horizontal bunk surface almost ice-free. The walls have some ice-free areas, with the remainder of the walls covered by layers between 20 – 60 mm thick. Ice on the walls was left to ablate for a season to avoid damage to underlying tar paper and wiring. Ice still remains in the corner ceiling area and underneath the bunk. Nine objects were recovered during excavation and remain on the bunk platform (see Appendix 1 for details). The excavated milk powder tin was placed back upside down as the contents would otherwise spill from the corroded base.

Murphy's bunk before excavation

Murphy's bunk after excavation.

Excavation of the northern bunk wall revealed the painted lettering of the bunk occupants as follows: **H.D.M 1912** and **Wireless 1913**. This lettering, combined with the presence of three coated wires on the bunks, two on the bunk base and a third on the North West bunk post, confirmed unambiguously the location of the wireless during the 1913 period, a matter that had been the subject of some speculation. More wires may be revealed after further excavation.

Writing on the wall of Murphy's bunk

Wires exposed on Murphy's bunk

Laseron's bunk area:

The slats used on Laseron's bunk were removed at some time in the past. The excavation of this area focused on removing ice and snow from the shelf below the bunk, as well as removing the hard ice deposits (as a result of melt water) on the slats located at the head of Laseron's bunk and the foot of Mertz's bunk.

No objects were moved from the positions that they occupied prior to their excavation. Some of the artefacts excavated from this area had been catalogued in the past but had not been identified with a catalogue number while others, which were described more fully this year, could still not be removed safely from the ice. Artefacts in this area did not have previously assigned catalogue numbers applied to their surface.

Before excavation

After excavation

Mertz's bunk:

As with Laseron's bunk, most of the bunk slats on Mertz's bunk had been removed in the past and only a small area of the original bunk surface required ice excavation. Excavation of the shelf below Mertz's bunk revealed a number of artefacts. These were not catalogued this season as they were still largely embedded in the ice. It is recommended that they be catalogued when they have been mapped in their location and can be safely examined out of the ice.

Before excavation

After excavation

Ninnis' bunk:

Ice excavation of the bunk surface, the shelving on the south wall and the upper shelving in the south east corner only revealed iron sheeting tacked to the south wall. Apart from small fragments of tar paper, no objects were located on the bunk or the shelving.

Before excavation

After excavation

3.6 Monitoring:

3.6.1 Snow and ice ingress:

At the end of the 2007/2008 season black plastic sheeting was laid in specific areas in the workshop and the main hut to monitor ice ingress over the year. In addition, a test excavation of the shelf above the door between the main hut and the workshop was conducted to monitor the seal between the two roof planes.

Guttering and inner ceiling wall junction:

During the 2007/2008 season ice was excavated from the shelf in the living quarters immediately below the junction between the workshop and the main hut roof (see Mawson's Huts Field Report 2007/2008[5]). The aim was to determine if the gutter join was effectively sealed from melt water running in the gutter between the two roofs. While there was no further ice formation from melt water this year, indicating that this join is effectively sealed, monitoring in this area should continue.

Workshop:

As was noted in the 2007/2008 report, the post-2002 accumulated snow was removed from the ice bench on the north wall of the workshop and plastic was laid on the top bench to monitor annual snow ingress in this area. Over 2008, fresh snow ingress occurred along the north and east internal walls of the workshop.

Fresh snow ingress on the internal north wall of the workshop

It is clear that the fresh snow ingress is a result of the combination of gaps in the external north wall, the break down of the tar paper lining and gaps between the internal lining boards. The external boards of the north wall of the workshop have been badly worn over the years and daylight now penetrates gaps in the internal lining boards inside the workshop. Measurements of the gaps between the external boards were made to provide an indication of the extent of the problem. Gaps of up to 15mm were found. It is recommended that the north wall be over-clad to protect the remaining boards and to prevent further snow ingress into the workshop. Without over-cladding, the ice benches left in place by the 2002 team cannot be removed as these help seal the workshop from further snow ingress. The reinstatement of shelving and objects into the workshop is dependent upon removal of the ice benches and therefore is also dependent on appropriate steps being taken to prevent further snow ingress through the north wall.

Main hut

Monitoring of snow ingress was carried out in the following areas (see the earlier Bunk Map): the roof of Mawson's Cubicle, Mawson's bunk, Bickerton's bunk, Ninnis' bunk, AJH 1912 bunk, FLS 1912 bunk, JGH bunk, PEC 1912 bunk and next to the stove in the kitchen area. While no further snow ingress occurred in these areas between January 2008 and December 2008 this is almost certainly due to the fact that snow levels external to the hut on the south wall, were above the roofline and would have prevented snow from entering along the roof/wall junction.

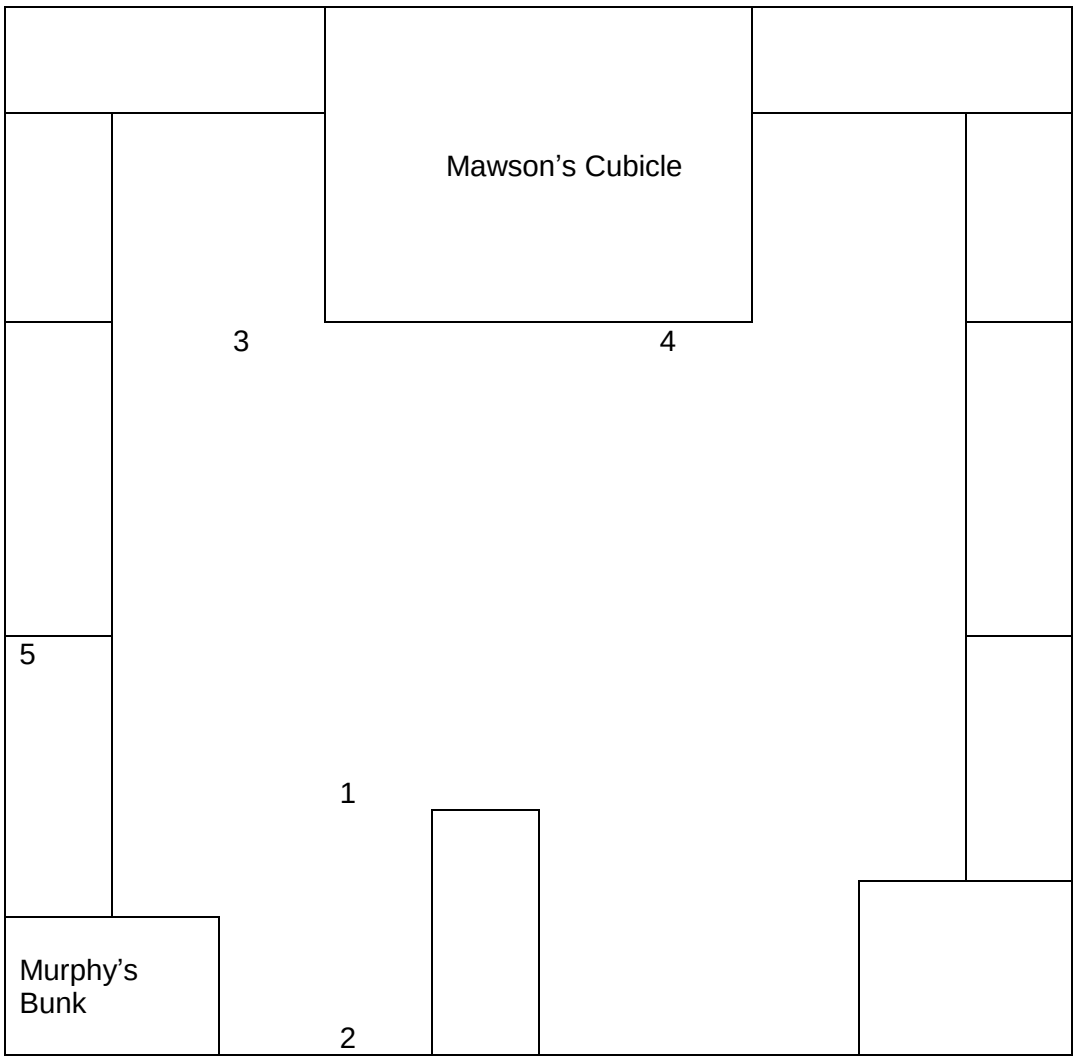
Various planks of wood and sheets of ply wood used by previous seasons for monitoring snow ingress were removed and stored under the Granholm Hut.

Black plastic was laid on Ninnis' bunk prior to departure to continue monitoring snow ingress in this area.

3.6.2 Ice ablation:

A small number of ice floor level monitoring points were established during the 2007/08 expedition, using weighted stringlines, to obtain an indication of the annual rate of ice floor ablation. These were not effective however, as the string lines stretched over the intervening 12 months, giving the impression of an increase in ice levels rather than a reduction.

An alternative method was adopted to measure ice ablation. Measurements and photographs were made at identified points inside the workshop and the living quarters so that snow heights could be measured against fixed points on the building. These are as shown and described in the figure below.



Ice height monitoring points 1 - 5

1. 250 mm – from the outer corner of kitchen bench, top of the rail (not top of table) to the ice surface.
2. 100 mm - from the top of the 10th board to the ice surface (10 boards from the top of the doorway.
3. 55 mm - from the top of 12th board to the ice surface (12 boards down from the top of Mawson's cubicle.
4. 150 mm - from the top of 10th board to the ice surface (10 boards down from top of Mawson's cubicle.
5. 200 mm - from the top of the rail of the shelf to the ice surface.

Workshop:

Only one point was measured in the workshop, at the east corner of the workshop bench at the external doorway. It was 290 mm from the top of the rail of the bench to the ice surface.

3.6.3 Environmental and structural monitoring:

Although the over-cladding technique used during the 2006 expedition was designed to minimise changes to the internal microenvironment inside the living quarters of the main hut, additional buffering provided by new air spaces, the new membrane and another layer of tongue and groove timbers could potentially alter the internal environment. In order to determine any environmental effects that may be attributed to changes to the roof structure and to the stability of the building as ice is excavated from the building, continued environmental and vibration monitoring is essential.

Stand-alone temperature/relative humidity loggers:

Data was downloaded from the Tiny Tag Ultra and Tiny View data loggers that had gathered data from the internal environment of the Main Hut during 2008.

Some of the Tiny View loggers were used to check the calibration of *in-situ* Vaisala loggers (Campbell Scientific/Australian Museum monitoring system) when in a low relative humidity environment created using silica gel. Older loggers were replaced by Tiny View loggers purchased by the Mawson's Huts Foundation. These new loggers and additional loggers supplied by the Western Australian Museum were subsequently reprogrammed and relocated in the main hut to collect temperature and relative humidity (RH) data until early 2010. Logger information and logging positions are given in Table 1 below.

Table 1: Stand alone temperature/relative humidity data loggers

Logger code (serial number)	Location	Logging interval (minutes)	Logger duration (days) -finish
WAM 35 (328719)	2nd highest shelf on outer wall of Mawson's cubicle	40	422 days: 10/1/09 - 8/3/10
WAM 36 (328473)	Hurley's darkroom	40	422 days: 6/1/09 – 4/3/10
WAM 37	Lower shelf in Mawson's cubicle (NE corner)	40	422 days: 6/1/09 – 4/3/10
MHF 2	Central collar tie in the workshop	40	431 days: 6/1/09 – 13/3/10
MHF 3	Apex of the living quarters	40	431 days:

			6/1/09 – 13/3/10
MHF 4	Collar tie in the living quarters (adjacent to the Vaisala sensor)	40	431 days: 6/1/09 – 13/3/10

Campbell Scientific/Australian Museum CR10X monitoring system:

When originally set up, the Campbell Scientific CR10X monitoring system consisted of a CR10X data logger with 1 Mb of memory, a 25 channel multiplexer (AM25T), a terminal block, a data logger battery, an Iridium 9500 Satellite Data Module with power supply and a separate battery for the Iridium and multiple sensors and thermocouples to collect temperature and relative humidity data. The system had been designed specifically for use in research at Mawson's Hut to collect environmental data and to transmit this data back to Australia via a satellite phone. The system has been progressively simplified over the years with the removal of redundant sensors (2006) and the multiplexer (2007/08). It was further simplified during the 2008/09 expedition. Problems with the satellite phone system prevented it transmitting data for most of 2008. Because of the complexity of that system, difficulties associated with transmission of data and no real need for data access during the year, it was decided to remove the satellite phone date and associated components, including the aerial on the roof of the main hut.

Prior to any alteration of the system, the previous year's accumulated data was downloaded. The amount of data downloaded however (~20,000 kb), was very small, indicating that less than a year's data had been recorded (expect ~ 170,000 kb). The logger battery voltage was low, a likely cause of the failure of the system to accumulate data for the whole year. The battery for the satellite phone system was tested and as it appeared to be sufficiently charged it was connected to the logger. The temperature and relative humidity sensors from the Campbell system were dried (bagged with silica gel) and tested. All were found to be operating and responding well to environmental changes.

While the satellite phone battery had sufficient charge to allow the sensors to be tested, it too soon lost charge. Because of this double battery failure, the monitoring system was moth-balled for 2009. All sensor connections were soldered, coated with Vaseline and reconnected, the desiccant was dried and replaced in the logger box, holes in the logger box from removed cabling were sealed and the batteries returned to Australia. The Vaisala sensors were also winterised, being sealed *in-situ* in polyethylene bags containing self-indicating silica gel.

As the sensors are working well and the system has provided reliable environmental information since the late 1990s, it should be reinstated during the 2009/10 expedition. This will simply require the installation of a new logger battery. The lithium battery in the CR10X unit was replaced during this expedition.

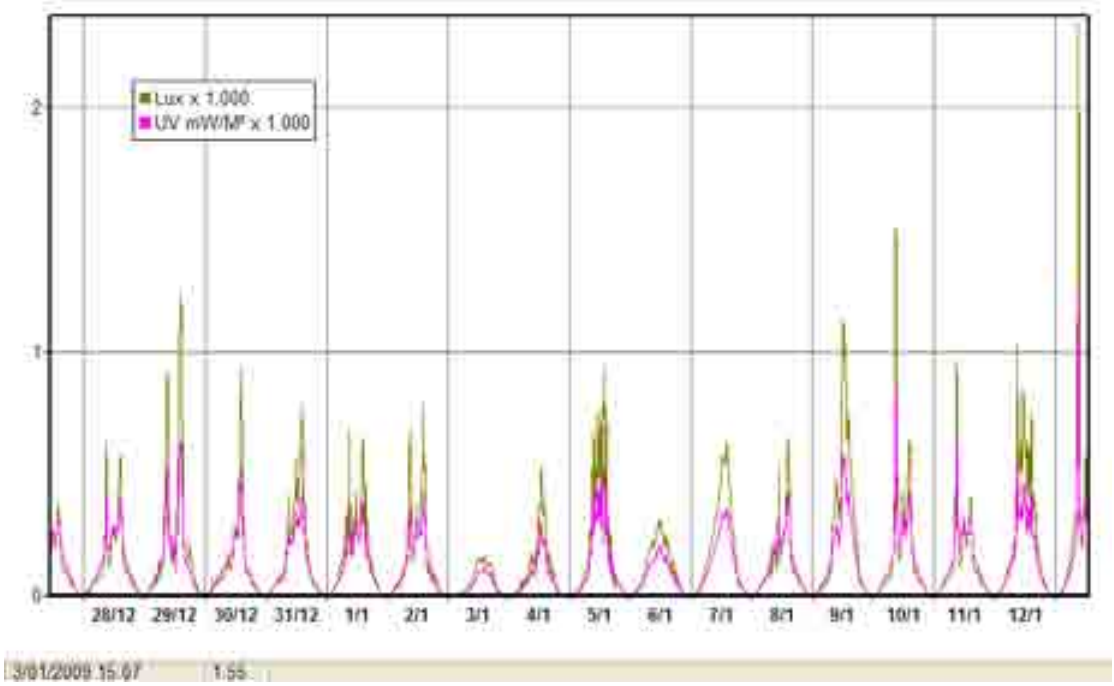
Internal light and ultra-violet radiation levels:

Concern had been raised about the possible impacts of direct sunlight and generally high light levels on sensitive objects like books and paper when the skylights are removed from the roof of the Main Hut. As a result, an Elsec 764C environmental monitor was used to record the temperature, relative humidity, light and ultra-violet radiation levels inside the living quarters for a period of 17 days over this expedition.

The monitor was placed on the shelf on the outer wall of Mawson's cubicle, immediately adjacent to newspapers and books and data was collected over a 17 day period. Light and UV values averaged 160 lux and 122,000 $\mu W/m^2$ respectively,

with ranges from 1 to 2350 lux and 0 to 1,251,000 μW/m^2. While these levels are limited to the duration of expeditions, they are still extremely high for light sensitive objects. It is recommended that action be taken to reduce the impacts of strong light penetrating the building when the skylights are removed during expedition visits. Possible action includes the following:

- Reinstatement of the platform in the living quarters to shield the library area.
- Covering sensitive objects (paper-based materials, textiles etc) for the duration of the expedition



Light and UV levels in the living quarters of the main hut

Vibration data loggers:

The Western Australian Museum and the Australian Antarctic Division supply Tiny Tag Plus data loggers to monitor vibration levels in the main hut, with loggers screwed to non-original timbers. Data was downloaded from the loggers, new batteries were installed in all loggers and they were then reprogrammed to continue to collect data for a further 447 days. All loggers were programmed to commence logging at 14:00 (WST) on 4 January 2009 and were in place by that time and date. Logger information and logging positions are given in Table 2 below.

Vibration data recorded since the 2007/08 expedition indicated that there had been virtually no movement of the structural elements of the building during that time, with a maximum vibration of 0.0033 mm/s recorded for the collar tie in the kitchen. Although there was increased vibration activity over the period July to mid-October for a central collar tie in the workshop, the maximum vibrations only reached 0.00098 mm/s during this period.

Table 2: Vibration data loggers

Logger code (serial number)	Location	Logging interval (minutes)	Logger duration (days) -finish
WAM V1 (239668)	Non-original timber attached to the Queen post just above the platform shelf	40	447 days: 4/1/09 – 27/3/10
WAM V2 (310425)	Collar tie near kitchen (E-W) in Main Hut (non-original)	40	447 days: 4/1/09 – 27/3/10
AAD V1 (319484)	Base of replica flagpole	40	447 days: 4/1/09 – 27/3/10
AAD V2 (319483)	Central collar tie in workshop (non-original)	40	447 days: 4/1/09 – 27/3/10

3.6.4 Corrosion monitoring:

Corrosion cells and experimental artefacts:

As it is important to continue to gather quantitative information regarding corrosion rates after changes to the roof on the living quarters, copper/steel corrosion cells and CLIMAT bolts were installed in various places in the living quarters and the workshop at the conclusion of the 2006 expedition. These corrosion cells were located and documented (see Table 3**)**.

High snow coverage again prevented access to the Magnetograph House. The corrosion cells and experimental artefacts that were installed there in 2002 will be retrieved for analysis during a future expedition.

Table 3: Corrosion cells

Object(s)	Location	State when found	2006 objects
Corrosion cells	Mawson's cubicle, lower shelf, NE corner	Hoar frost on cells	1125/1014
Corrosion cells	Hurley's darkroom, shelf, NE corner	Snow and ice free	1123/1112
Corrosion cells	Outer N wall of Mawson's cubicle, 2nd shelf from the top	Snow and ice free	1121/1091
Corrosion cells	Main hut, centre of E wall above upper bunk (CL 1912)	Hoar frost on cells	1131/1111
Corrosion cells	Hurley's bunk (JFH 1912), shelf above bunk, N end of W wall	Fine ice crystals on cells	1119/1092
Corrosion cells	Workshop, W side, on ice shelf, ~ 0.3m above the vice	Snow and ice free	1138/1113
Corrosion cells	Workshop roof	Snow and ice free	1118/1110
Corrosion cells	Anemometer Hill	Snow and ice free	1126/1115
Corrosion cells*	Workshop, NE corner, covered with snow/ice		1139/1116
Corrosion cells	Main Hut, lower shelf next to workshop door	Snow and ice free	1117/1109
Experimental artefacts** Corrosion cells**	Magnetograph House, shelf, NE corner	Condition unknown	MH8 (2002 code) 2708 (2002 code)

* Corrosion cells were uncovered and left with a small amount of compacted snow on them for 3 days before being recovered with snow.
** Not located due to complete burial of Magnetograph House at time of the expedition

Corrosion sampling:

In order to compare patterns of iron corrosion occurring at Cape Denison with that of iron objects in the Ross Sea area (Scott and Shackleton's huts), samples of corrosion products and corroded iron were taken for analysis in Australia (Table 4). Because of the different environmental conditions at the respective sites, with on-shore breezes a rarity at Cape Denison, differences in chloride levels and corrosion products are expected. This has obvious conservation implications. Shown below are two of the areas from which corrosion products were taken for analysis.

Corrosion sample ex stove top, kitchen

Corrosion sample, ex can, JHC 1912 bunk

Table 4: Corrosion samples and locations

Sample Number	Type of sample	Sampling location
1	Can fragment	Rocks closest to Boat Harbour
2	Nail and can fragments	Close to Boat Harbour
3	Nail	Artefact scatter, close to the workshop
4	Nail and screw head	Artefact scatter, close to the workshop
5	Corroded fragments and nail	Floor of the Transit Hut
6	Flattened biscuit tin	Floor of the Transit Hut
7	Corrosion products	Ex shelving bracket, workshop, west wall
8	Corrosion products	Ex file, kitchen shelf, near workshop door
9	Corrosion products	Ex shelving bracket, book shelf, north outer wall of Mawson's cubicle
10	Corrosion products	Ex cocoa tin, JHC 1912 bunk
11	Corrosion products	Ex top of cast iron stove, kitchen, Main Hut

3.6.5 Moisture testing of timbers:

The moisture contents of internal timbers were determined using a Protimeter Mini C moisture meter with crude data recorded in Appendix 2. Data included in this report is uncorrected and should be adjusted to give accurate values for the wood type being measured (Baltic pine and Oregon). In many cases extensive hoar frost coverage prevented measurement of moisture contents. In general the readings this season were significantly higher than those recorded in December 2006 for the same timbers. This may have been due to the higher ambient temperatures experienced

this season (moisture present in the wood rather than ice). In summary, moisture contents of:

- planks on the walls of Hurley's bunk were in the range 23-60%
- structural bunk timbers (Hurley) were in the range 19-25%
- panels on the dark room door were in the range 19-25%
- the planks on the NW outer corner of Mawson's cubicle were in the range 19-40%
- the planks on the outer NE corner of Mawson's cubicle were in the range 23-48%
- original timbers in the platform (average of 5 measurements for each of the posts and rafters) were in the range 19.5 -22%
- replacement timbers in the platform (average of 5 measurements for each of the rafters) were in the range 17-17.5%
- planks on the eastern wall, FHB bunk were in the range 25-50%
- planks on the eastern wall, upper bunk (CL 1912) were in the range 23-28%

A range of lower ceiling boards were also tested, giving average readings of 28%. The high moisture contents of the wood ensures that they remain swollen and tight fitting.

3.6.6 Timber thicknesses:

Timber thicknesses were recorded, using digital vernier callipers, for exposed timbers on the absolute magnetic hut, the magnetograph house, the memorial cross, the replica memorial plaque and the replica proclamation plaque. Timber thicknesses of boards on the southern veranda wall of the main hut, previously measured in 2000/01, could not be measured this season because of the snow build-up on the southern face of the building. Data recorded on this trip is compared and contrasted with that recorded on earlier expeditions.

Absolute magnetic hut:

Readings were taken from an original timber that had been repaired by the 1997/98 MHF team (see Appendix 3 for details). This timber, on the south side of the stable door had been previously documented during the 2000/01 field season and was found to have suffered very little abrasion over the intervening eight year period. Physical protection, via snow burial is the most likely explanation for the minimal abrasion suffered by this piece of timber.

Magnetograph house:

Although most of the building remained buried, measurements were obtained from two positions for future comparison; from a facia board on the north-east corner of the building and from a small piece of wood on the south-west corner. More precise locations and the raw data are provided in Appendix **Z**. Comparison with data for the NE facia board, previously obtained in the 2000/01 field season, indicated that there had been very little abrasion, more evidence for the physical protection afforded by snow burial and the stone wall on the south side of the building.

Transit hut:

Thicknesses of the widest timber on the southern face of the Transit Hut were measured in 2000/01. These measurements could not be repeated during this

expedition because of the loss of this and many other boards from the southern wall of the building (see 3.7 below, Documentation of Buildings for details and images).

Measurements were also taken of metal thicknesses of the brackets in the upper north-east corner of the hut. These were compared with those taken from the same shelving bracket in 2000/01. There were no significant differences between the two sets of data, with readings within the range and error band associated with the measuring instrument, indicating that corrosion and subsequent metal loss from these exposed fittings is minimal in the short term. Data for both seasons is provided in Appendix 3.

The memorial cross and plaque:

While timber thicknesses were not taken from many points, the post shows clear evidence of wood loss over the years, with differences of 16 mm in measurements taken at three points on the structure. Despite this the post and cross-arm are in robust condition.

The backing board of the replica memorial plaque continues to abrade at a rapid rate. In 2 years just over 2 mm of wood was lost from parts of the backing board, a rate of wood loss consistent with that recorded in 2006. The rate of wood loss from this plaque is in marked contrast to that of the proclamation plaque which has suffered very little loss (see below). It is likely that wind-borne particles, other than snow and ice, contribute to the memorial plaque's abrasion. The wind has a considerable fetch along the rocky ridge before it reaches the memorial plaque, whereas there is little in the way of rock, dirt and penguin detritus in the area south of the proclamation plaque.

Replica memorial plaque and base of the memorial cross (view from the east)

Replica proclamation plaque (view from the east)

Proclamation plaque:

The replica plaque is in very good condition, with some staining on the front surface and minor abrasion. Despite its exposed location, there appears to be only minor abrasion by wind-borne particles, a situation that is in complete contrast to that of the backing board on the replica memorial plaque. Timber thickness data is recorded later in this document (Appendix 3).

Replica proclamation plaque

Wooden survey mark – east of the absolute magnetic hut:

The wooden marker, located on a ridge in a rocky outcrop, was documented and thickness measurements taken so that the timber loss can be monitored in future seasons. Assuming that the marker was originally rectangular in shape, it has lost a little over half of its original thickness near its apex, with a thickness at its narrowest point near the top of 21.75 mm and a maximum thickness of 46.5mm where it is protected from abrasion by the rocks.

Survey marker, east of the absolute magnetic hut

3.6.7 Food and mould sampling:

In order to determine the state of preservation of food stuffs in the main hut and also to ensure that no pathogens were present in these materials, samples were taken from a variety of accessible sources. These are listed below:

- Sample 1 - taken from a large, heavily corroded tin on LW 1912 bunk (RB 1913). This is a greasy, very smelly, fat-like substance
- Sample 2 – taken from a Colman's mustard tin, shelf on the outer wall of Mawson's cubicle
- Sample 3 – taken from a Dutch cocoa tin, BW brand, JHC 1912 bunk
- Sample 4 – potato on the floor near Hurley's 1912 bunk
- Sample 5 – Flour from Colman's tin, ex AMcL 1912 bunk
- Sample 6 – taken from artefact 2450, horse radish powder

Mould samples were taken in 2006. Unfortunately delays in processing and exposure to warm weather possibly compromised the results. Samples were retaken from the same areas as in 2006 and in some additional locations. A repeat of the earlier samples will not only give more precise information about the nature of microbiological contamination inside the main hut, but will also give information about the competitiveness of the microorganisms present. Where mould or bacteria appeared to be active, samples were taken in order to:

- Determine the presence of microorganisms on sampled materials
- Identify any microorganisms found
- Determine whether identified microorganisms are potentially dangerous to human health and/or damaging to artefact material types

Mould on apple syrup containers

Samples were taken using a sterile swab (Transwab® for aerobes and anaerobes) supplied by Professor Tom Riley of the University of Western Australia. Sample descriptions and locations are given below:

Sample Number	Description and location from where the sample was taken
1	Repeat sample not taken for sample 1
2	wooden boxes (sledging rations) under CL 1912 bunk
3	5th plank up from the floor, outer NE corner of Mawson's cubicle
4	Pages of the book (The Crimson Sign by Keightley) on the 2nd top shelf, outside Mawson's cubicle
5	Trousers hanging below the acetylene plant
6	Seal blubber (?) on the shelf above the entrance to the workshop from the Main Hut – sample taken from blackened area.
7	Part of the contents of the rustiest tin on the shelf in McL 1912 bunk
8	Label on the apple syrup containers, top shelf of McL 1912 bunk
9	Paper label (Antwerp/Amsterdam) on the lower shelf, McL 1912 bunk
10	Potato on the floor below FJH 1912 bunk
11	Boards on the wall of FJH 1912 bunk
12	Contents of Colman's mustard tin, shelf outside Mawson's cubicle
13	White, bacteria-like substance on seal blubber (see Spl 6 above)
14	White, 'fluffy', mould-like area on seal blubber (see Spl 6 above)
15	Ex large tin on the southern end of AMcL 1912 bunk, under the poison bottle

3.6.8 Grandmother – One of Mawson's huskies:

Grandmother was exhumed from his temporary coffin, underneath layers of snow and ice, in the workshop. After an examination by the team doctor and the conservation team, it was concluded that he remains in good condition and is stored in a stable environment. There was no visible evidence of further deterioration and no signs of any microbiological activity (smell, areas of active fungal and/or bacterial attack).

Grandmother in his 'coffin'

3.6.9 Miscellaneous sample:

A sample of a grey/white powder was scraped from the interior of a container (Registration number 2472), thought to have been used as part of the acetylene production process. The sample was returned to Australia so that its chemical composition could be determined and thus the function of the container clarified.

3.7 Documentation of Buildings:

3.7.1 Transit hut

Boards and structural timbers have been lost from the north and south walls of the transit hut since January 2008, adding to the many that have been lost in the first decade of the 2000s. Four boards were retrieved from the snow on the north side of the hut and were identified for reattachment. The fastenings of several boards on the south face of the hut were loose and were refastened (see Carpenters' Report). No timbers were lost from the east wall, with two timber battens lost from the west wall since the 2007/08 expedition.

Transit hut, south wall, 2000/01

Transit hut, south wall, 2008/09

Transit Hut, north wall, 2007/2008

Transit Hut, north wall, 2008/2009

Transit Hut, west wall, 2007/2008

Transit Hut, west wall, 2008/2009

The carpenters confirmed that the asbestos sheet is part of original construction and had been attached with cleats during its original construction. There are broken sections of asbestos sheets lying in the rocks adjacent to the hut, no larger than 15 cm across.

The condition of the plinth lettering was compared to 2000/01, with close up images taken to monitor deterioration. Unfortunately the earlier photograph was not taken under the same lighting conditions or with the same degree of definition. Despite

these drawbacks, there appears to be some paint loss since the earlier image was taken. It is difficult to recommend how this lettering can be protected as it is on the north face of the plinth, the best position for protection against ice abrasion. Consolidation is not considered an option as it may cause the remaining paint layers to peel when the consolidants deteriorate.

Plinth 2008/09

Plinth 2000/01

3.7.2 Magnetograph house:

There are two rocks sitting on the roof of the hut which are visible in previous expedition photographs. Tidemarks from melt water are visible on the north face of the hut along with the remains of a dead penguin and sheepskin. The sheepskin remnants located along the northern roof edge are still firmly attached. The roof and walls which were visible are intact and still structurally sound. No loose boards were observed. The resin coating on the roof remains surprisingly intact. Entry inside the hut was not attempted due to the snow and ice build up at the doorway. Comparison photographs were not available from last year due to the height of the snow obscuring the hut at that time.

Magnetograph house – view from the east

3.7.3 Absolute magnetic hut:

The hut was only partially exposed this year. The weight of snow has forced the wooden slats away from the frame of the hut and the fastenings of the top edges of several boards on the east and south walls have failed. The door is still intact and in position. Black painted lettering was visible on the internal surface of southern wall beam. Three loose boards were observed north of the hut in the rocks. These were not retrieved as it was unclear if they were part of the hut. Comparison with an image from 2000/01 indicates that, despite periods of burial, the timbers are slowly being dislodged from the structure

Absolute magnetic hut – from the north 2008/09

Absolute magnetic hut – from the north 2000/01

3.8 General Observations and Recommendations:

1. Continue selective and systematic ice excavation within the main hut.

2. Recognise and monitor exposed objects which are prone to damage from pedestrian traffic. It is difficult for tourists, and even ourselves, to be aware of their surroundings inside the hut when shrouded in oversized clothing. Guides and visitors would benefit from being provided with a Code of Conduct for the huts. A short list of vulnerable spots in the huts could be provided to the tour ships each season. This type of relationship with the tourist operators should be encouraged as the interior of the hut will be under continual change over the next decade.

3. The platform should be reinstated. This will help in interpretation of the living quarters and also provide some protection against strong light for sensitive books and papers in the library area.

4. Each MHF expedition group also needs to be made aware of conservation aims and issues of the site. Not everyone is used to working in and around heritage sites and a simple walk-through at the start of the season would be beneficial to clarify behavioural expectations.

5. A map showing asbestos locations on the site should be drawn and updated, with a copy given to each expeditioner prior to the field season. Once on site, a walk-through to indicate these locations should be undertaken. This could eliminate future OHS issues as further carpentry and conservation work continue on the site.

6. Hard plastic shovels should be obtained for use in and around the hut. They should also be mandatory for guides to use when clearing the last bit of snow from the entrance door. These have been used on other Antarctic heritage sites and they are very effective.

7. When exposed at the height of the season, the door frame at the hut's entrance is sustaining some tread damage. Thought should be put to placing a protective layer, of ply for example, over this spot when there is no ice protection. Flood mitigation at the front door is also necessary when the melt water pool starts getting more than ankle deep. At that point a drainage channel should be cut downstream. This would make it easier for both workers and tourists to move into and out of the hut.

8. General guidelines should be developed for artefact retrieval, packing, moving and conservation treatments. This will become particularly relevant with continued excavation and for dealing with artefacts, such as food items, for which thawing is problematic. It will be beneficial if conservators develop and pass on a successful working pattern for taking artefacts to and from the Sorensen and dealing with them on arrival.

9. It would be useful to build on visitor surveys that have been conducted in the past, with questionnaires made available to all passengers on visiting ships.

10. Collection management processes will become increasingly important as the seasons progress. It is crucial to establish good conservation data management, particularly now that the lab is up and running and artefact conservation output will increase.

4. CARPENTERS' REPORT by Peter McCabe and Ben Burdett

The following is a report complied by Peter McCabe and Ben Burdett and comprises a summary of carpentry works completed this season. It also includes an account of other operations such as cargo, mechanical repairs, tide gauge deployment and other duties that the expedition carpenters generally undertake. Any recommendations touched on in the paragraphs that follow have been summarised in the latter part of this report.

Completion of Conservation Lab and Bunkroom

The first priority on our works plan was to fit out the new rooms in the Sorensen Hut extension. 'H' cowl roof vents and mushroom screw in wall vents were installed providing excellent ventilation to both rooms provided the wall vents are kept clear inside and out. The freezer panel floor in the new extension was over clad with 17mm plywood in the same method as the existing, providing a solid insulated surface. The interior of the new lab consists of perimeter bench units, custom made in Tasmania, using a Unistrut shelving system. The MDF bench tops were sanded and coated in Tasmania and fitted onsite. Additional head high shelves were made using pre fabricated brackets, form ply and timber from the stack near Sorensen. The conservation equipment was set up in the lab and with loads of bench and shelving space it proved to be a very user friendly work space for three conservators.

The completed lab

The bunkroom was the next job on the list. Three double bunk beds were built using plywood and Tasmanian oak. The timber is still raw and requires a coat of varnish. Six new mattresses were custom made to fit the bunk dimensions. The beds are designed to fit six plastic Nally bins under each lower bunk, and the remaining wall space between each bunk was filled in with shelving units made from the ply off cuts from the bed ends. These shelves were also designed to fit plastic Nally bins, providing a virtual pull out drawer system and proving to be an excellent and efficient place to stow personal gear.

About four days after the bunk room was complete all six beds were occupied with everyone opting to move inside; with the cardboard insert in the window it provided a peaceful, dark pace to get a good night sleep, as long as you are asleep before the snoring started!


The construction of the bunk room

Additional Sorensen work

The southern end of the new corridor was transformed into a shower facility. An additional layer of ply was installed with a fall to the middle into a floor waste. There is a ply door and shower curtain for privacy and heaps of clothes hooks. The corners of the floor wall and ceiling were wet sealed. A 12 volt camping shower head hangs from the wall and has been wired back to the battery bank and mains board. The user simply places an empty bucket under the drain pipe on the outside south wall, prepares a warm bucket of water, places the small pump into the water and flicks the water proof switch in the shower. The long pipe from the drain was placed in the shower upon departure and the drain in the floor has been filled with cloth and taped over to prevent snow ingress over the winter – a most important aspect to remember when 'winterising' the Sorensen prior to departure.

A metal grill door mat was made for the front door and is sitting inside the entry, it is best to screw this down to the deck for easy and safe use and remove it at the end of each season. The guy wires on Sorensen Hut and the apple were all checked and tensioned where necessary. The North West wire had to be re-anchored. Some snow ingress was detected at the rear of the corridor upon arrival and in light snow the flat roof gathers melted water. Some dripping was detected in the old and new sections. The exterior wall and roof joints were thoroughly examined for any potential ingress points, and after some resealing work the interior seemed well protected. Some melt was detected just outside the door to the new bunk room, immediately prior to our departure. Unfortunately there was no time to do any sealing work on the roof at that time. It is important to note any ingress of snow or melt water upon arrival next season.

Two new batteries were brought down to hook into the solar/generator power system. A shelf has been made for these batteries but the batteries have been returned to Australia and will need to be brought back and forth each year to get maximum life out of them. A comprehensive report on the power system has been prepared by Dr Chris Henderson.

Heritage Work

Mawson's Hut

This year we had considerably more snow ablation than last year, which gave us an excellent opportunity to assess the exterior cladding. Of most concern were some loose boards on the north-west corner of the workshop. Some of these external cladding boards have spit or deteriorated around the nail heads and are at risk of being lost in a blizzard. There are also some small holes high on the northern wall of the workshop which need attention and if the workshop is eventually cleared of its ice and snow there will almost certainly be more holes appearing that are currently

covered by ice. The workshop external north wall has lots of gaps between the vertical joins, and it is our opinion that it would benefit from over-cladding.

The interior of the hut was also assessed for any urgent work required. The steel strap holding the platform of the acetylene plant was reinforced as the timber it was supporting was starting to twist under load. The shelves in Hyde Park Corner that back onto Mawson's cubicle had collapsed on one side. Without sufficient time to repair this, we clamped a temporary strut on the collapsed side to prevent further slipping this coming winter.

Many of the shelves inside the main hut and workshop have collapsed under the weight of ice and it is recommended that the internal ice continue to be removed and the shelves repaired along the way. This would need to be a dual operation with the conservators as there are many artefacts on these damaged shelves that need removing and treating at the same time. Some of the old brackets need to be replaced as they are either completely missing or severely damaged. There are a variety of brackets that were originally used, but only two types that need replacement. With approval, we removed and sent home two brackets so that replicas can be produced. Ten replicas of each bracket would be sufficient for shelf reinstatement next year.

The timbers on the observatory roof on the north wall of the workshop are also very thin. A temporary clamping system was assembled this season that will keep the loose boards secure until they are over clad. The photos below show the temporary restraint on the observatory roof.

Transit Hut

The Transit Hut has lost many boards in the past few seasons; photographs show considerably less boards as the years go on (see the Conservation Report). This season we reinstated numerous boards that had blown off but were still close by. The structure is racking quite badly in strong winds, causing many of the modern screws to shear off. To remedy this we used polyurethane which performs well as it is a very flexible product. An extra bracing piece was fixed across the top of the south wall. Although this is not a part of the original design we deemed it necessary to increase the hut's ability to withstand winter winds. Further information regarding the polyurethane techniques is available in the recommendations section in this report.

An example of one of the braces on Transit Hut with a sheared screw

Granholm Hut

The Granholm Hut was found to be in good condition and its comprehensive range of tools and fixings provide an excellent stock for various jobs and repairs that arise during each trip. A full inventory was conducted and the complete list is available at the back of the trip report.

Quad bikes and Machinery

The three quad bikes all ran well this season, with no batteries needing to be replaced. One of the bikes seemed to have problems starting towards the end of our trip. It seemed to be a solenoid problem as on occasions it would make contact and start without any problems. We brought down a full set of fully inflated tyres and rims that are now in Granholm and listed on the inventory. There are three new batteries onsite, stored dry and with the battery acid in the cardboard box with them. The quads were winterised which involved removing the sponge air filter and packing the air box and intake with rags, taping over the exhaust and key slots, filling the fuel tanks, turning the fuel lines off and tying them back down to the tent platform. **The keys are in the white board pen tray inside the Sorensen and the sponge air filters are in a plastic bag under the white board.**

Air filter connected

Air filter removed and intake packed with rags

We have two generators and they both ran well this season. The larger Dunlite generator was only used when the smaller Honda was needed over at Mawson's Hut. It is recommended to use the smaller generator as it achieves excellent fuel economy. Each generator has its own silicone coated extension lead that connects to the hut. The large Dunlite uses the orange lead, and the smaller Honda uses the maroon lead. **Be sure to sit the generators level and check their oil level as they will not start if the oil is low**. The smaller Honda Generator has been a work horse for the past two seasons and should be returned next season for a service.

This year we had two chainsaws on site, a new Makita electric chainsaw, and a Stihl petrol chainsaw. The Stihl broke its chain this season and has been sent back for repair. Spare chains and a chain repair kit should be purchased for both the chainsaws as they are an extremely useful item.

Cargo Operations

This season we travelled to Cape Denison with Aurora Expeditions ship *Marina Svetaeva* and returned with the French re-supply vessel *L'Astrolabe*. Both arrival and departure operations used helicopters with the majority of cargo being sling loaded to the site using cage pallets. As cage pallet cargo on the *Marina Svetaeva* will be exposed to rain and sea spray, it is important to use heavy tarps and water proof cases for fragile equipment. The AAD has provided us with a few stiff plastic pallet liners in the past. These are extremely useful for keeping cargo dry and also for storage of items once at Cape Denison. It should be arranged a few months in advance to secure three of these pallet liners as they are not always available.

Helicopter sling loading is by far the most efficient method of cargo transport. Two or more members of the group need to have experience around helicopters to assist in operations. This may require a short sling loading course prior to departure. Plastic Nally bin lids need to be tied with cord when using helicopters to prevent the lids blowing around.

Tide Gauge and Survey Work

This season we continued the tide survey work for the mapping department and the AAD. While this work is important and its results will have very exciting answers for sea level measurements over the last 97 years, it is very time consuming. For height surveying to be accurate it requires a no rush approach and it absorbs many man hours from the conservation team. While I am happy to invest the time in Hobart learning to use all the equipment and am genuinely interested in the final results, it is worth highlighting that other conservation work was not achieved because the tide gauge survey work tied us up for many days. There is still at least one season of surveying work to be done, and with a busy works plan, the conservation team can really only fit this work in once our larger projects are complete. If the AAD sent one person to Cape Denison with us, with the specific task of doing the tide gauge work, it would conclude the work as well as achieve the accurate millimetre results that are necessary for this survey.

RECOMMENDATIONS FOR NEXT YEAR

Cargo operations

- It would be an enormous asset to produce 'Mawson's Huts Foundation' cargo stickers. The AAD Commonwealth Bay stickers that are currently used are quite prominent on the cargo and equipment that is already at Cape Denison. MHF stickers would then feature prominently in future photographs of our operations.
- Recommend using helicopter sling loading for cargo operations
- Try to secure three plastic lined cage pallets from AAD for weather proof transport and storage of equipment

Honda quad bikes / Mechanical

- There is some metal fatigue to the chassis of one of the quads. It would be a good idea to make a thorough inspection.
- Contact Dave McCormack from the AAD for advice on fixing the faulty solenoid on the bike that is not starting.
- Return small Honda generator for a service at the end of the 2009/10 season
- Spare chains and chain repair kits needed for both chainsaws.

Spirit of Denison (large catamaran sledge)

- Along the draw bar of the sledge, it would pay to drill and fix an eye bolt 700mm back from the tow hitch. From that point you can create a rope bridle back to the sledge clear of the rear wheels of the quad. The bridle takes out the second 'swivel' action, improving the safety and handling.

Sorensen Hut

- ABSOLUTE PRIORITY: The installation of smoke detectors is a must! Battery type detectors are really the only type to be installed; hard wired detectors would not suit the electrical installation without major design adjustments by an electrician. The only thing to consider is the life span of the 9V batteries which run a detector. It would be essential to remember to send new batteries each summer or perhaps send down re-chargeable batteries and a charger for the team to charge and install upon arrival each summer. Five detectors should be installed, one in each room: The bunkroom, the conservation lab, the cold porch, the dining room and one in the Apple Hut.
- Proper mounting of the extinguishers is also a priority! There are plenty that were sent down this year, but they are only small ones. It is recommended that perhaps the carpenters install these small extinguishers in pairs for each location and that pre-departure, basic fire training be given to those who have not previously had this type of training.
- Ventilation: Each room is individually ventilated, but as a safety measure against blockage from a misplaced bag or a blizzard, we need to install vents through the three doors leading to the cold porch. Six 'off the shelf' louvered metal vents can be sent down to fix over a hole on each side of the three doors.
- Further to the ventilation system, is the installation of three protective cages. We need two over the wall vents outside on the western porch to protect the adjustable ventilation covers from accidental breakage. The third cage should be installed over the inside of the wall vent under the bench in the lab to prevent accidental obstruction. The cages can be fabricated in Australia, and simply

screwed to the walls down there. They need to be 150mm x 150mm and stand off the wall 100mm.

- For hygiene and durability the new bunks need to be varnished. Sand clean any scuff marks and varnish. Also touch up any scratches to the varnish on lab benches. This would be an ideal blizzard day job. A 4 litre can of varnish and brushes need to be sent down.
- The petrol (jiggle type) siphon hose has a split. This has been caused by poor storage (hanging the hose over a nail in Delaney's Dunny). We had intended to take a measurement of the clear hose for repair; it's approximately 30mm in diameter. A new one might need to be sent down. The old one could be repaired with correct primer and polyurethane, or a new hose could be bought to slip over the siphon fitting for the following year so that we have a spare. An improved storage system (like a spring hanging clip) to avoid kinking and subsequent splitting again, is necessary.
- A sturdy metal 'pull' handle needs to be installed on the front door. Currently the cool-room type plastic push button is the only thing to pull with, but it is not strong enough and does not allow you to close the door quietly.
- To prevent possible theft of expensive equipment by visitors when the hut is vacant, a keyed entry set needs to be sent down and installed on the laboratory door. The lockset should be a lever type, brushed stainless finish with a 70mm back-set to fit the existing hole.
- A mid-rail should be installed on the existing veranda handrail for safety during icy periods. I would suggest that the section immediately in front of the door be designed as removable (i.e. bolted) for the purpose of re-supply and passing materials if needed. (We found that this was a good place to pass Nally bins etcetera when moving in).
- The ply veranda needs some small timber or metal runners laid in strips across its surface to provide grip to pedestrians in snowy conditions
- A 'shower caddy' would be a great addition to the new shower for soap and shampoo. A cradle to support the shower 'slops' bucket would be another small improvement to the shower system.
- New longer gas hoses were supplied for the heaters this year but did not fit so they were returned to Hobart. New larger fittings need to be adapted onto the hoses and sent back down. The intention is to drill a hole through the floor of the building at each heater position, insert the gas line and seal the hole with polyurethane sealant. This means the gas bottles are outside the building for obvious safety reasons.
- We had some blizzard and water ingress into the new building (above and below), but hopefully all of these leaks were repaired. If there are more, the area to be sealed should be cleaned using a light wipe of acetone, and sealed with white Sikaflex polyurethane (there are tubes in Granholm Hut). On the old parts of the building where silicone has been used, silicone will need to be used again because polyurethane won't stick to silicone. Where polyurethane is sealing to plastic, an appropriate primer needs to be used.
- Right at the end of our time when the snow had ablated, we realised that one of the rock eye-bolts for a guy wire on the western side is fixed to a relatively small independent rock. These were installed in the previous year when snow levels were much higher. We had no time left to rectify this, but it should certainly be assessed and rectified next season. There is a drill, grout and new bolts if required, for this job in Granholm.
- Another blizzard day job for the carpenters is construction of new photo frames to continue A4 sized team photos from left to right, also the mounting of the 1986 Sorensen crew and the late Sir Peter Derham (in picture frames already).

Apple Hut

- The old insulation in the Apple Hut has perished over the years and is coming off like dust. For health reasons this really needs to be sealed or 'locked off'. This could be done on a blizzard day. I would suggest using a non-solvent based paint, such as a cheap acrylic waterproofing membrane that is suitably durable and provides a high-build coating. (Being acrylic, the use of such a product in sub-zero temps might need to be checked).
- The inside door handle needs to be repaired.

Granholm Hut

- We recommend that it is kept as an important safety refuge for tourism in Commonwealth Bay. As much as some may argue that it intrudes on the heritage site, as tourism increases it equally protects the special buildings from damage in the impending case of a large group seeking emergency shelter.
- The camouflage paint job works very well but could be continued around the rear and on top of the roof where it is visible from Memorial Hill. These areas have not been painted yet. There is still paint down there which might just finish the job; otherwise the empty can should be brought back for colour matching to finish the camouflage in the following season. To improve upon the camouflage further, the paint colour could be mixed to match the surrounding rocks even more closely.

Transit Hut

- Robertson screws are not working on the Transit Hut. We've found that they are simply snapping like carrots in the cold and are not achieving retention of the boards either. This is because the thinning, ice abraded, brittle timber simply splits around the screw and sails off in the wind. Glue fixing is the only option that will work, because it fastens the whole surface of the brittle timber. Polyurethane sealant is the superior product for this purpose as it is flexible, UV resistant, bridges gaps, and is very strong. If the job is done skilfully, this method of fixing will also be less visible than screw heads. **Silicones do not work.**

  The only challenge with polyurethane is that it can be a tricky product to manage, so the use of masking tape, gloves and rags or paper towel is critical. It has to be a 'surgical' procedure. Some critical boards were fixed using all we had available, which was white polyurethane. Using Sika brand 'Dark Amber'- fast cure polyurethane sealant is the best answer in the future. Fast cure is important because polyurethane is a moisture cure product. As Antarctica is very dry, normal polyurethane sealants take too long. I have had extensive experience with these products in remedial construction, so any questions from future teams can be emailed to ben@burdettconstructions.com.au
- Loose boards need attention. We had time for some this year, but there are many more that need attention or putting back. There are some original and 2002 edition roof braces and a top plate that is stored in Mawson's workshop, and need to be put back. (They are labelled). Using masking tape and great care; glue/glue and re-screw loose boards with fast cure Dark Amber polyurethane. (As described in the previous bullet point).
- A protective screen could be introduced for the Transit Hut. If it is left as a 'standing ruin' we will eventually have just a pile of rocks where it once stood, and lose all of the information. Is there any merit in that idea? I propose the idea of a screen along the eastern and southern sides of the hut to protect it from ice abrasion. I see the screen being constructed of a steel tubular frame and clad in

Baltic Pine to match the buildings. It could be set back 2m each way and parallel with the two walls of the Transit Hut. From the direction of Boat Harbour it would hardly be noticed. The problem of a blizzard tail would be something to consider in the design. We encourage that the idea is discussed.

Main Hut and workshop

- ABSOLUTE PRIORITY: A new skylight hatch fastening system needs to be introduced. Currently, the timber hatches that protect the glass skylights during the winter months are screwed down with four batten screws each, which are only holding onto 20mm of Baltic cladding. Our opinion is that the current fixing may prove insufficient in a 320km/hour wind gust. If a hatch is lost, and the glazing broken, we could have a hut full of snow all over again. The surface area of these hatches is quite large, so they are quite a big sail. The other thing that we noticed is that each time these are screwed down, new screw holes are sometimes being created and peppering the building, and in some cases peppering the original skylight frame. This not only ruins the timber, but the holding power of the screws is diminishing. A very simple bolt-down system needs to be introduced that provides a more secure fixing to the building, and is still visually sympathetic. A solution needs to be installed in the coming season.
- Over-clad observatory skillion roof with battens and (consideration of bead profile) T+G boards like the original. The roof should be over-clad in a similar way to the Main Hut roof with minimal fixings into the original structure. Battens should be carefully sculptured over the contours or a press-able seal placed underneath to mould to and cushion the original cladding. Cover batten ends along barges with quadrant like original. (We ran out of time to take measurements and notes on this). A timber order should be compiled for the following 2010/11 season.
- Loose boards need attention along the walls of both huts. Repair using the same method as outlined in the Transit Hut report.
- The silicone joint where the metal hip caps meet on the apex of the main hut is broken. This illustrates the flexible limitations of silicone as opposed to polyurethane sealant. This area should be assessed as a possible point of blizzard ingress, and subsequently repaired.
- Removal of ‘Intergrain’ decking finish from the workshop roof: It is estimated that it will take at least 10, possibly 90 years for this to wear off naturally. It has been assessed and determined that using triangular scrapers it would take 2 men perhaps up to six days. This would be the best method as it follows the cupping, natural contours and patina that have already developed on the new boards, to sympathise with the original boards. Mechanical sanding would flatten cupping out and sanding or paint strippers could promote unwanted dust or chemicals to penetrate the building. A triangular scraper is efficient if kept sharp, so a bench grinder should be sent down for this purpose. (We don’t have one there yet but there is a sharpening stone and neat’s-foot oil). There are two triangular scrapers down there, but two extras should be bought for the project, and a vacuum cleaner would also be essential from an environmental perspective. A durable Makita (such as model 446L) could be handy for the project and as a long term asset, or a $150 domestic job might last for the project. (The conservators have an expensive vacuum cleaner for the lab but his could be damaged working on top of the workshop roof, and has been bought especially for conservation work). A vacuum cleaner could be lashed to the roof during the works.

Robertson Screws

- Having observed screws snapping on the Transit Hut, for future projects we may need to consider alternatives for the stainless and silicone bronze screws that are failing. They are certainly a neat looking finish, but in the extreme winds of Cape Denison these fastenings are shearing with metal fatigue. Perhaps simple galvanised treated pine particle board screws would be better. They are certainly stronger, and less likely to shear. We encourage that this idea be discussed amongst a pool of heritage carpenters.

Shopping List

- Box of red carpenters pencils.
- Box of 32mm treated pine screws.
- Box of 45mm treated pine screws.
- Box of 65mm treated pine screws.
- Box of 75mm treated pine screws.
- 2 pairs of safety specs.
- Packet of No. 2 Phillips driver bits.
- 2 x Magnetic bit holders (for Phillips bits).
- Disposable face masks (also recommend to BYO facemask).
- 6 x sausages of 'Dark Amber' fast cure Sikaflex polyurethane.
- Sika primer for sealing polyurethane to plastic and metal. We had some last season but most of it is gone. (Refer to the Granholm inventory). The primer last year was black, but perhaps there is a clear product?
- 1 new Bostik brand sausage gun. (The Fuller ones down there aren't the same quality).
- Spare parts; plunger, nozzles for sausage gun.
- 6 x rolls of (25mm minimum width) masking tape
- 2 x 1 litre bottles of acetone
- 4 boxes of latex gloves
- Bostik brand or similar industrial cleaning wipes. (for cleaning up polyurethane).
- Assorted disposable paint brushes; 10/12mm, 8/50mm, 6/75mm, 4/100mm.
- 2 x triangular scrapers.
- A 6" or 8" bench grinder.
- Vacuum cleaner for carpenters, (i.e. the workshop roof project).

General tips

- Lashing and securing of objects outside was largely supervised and checked by the carpenters this season. We often found Nally bin lids and light weight objects unsecured and in situations where they could become airborne. Everyone needs to think of the winds at Cape Denison as if preparing for a cyclone daily.

Anyone who would like to discuss items in this report are invited to email us.
Ben : ben@burdettconstructions.com.au
Pete: cabes80@hotmail.com

Thanks team for a great season.

The Chippies

5 THE SEARCH FOR MAWSON'S AIR TRACTOR by Dr Chris Henderson

SUMMARY

The location of the Air Tractor was estimated from images from 1911, 1931 and 1976. Ground Penetrating Radar (GPR) was used to search the ice where the Air Tractor was thought to be buried at Cape Denison. An area within the ice was found which looked consistent with the frame of the Air Tractor. An exploratory trench revealed it to be a layer of hard ice at sea level. Evidence is presented here that the Air Tractor may have been freed from the ice sometime after 1976 in a significant melt. It is likely that its current position is deeper in the ice among the rocks at the edge of Boat Harbour.

Suggestions are made for mounting another search.

HISTORICAL NOTES ON VICKERS AEROPLANE[1]:

Some highlights of the history of the Air Tractor are reproduced here.

The Vickers monoplane was based on the R.E.P. 60 HP five-cylinder air-cooled semi-radial engine plane. It was designed by Robert Esnault-Pelterie, a remarkable French inventor. The steel fuselage was built in France while the wings were made in England. After being tested at Vickers' new airfield at Joyce Green, Dartford, and then at Brooklands, it was crated and shipped to Australia for use by the Australasian Antarctic Expedition. However, the wings were damaged beyond repair on October 5, 1911, during a practice flight at Cheltenham Racecourse, Adelaide, before the expedition left for the Antarctic.

Mawsons reasons for using the air tractor

After his return, writing in the *Home of the Blizzard*, Mawson said that the reason for taking the aircraft was more to attract publicity for the expedition's cause rather than for its serious use in reconnaissance in the Antarctic. Shackleton and Scott had previously tried a motor car and a motorised sled, both of which had failed, and the air tractor represented a different idea.

[1] Some of the following infomation on the history of the Vickers plane is taken from a post on the Aerodrome Forum which can be found at: www.theaerodrome.com/forum/aircraft/39071-forum-attic-item-14-a-3.html . 'Home of the Blizzard' is available free for download from www.**gutenberg**.org/etext

FLIGHT

AUGUST 26, 1911.

THE VICKERS MONOPLANE.

IT is only typical of the unerring foresight that Messrs. Vickers exhibit in all their new undertakings that they should have turned some of their vast energy to aeroplane construction, and further that, in doing so, should commence work on such a successful and well developed machine as the R.E.P. monoplane.

The experience of such a pioneer as Robert Esnault-Pelterie counts for a good deal under any circumstances, but coupled with monoplane, in fact it only appears in three places, the rear skid, the two main skids, and the wings. The wings are going to have metal booms, and there is little doubt that, in these times of rapid advancement, all these parts will be fashioned from steel, much in the same way as in motor car construction the wooden chassis frame, even though armoured with metal, had soon to give way to the neat and homogeneous steel stamping.

The Vickers Monoplane.—Side view, showing the protruding engine and the manner in which the wing trasses are carried to the base of the fuselage. An idea of the wing cross section may also be gathered.

Figure 1 The Vickers plane used by Mawson. Note the ski attachments which proved essential on the ice.

Mawson, in the *Home of the Blizzard* writes:
“As erroneous ideas have been circulated regarding the "aeroplane sledge", or more correctly "air-tractor sledge", a few words in explanation will not be out of place.

This machine was originally an R.E.P. monoplane, constructed by Messrs. Vickers and Co., but supplied with a special detachable, sledge-runner undercarriage for use in the Antarctic, converting it into a tractor for hauling sledges. *It was intended that so far as its role as a flier was concerned, it would be chiefly exercised for the purpose of drawing public attention to the Expedition in Australia, where aviation was then almost unknown. [my italics].* With this object in view, it arrived in Adelaide at an early date accompanied by the aviator, Lieutenant Watkins, assisted by Bickerton. There it unfortunately came to grief, and Watkins and Wild narrowly escaped death in the accident. It was then decided to make no attempt to fly in the Antarctic; the wings were left in Australia and Lieutenant Watkins returned to England. In the meantime, the machine was repaired and forwarded to Hobart.”

Note: Pilot Watkins was originally a member of the expedition to Antarctica, so, despite the comments above, it implies there was an intention to fly the plane at Cape Denison, and that it was not just a publicity stunt.

Figure 2: loading the airframe onto the Aurora in 1911

The Air Tractor in the Antarctic in 1911-1913

Minus its wings, the machine was converted into an air-tractor, and taken south. The first test of the machine as an air-tractor was made on November 15, 1912. After a short trial trip on November 20, 1912, the vehicle made a successful depot-laying trip with a load of 700 pounds on December 2, 1912. At 4 PM on December 3rd, the air tractor was taken by three men from the expedition's base at Commonwealth Bay on a major trip. Bickerton takes up the story:

Bickerton describes the working of the plane:

"I had always imagined that the air-tractor sledge would be most handicapped by the low temperature; but the wind was far more formidable. It is obvious that a machine which depends on the surrounding air for its medium of traction could not be tested in the winds of an Adelie Land winter. One might just as well try the capabilities of a small motor-launch in the rapids at Niagara. Consequently we had to wait until the high summer.

With hopes postponed to an indefinite future, another difficulty arose. As it was found that the wind would not allow the sea-ice to form, breaking up the floe as quickly as it appeared, the only remaining field for manoeuvres was over the highlands to the south; under conditions quite different from those for which it was suited. We knew that for the first three miles there was a rise of some one thousand four hundred feet, and in places the gradient was one in three and a half. I thought the machine would negotiate this, but it was obviously unsafe to make the venture without providing against a headlong rush downhill, if, for any reason, power should fail.

After much consideration the following device was adopted:

A hand rock-drill, somewhat over an inch in diameter, was turned up in the lathe, cut with one-eighth-inch pitched, square threads and pointed at the lower end. This actuated through an internal threaded brass bush held in an

iron standard; the latter being bolted to the after-end of a runner over a hole bushed for the reception of the drill. Two sets of these were got ready; one for each runner.

The standards were made from spare caps belonging to the wireless masts. The timely fracture of one of the vices supplied me with sufficient ready-cut thread of the required pitch for one brake. Cranked handles were fitted, and the points, which came in contact with the ice, were hardened and tempered. When protruded to their fullest extent, the spikes extended four inches below the runners.

The whole contrivance was not very elegant, but impressed one with its strength and reliability. To work the handles, two men had to sit one on each runner. As the latter were narrow and the available framework, by which to hold on and steady oneself, rather limited, the office of brakeman promised to be one with acrobatic possibilities.

To start the engine it was necessary to have a calm and preferably sunny day; the engine and oil-tank had been painted black to absorb the sun's heat. On a windy day with sun and an air temperature of 30 degrees F., it was only with considerable difficulty that the engine could be turned--chiefly owing to the thickness of the lubricating oil. But on a calm day with the temperature lower - 20 degrees F. for example--the engine would swing well enough to permit starting, after an hour or two of steady sun. If there were no sun even in the absence of wind, starting would be out of the question, unless the atmospheric temperature were high or the engine were warmed with a blow-lamp."

How the air tractor was abandoned:
Bickerton writes that the first trial came in November:

"It was not till November 15 that the right combination of conditions came. That day was calm and sunny, and the engine needed no more stimulus than it would have received in a "decent" climate.

"Hannam, Whetter and I were the only inhabitants of the Hut at the time. Having ascertained that the oil and air pumps were working satisfactorily, we fitted the wheels and air-rudder, and made a number of satisfactory trials in the vicinity of the Hut.

"The wheels were soon discarded as useless; reliance being placed on the long runners. Then the brakes were tested for the first time by driving for a short distance uphill to the south and glissading down the slope back to the Hut. With a man in charge of each brake, the machine, when in full career down the slope, was soon brought to a standstill. The experiment was repeated from a higher position on the slope, with the same result. The machine was then taken above the steepest part of the slope (one in three and a half) and, on slipping back, was brought to rest with ease. The surface was hard, polished blue ice. The air-rudder, by the way, was efficient at speeds exceeding fifteen miles per hour.

On the 20th we had a calm morning, so Whetter and I set out for Aladdin's Cave to depot twenty gallons of benzene and six gallons of oil. The engine was not running well, one cylinder occasionally "missing". But, in spite of this and a head wind of fifteen miles per hour, we covered the distance between the one-mile and the two-mile flags in three minutes. This was on ice, and the gradient was about one in fifteen. We went no farther that day, and it was lucky that we did so, for, soon after our return to the Hut, it was blowing more than sixty miles per hour.

On December 2 Hodgeman joined us in a very successful trip to Aladdin's Cave with nine 8-gallon tins of benzene on a sledge; weighing in all seven hundred pounds.

After having such a good series of results with the machine, the start of the real journey was fixed for December 3. At 3 P.M. it fell calm, and we left at 4 P.M., amid an inspiriting demonstration of goodwill from the six other men. Arms were still waving violently as we crept noisily over the brow of the hill and the Hut disappeared from sight.

On the two steepest portions it was necessary to walk, but, these past, the machine went well with a load of three men and four hundred pounds, reaching Aladdin's Cave in an hour by a route free of small crevasses, which I had discovered on the previous day. Here we loaded up with three 100-lb. food-bags, twelve gallons of oil (one hundred and thirty pounds), and seven hundred pounds of benzene. Altogether, there was enough fuel and lubricating oil to run the engine at full speed for twenty hours as well as full rations for three men for six weeks.

After a few minutes spent in disposing the loads, our procession of machine, four sledges (in tow) and three men moved off. The going was slow, too slow--about three miles an hour on ice. This would probably mean no movement at all on snow which might soon be expected. But something was wrong. The cylinder which had been missing fire a few days before, but which had since been cleaned and put in order, was now missing fire again, and the speed, proportionately, had dropped too much.

I made sure that the oil was circulating, and cleaned the sparking-plug, but the trouble was not remedied. A careful examination showed no sufficient cause, so it was assumed to be internal. To undertake anything big was out of the question, so we dropped thirty-two gallons of benzene and a spare propeller. Another mile went by and we came to snow, where forty gallons of benzene, twelve gallons of oil and a sledge were abandoned. The speed was now six miles an hour and we did two miles in very bad form. As it was now 11 P.M. and the wind was beginning to rise, we camped, feeling none too pleased with the first day's results.

While in the sleeping-bag I tried to think out some rapid way of discovering what was wrong with the engine. The only conclusion to which I could come was that it would be best to proceed to the cave at eleven and three-quarter

miles--Cathedral Grotto--and there remove the faulty cylinder, if the weather seemed likely to be favourable; if it did not, to go on independently with our man-hauled sledge.

On December 4 the wind was still blowing about twenty miles per hour when we set to work on the machine. I poured some oil straight into the crank-case to make sure that there was sufficient, and we also tested and improved the ignition. At four o'clock the wind dropped, and in an hour the engine was started. While moving along, the idle cylinder was ejecting oil, and this, together with the fact that it had no compression, made me hope that broken piston-rings were the source of the trouble. It would only take two hours to remove three cylinders, take one ring from each of the two sound ones for the faulty one, and all might yet be well!

These thoughts were brought to a sudden close by the engine, without any warning, pulling up with such a jerk that the propeller was smashed. On moving the latter, something fell into the oil in the crank-case and fizzled, while the propeller could only be swung through an angle of about 30°. We did not wait to examine any further, but fixed up the man-hauling sledge, which had so far been carried by the air-tractor sledge, and cached all except absolute necessities.

We were sorry to leave the machine, though we had never dared to expect a great deal from it in the face of the unsuitable conditions found to prevail in Adélie Land. However, the present situation was disappointing.

Having stuffed up the exhaust-pipes to keep out the drift, we turned our backs to the aero-sledge and made for the eleven-and-three-quarter-mile cave, arriving there at 8 P.M. There was a cheering note from Bage in the "Grotto", wishing us good luck."

The Western Party then went on a two month sledging trip, and on their return saw the air tractor again:

"After continuing for about a mile Hodgeman told us to stop, flung down his harness and dashed back to the sledge, rummaging in the instrument-box till he found the glasses. "Yes, it's the aero plane", he said. This remark took us by surprise as we had not expected it for eight miles at least. It was about midnight--the time when mirage was at a maximum. Consequently, all agreed that the machine was about twelve miles away, and we went on our way rejoicing, steering towards the Cathedral Grotto which was two miles south of the aero-sledge. After three miles we camped, and, it being my birthday, the two events were celebrated by "blowing in" the whisky belonging to the medical outfit.

On the 16th the weather was thick, and we marched east for ten miles, passing a tea-leaf, which it was afterwards found must have come downwind from the Grotto. For eight hours nothing could be done in thick drift, and then, on breaking camp, we actually came to a flag which had been planted by Ninnis in the spring, thirteen miles south-east of Aladdin's Cave. The distance

to the air-tractor had been over-estimated, and the Grotto must have been passed quite close.

We made off down the hill, running over the crevasses at a great pace. Aladdin's Cave with its medley of boxes, tins, picks and shovels, gladdened our eyes at 10 P.M. on the 17th. Conspicuous for its colour was an orange, stuck on a pick, which told us at once that the Ship was in."

The frame was recovered in Jan 1913 by Capt. Davis of the Aurora:
"When Dr. Mawson's party was a week overdue, I considered that the time had arrived to issue a provisional notice to the members of the Expedition at Commonwealth Bay concerning the establishment of a relief party to operate from the Main Base. A party of four left the Hut on the 20th (20 January 1913), keeping a sharp look-out to the south-east for any signs of the missing party. They travelled as far as the air-tractor sledge which had been abandoned ten miles to the south, bringing it back to the Hut."

Was the Air Tractor Vickers No1 or Vickers No2?
There has been some discussion about the designation of the air tractor – whether it was the first or second Vickers plane. In fact it was originally No2, but was promoted to No1.[2]

"...A.R. Low [the designer of the Vickers-R.E.P No.1 Monoplane] was phoned by Bertie Wood, who asked him to go to Brooklands to watch test flights being conducted by Robert Fenwick and Lieut. H.E. Watkins acting on behalf of Dr. Douglas Mawson, to whom Captain Wood had sold the next Vickers-R.E.P. for the following year's Australian Antarctic Expedition. Fenwick took off with an abnormally sharp climb, turned sharply at the end of the aerodrome, stalled, and spun half a turn in the ground. Vickers had quickly acquired their first repair job....."

Herbert Wood did not let it be generally known that the first machine had crashed. No.2 was quickly substituted and re-designated No.1, and then sent to Australia for Mawson. In short Mawson ordered the No.2 but owing to the crash of the real No.1, the second aircraft was renamed as the No.1.

References
Further references to Mawson's plane can be found in:
Moments of Terror: The Story of Antarctic Aviation: David Burke, NSW University Press (1993)

[2] Harald Penrose "British aviation - the pioneer years" - p.308

THE SEARCH FOR THE AIR TRACTOR AT CAPE DENISON

The air tractor had been abandoned on the shores of Boat Harbour when the Mawson Expedition finally left in 1913. By this time the engine had seized, and the tractor idea had been abandoned. The engine, propeller and associated useful items were removed and returned to Australia, and the frame was left on the ice. A third seat had been added, and this was found and catalogued by Anne McConnell in 2008 on the other side of the harbour (see photo by Dr Tony Stewart in 2008 report). It was cut from the frame sometime before leaving, and tells us nothing about the position of the frame.

Figure 3: Bickerton with the air tractor. Note third custom-built seat which was cut from the frame, and recently found at Cape Denison among the rocks across the harbour. The frame is at least 2.5m tall.

Remains of air tractor seat found and catalogued in 2008 by Anne McConnell. The seat was found on the north eastern edge of Boat Harbour about 200m from the frame. Note the remnant of canvas on the back of the wooden platform. (Photo: David London).

Mawson did finally get into the air in Antarctica in 1929-1931.
Mawson made to the Antarctic coast aboard the Discovery during 1929-1931 (the two BANZARE voyages), and visited Cape Denison for an overnight stay. He took two pilots Eric Douglas[3] and Stuart Campbell, both of whom took pictures of the area, and of the Air Tractor frame, which were used in this report.

Eric Douglas comments in his diary:
"Flying was carried out only on fine days, generally the first fine day after a blizzard. Sea conditions generally ideal, sometimes slight ocean swell on, which made it difficult getting off. Air conditions perfect, practically no bumps, although some were felt when flying over the Antarctic coast. Engine ran splendid, developed full power and oil pressure remained steady (38 to 40 lbs/sqin). Machine controls gave no trouble and the machine behaved quite normally in the air ie stalling and climbing speeds as designed. Lowest air temperature experienced was 15 F at 4200 ft. With the usual winter flying clothes on and good woollen underwear the low temperature was hardly noticeable.
Of course our flights were of short duration, generally about one hour, and it was midsummer."
"The engine would start up when doped with a mixture of 2/3 petrol and 1/3 ether. But generally it was heated with warm air (conveyed through canvas flue from the boiler room) for about an hour previous to starting up. Temperature of engine raised to 45 F. Starting then quite easy and doping not necessary. (Crank case in air vent covered up. Oil pipes lagged with asbestos)"

Figure 4: Mawson finally takes to the air in Antarctica in a Gypsy Moth (RAAF) VH-UDL on the BANZARE voyages with Eric Douglas and Stuart Campbell as pilots.

Four images from the 1931 visit showing the Air Tractor Frame
The following two pages show the valley at Boat Harbour with the air tractor in 1931. The pictures are all from the collection of Sally Douglas, Eric Douglas' daughter. They clearly show the position of the frame and the level of the ice at the time of the visit.

[3] Sally Douglas, daughter of Eric, has kindly given permission for some photographs from her collection to appear in this report, along with an extract from Eric's diary.

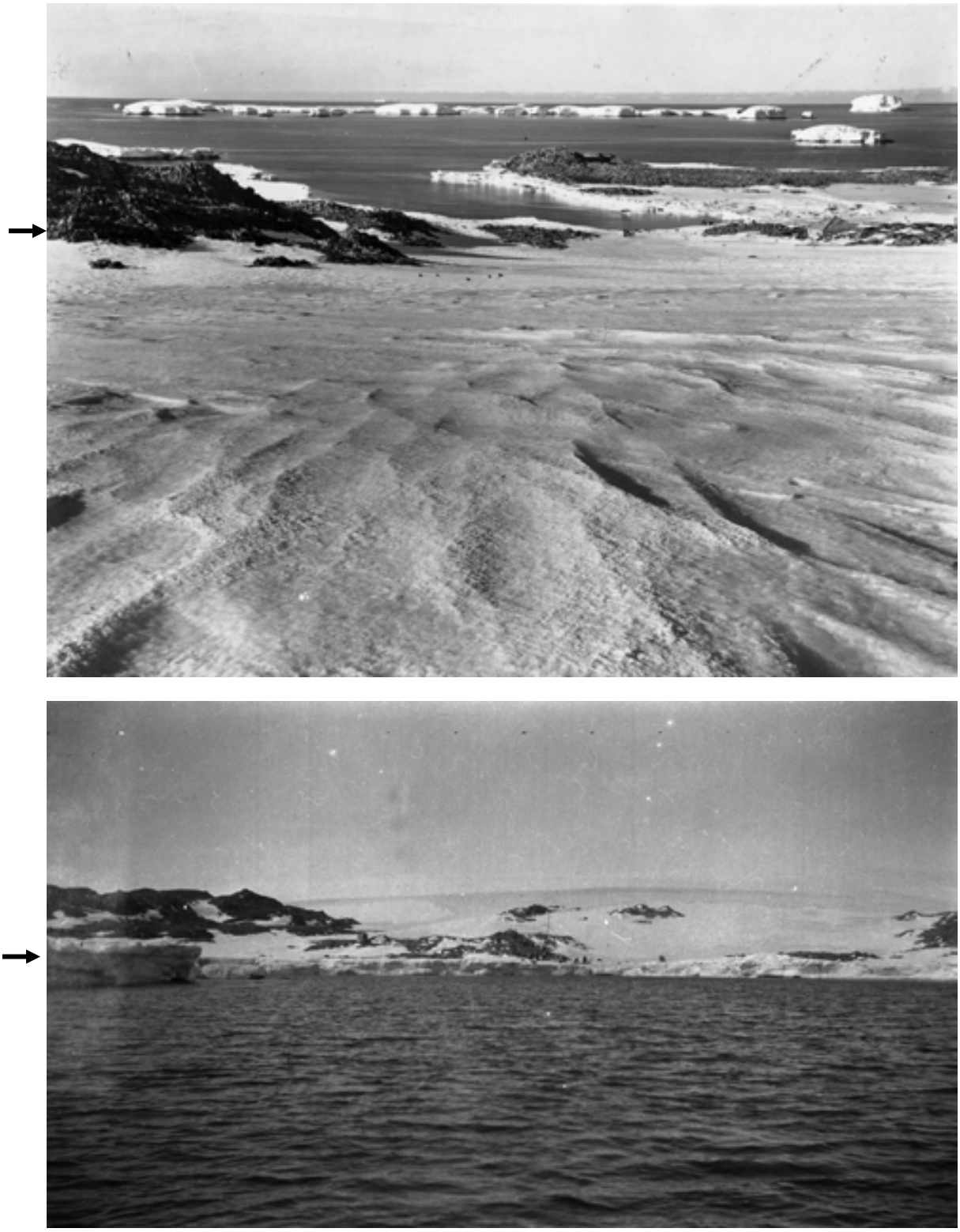


Figure 5 Pictures of Mawsons Huts and valley 1931 by Eric Douglas from South (top) and North (bottom). The Air Tractor frame can be seen near the harbour in the top image, and as a small dot under the right edge of the double rock outcrop to the right of mid-photo of the bottom one. (Photos from Sally Douglas collection)

Figure 6 Pictures of Mawsons Huts and valley 1931 by Eric Douglas from East (top) and West (bottom). The Air Tractor can be seen just above the front of the hut in the top image, and in line with the transit hut in the bottom image. (Photos from Sally Douglas collection)

After 1931

The French visited Cape Denison from around 1959 onwards as they established their presence at Port Martin, and Dumont D'Urville. It is not recorded (at least in Australian archives) exactly what they did when at Cape Denison, but clearly they did not move the frame.

The next Australian contact was in 1976 when AAD photographer Bob Reeves visited, and took the last photograph we have of the frame nearly buried in the ice (see below). Geologist Neil Young visited the following year with Dick Lightfoot and made a comment in a fax sent on 26th February 1977, from the Thala Dan. They had visited Cape Denison by helicopter from Dumont D'Urville, for approximately 5 hours. In the telex Young states "Aircraft parts as photographed last visit have now been carried to sea by movement of ice in this area, have recovered one aircraft wheel and what is possibly ice control skid for RTA and restoration." Both of these items are now in the AAD library at Kingston. It is possible that the ice control skid is actually the rudder from a boat which was wrecked later in Boat Harbour.[4]

The Oceanic Research Foundation under Dr David Lewis visited Cape Denison in summer 1981. The engineer, Dr Don Richards, and the cameraman Mal Hamilton, are certain there was no air tractor visible, and the photo at the end of this report supports their statements (figure 38).

Bob Reeves visited Cape Denison again in 1987, and remembers[5] that the ice level was higher up the rocky outcrops. He was interested in the frame and looked around to see if he could see any sign of it, but could not.

A number of other visits have taken place over the years, but (so far) the last documented sighting of the frame is in 1976; which begs the question of where it is now. The frame was a large steel object (at least 6 x 2 x 2 m), and it would only have come out of the ice if it had melted, or the ice moved. The ice is not glacial at the edge of Boat Harbour, and does not appear to move, so it seems unlikely that ice carried the frame away.

The assumption on which this report is based:

The current search is based on the assumption that the frame is unlikely to have shifted far from its position in 1913. The reasoning behind this assumption forms the rest of the report.

THIS REPORT details the process of conducting the search for the frame of the Air Tractor during the 2008-9 expedition. Ground Penetrating Radar (GPR) was used to visualise objects up to 5m below the surface of the ice. Patterns in the scan maps which were thought to represent the air frame turned out to be layers of hard ice, and the frame was not found despite a trench being dug in the 'right' spot to nearly 3m.

[4] Personal communication, Andie Smithies, AAD Librarian
[5] Bob Reeves, personal communication

Details of the operation of Ground Penetrating Radar (GPR) are in a separate section for those who wish to know the technicalities. However, essentially it is a way of forming a picture of the 'shape' of the ice (rather like an echo sounder on a boat) at different depths. If an object is present, and big enough, it will show up. One of the problems with using GPR for this sort of search however, is that it will show up any discontinuity, including a change to a layer of hard ice. These discontinuities can look very like a buried object.

However, the fact that the frame was not found leads on to an examination of why it wasn't. Using evidence from photographs of the landscape, and from weather data, a current position can be deduced. This should form the basis for another search next year, perhaps using different equipment.

FINDING WHERE THE AIR TRACTOR HAD BEEN FOR 64 YEARS

The first search, including digging a trench, did not find anything. I decided to start from scratch with the pictures of the frame given to me by Dr Tony Stewart, and derive a new position for the frame.

This section details the way in which the pictures were used to derive a precise position for the frame. This position is absolutely crucial to everything that follows, since the searches and the hypotheses about the frames present position depend on knowing where it was when it was last seen. The images in the text should be large enough to allow anyone else to check the reasoning, and to find the position again.

Note that none of this uses GPS coordinates to specify a position. GPS is notoriously inaccurate at pinpointing objects, despite what the makers say. Using differential GPS certainly helps, but it was not convenient to set up a DGPS system. Land based reference points are always accurate and are likely to last a long time.

Estimating the position of the air tractor from transits.

In order to accurately estimate the position of the air tractor, comparison was made between photographs from 3 sources (all supplied by Dr Tony Lawler prior to the trip to Cape Denison). These are pictures from 1912, pictures from the 1931 visit by Mawson and S Campbell and the 1976 visit by Bob Reeves.

Careful study of the pictures enabled three transits to be developed as shown on the Google Earth picture below:

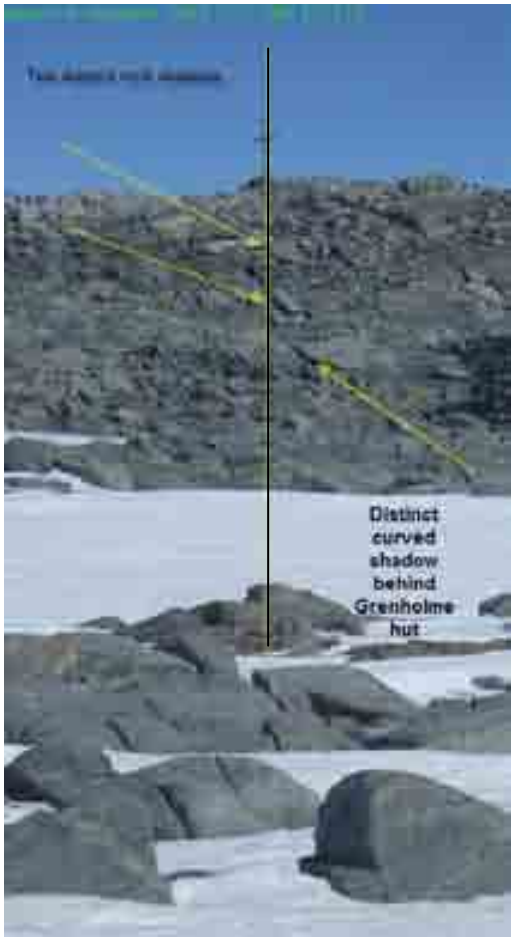
Figure 7 : Google earth picture of Cape Denison showing the three transit lines (white)) derived from a study of images from 1931 and 1976. The lines were used to pinpoint the position of the air tractor frame.

The three transits were tested on the ground and found to be very sensitive to translation, well separated from each other, and readily identifiable. They were therefore considered to be reliable indicators of the position of the air tractor frame. Given that it was known (see appropriate section below) that the ice did not move in the area (ie it is not glacial ice) then the position was accepted with confidence. This position is vital to all search efforts. A description of the three transits follows:

1) transit looking East

This transit is derived from the 1976 picture by Bob Reeves. It shows the frame about 500 mm out of the ice, and the transit points are the Proclamation Pole on the hill, and the NW corner post of the small porch on the workshop of Mawsons Hut.

2) transit looking West

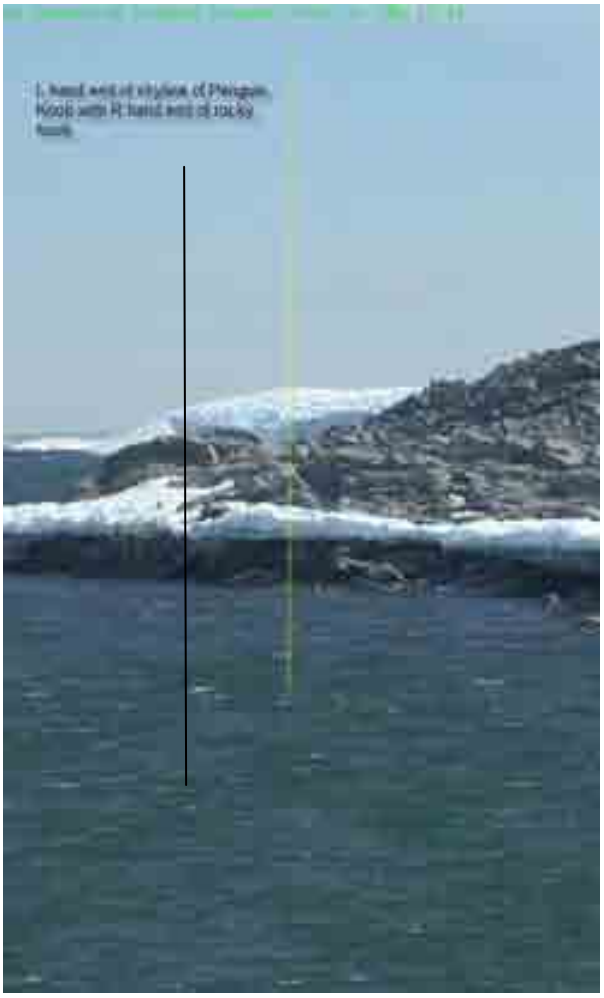


This picture is taken from the 1931 expedition by S Campbell. The rock shadows provide the transit in conjunction with the Memorial Cross – it is necessary to see the rock face in sunshine at about 1pm to match the original photo.

The transit points are the Memorial Cross, and two distinct rock shadows on the hillside. The curved shadow behind Granholm Hut provides a good orienting feature.

The triangular rock at the bottom right of the picture is an obvious feature which appears on other photographs, and proves useful to orient the view.

3) *transit looking North*



This picture is from 1931. The rocky knob is about 100m in front of Penguin knob, and the transit line is quite easy to see, though it looks hard in the picture.

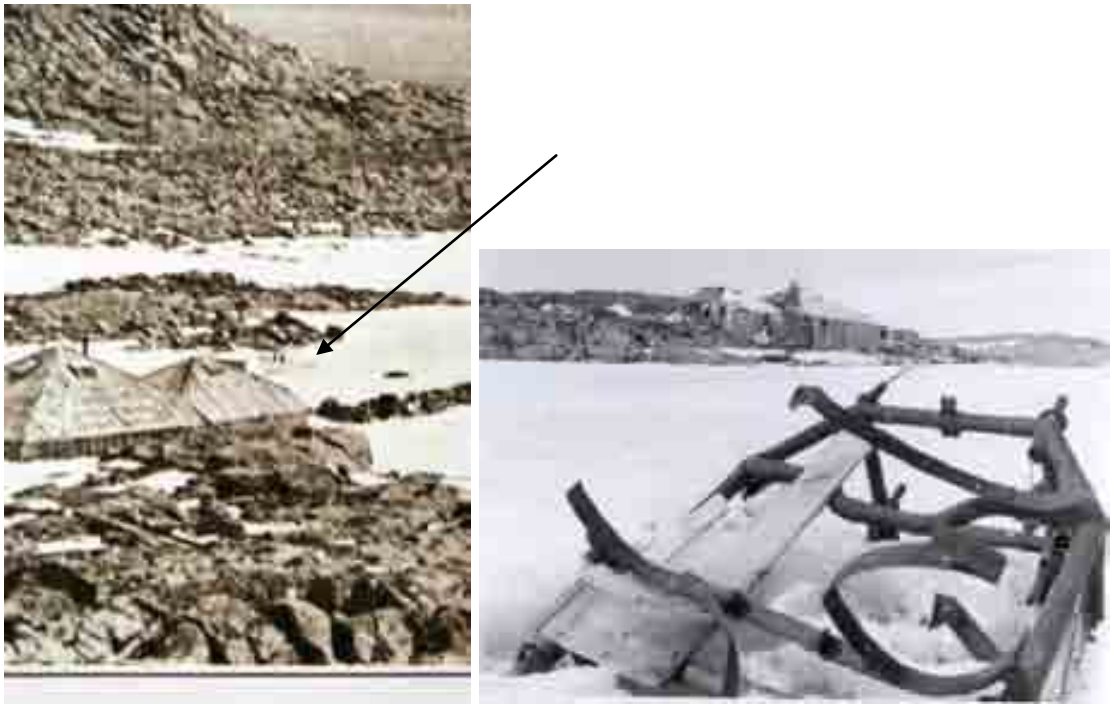
Using these three transit lines, it was possible to find a place on the ice where the frame used to lie. In practice it was relatively easy to find the spot, providing the shadows on Memorial Hill are right direction, which means waiting till about 1pm. The transits also prove to be sensitive to movement – it only took movement of half a metre or so in any direction to affect the transit lines.

Establishing whether the ice under the plane moves

The next step in the search was to decide whether the ice moves in the area. The glacier is about 500m up the hill, and the ice on either side of the Cape Denison area is constantly moving. However, it was shown from the photographs that the plane did not move in at least 45 years.

Obviously it is vital to know if the plane is buried in *glacial* ice, in which case it would be expected to move slowly toward the sea. From pictures taken in 1912, 1931 and 1976 it is clear that this is not the case:

Figure 8: the airframe in 1912 This photograph is taken from a few metres north of the place in the 1976 image below. Moving the camera into the 1976 position would give exactly the same transit as the 1976 picture. The frame is already partly buried in the ice. [Note that the third seat has been cut from the frame, which establishes that its 2008 discovery on rocks across the harbour is not related to the position of the tractor.]



(1931) *(1976)*

Figure 9: taken from 1931 and from 1976 – the photographs are taken from points almost exactly opposite each other (the air tractor frame in 1931 is shown by an arrow). No movement of the frame is seen in 45 years, supporting the proposition that the ice is not glacial in this area. Comparing the 1976 picture with the 1912 picture in figure 6 shows there has been no movement in 64 years.

Capacity of the Ground Penetrating Radar to sense the plane:

Ground Penetrating Radar is particularly sensitive to metal objects. Two aerials were used – 250 Mhz and 500Mhz. These have an effective depth of about 4m and 5m in ice, and a resolution of 45 cm and 25cm respectively. A thin rod sideways to the aerial would not be seen, but lengthways it would. The air tractor frame is made of steel tube about 40mm x 1.5mm. Individual tubes would be too small to be seen when crossing the beam, but the whole frame is made of tubes and metal straps oriented in many different directions. It is 6m long, and it is unlikely that either aerial would miss the aggregate mass of metal.

Figure 10: from BANZARE 1931: indication of the amount of metal in the airframe. Pilot Eric Douglas is seen sitting in the frame in the right hand picture, on the left an unknown man (possibly Frank Hurley) gives scale to the frame. (Photo Sally Douglas collection)

Figure 11: the amount of metal in the frame should make it visible to radar using either the 250 Mhz or 500Mhz aerial. The lower picture shows Bickerton at work on the frame in the 'aircraft hangar' on the west side of the main room of the hut.

Is the air frame likely to be on rock?

One of the theories about the air frame was that it had sunk down to the rock, and was stuck there, sitting just below the surface. This was tested by comparing photographs taken when there was a big melt which exposed the subsurface features in the valley. In 2002 Dr Ian Godfrey, Expedition Leader, took a number of pictures of the landscape, some of which are used here. He did not see any sign of the air tractor in 2002.

After the position of the frame had been found from the transit lines we knew where the frame had been (at least up to 1976). We could then place an object of similar size (a quad bike and trailer) at the spot, and, comparing the pictures; effectively locate it back to the melt of 2002 to see if the frame was on or near rock.

Photographs were taken from the same place, using the same lens, and matching the images. This wasn't nearly so easy as it sounds, and I would like to acknowledge David London, photographer, who provided his expert assistance in this part of the project.

At the end of this exercise it was clear that the air tractor frame had been sitting close to a melt creek, and that it was in an area of ice – not rock. We now knew three things:

1) that it was not visible in 2002,
2) the height of the frame was at least 2.5m,
3) the depth of ice in 2002 was lower than present day by about 1m.

Dark objects warm up on the ice surface, and sink remarkably fast – we were constantly digging out our equipment, especially after warm days. Therefore the frame, if it were present, would have sunk to at least 1m below the present

day surface level. A rough estimate of the rate at which it was sinking was hard to make – careful analysis of the photographs showed it had not sunk much in the 19 years between 1913 and 1931, but it had clearly sunk faster in the next 45 years. A rough estimate was 40mm per year from 1931 to 1976 when it was last seen. At that rate it should be a further 1m lower by the time we searched for it in 2009, which would put the top of it about 500 mm below the surface.

And as it turned out an object looking very like the air tractor frame was found 2.5m down on the radar scan, but there was nothing near the surface.

The air frame and the melt creek

One prominent feature of the 2002 photographs, and noted by Ian Godfrey, was that in 2002 the ice melted. He said there was 'water everywhere', with a large running creek down the middle of the valley, and exposed rock and artifacts everywhere. The size of the creek and the position of the frame, are very significant in a later discussion of its present position.

The following images show the melt of 2002 compared with 2008, and the ice level from 1931.

2002 from SE of the hut, showing Boat Harbour *(Photo: Ian Godfrey)*

Figure 12: Extensive exposed rock is seen in 2002 (top). The air tractor frame position is represented by the quad bike and trailer seen in the lower image above the hut roof (arrowed). It can be seen that the frame would have been close to the edge of the harbour in a melt. (Photo: David London).

(Photo:Ian Godfrey)

Figure 13: Facing Memorial Hill. The depth of snow cover was estimated by measuring the prominent rock in the middle of the picture, and is about 1m higher in 2008 (lower picture). The quad bike and cart represent the place where the air tractor was estimated to have been. (Photo: David London).

(Photo: Ian Godfrey)

Figure 14: Facing S across Boat Harbour. The air tractor position is arrowed and can be seen to sit almost over the 2002 glacial melt stream. Note exposed rocks in upper picture (2002). Compare the level of snow 2002 with 2008 (bottom). (Photo: David London).

Figure 15: If the air tractor had sunk in the ice, and was still there, where would it be? This is a general view of the bay seen facing N from the hill behind the huts. The images are from 3 different years. The air tractor is seen in the upper picture (1931) and the quad bike (arrow) in the lower one (2009). The middle picture is from 2002. The ice level in 2002 is about the same as in 1931, and about 1m lower than 2009. The frame is about 2.5m high.

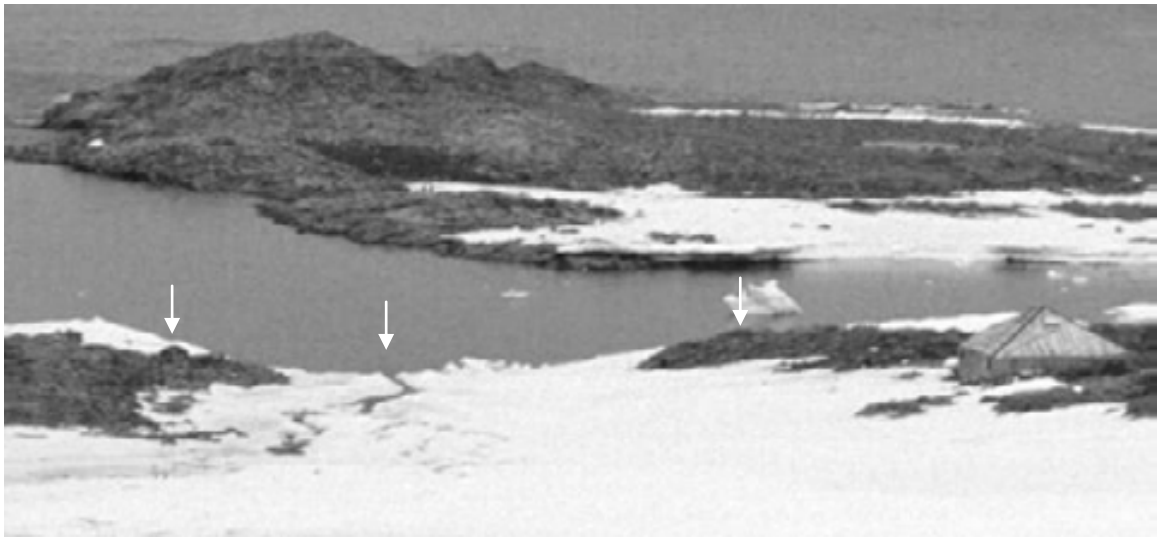
A magnified image of the air tractor in the top picture shows that it had already sunk about 1m down in the ice by 1931. By 2002 it was not visible. Therefore the top of the frame would be at least 1m below the 2009 surface, and the bottom about 3.5m below it.

We found a radar anomaly at 2.5m, and dug down to the sea level at 2.7m but found no frame.

(Photos: Eric Douglas 1931, Ian Godfrey 2002, David London 2009)

The air tractor frame and the melt stream

The position of the air tractor relative to the melt stream is important, as will be seen later, in making an estimate of its present position. It is likely that the ice melted around the frame sometime after 1976. If the frame was sitting more or less in what would have been a substantial watercourse, and this in turn fed into a channel in the rocks, then it is probable that it was washed, or fell, into the channel – where it remains now.



This is a picture of the important area from the 2002 image (above) showing the melt stream. Note the prominent rocks on either side of the stream (all arrowed) which are used to determine the position of the frame using the 1931 picture below. The frame was in the melt stream, suggesting that a larger melt creek would have directly affected the frame. (Photo: Ian Godfrey)

Three pictures, all taken from the hill toward the South allow a precise placement of the air tractor. A picture taken in 1931 by Eric Douglas of the frame and the harbour (below) is compared with Ian Godfrey's 2002 picture of the snowmelt (above), and this year's picture of the transit-line cross (below). The exact place from which the pictures were taken varies, as does the focal length of the camera lens so it is not possible to directly superimpose the images as has been done above. However, prominent rocks can be identified in all three pictures. These rocks are in line with the Air Tractor, and thus at the same focal distance from the lens. These points can therefore be used to define a proportional scale which is used to compare the images, and thus to place the tractor relative to the stream.

Figure 16 This picture from 1931 clearly shows the air tractor near the edge of Boat Harbour (photo Sally Douglas collection)

Figure 17 Picture taken this year showing level of ice, identifiable rocks in the same focal plane, and the air tractor position represented by the quad bike.

Sastrugi and its effect on Ground Penetrating Radar

The area where the search was carried out was subject to extensive sastrugi (wind-blown frozen 'waves'). It was clear from the first search that the radar unit was forced to rock back and forth when traversing the sastrugi, so it was decided to flatten them out as much as possible before the second search to eliminate any possible error.

Accordingly a large area encompassing the proposed new searches was flattened using a device built with the help of Ben Burdett, Carpenter. This was remarkably effective, and soon provided a relatively smooth, gently undulating surface.

Figure 18 sastrugi disturbed the stability of the radar aerial (Photo: David London)

Figure 19: clearing sastrugi with a custom made cutting implement (Photo: David London)

Figure 20 : smoothed sastrugi gives clear surface for second radar scan. Ben Burdett (front) and Chris Henderson (rear) demonstrate different opinions on how hard it is to pull the cart. (Photo: David London).

THE SECOND SEARCH USING GROUND PENETRATING RADAR

This section of the report deals with the second, more detailed search for the frame. Results from this scan were used to determine where to dig a trench. As it turned out what we found was an ice layer, not a frame. But what we also found was a probable channel in the rocks where the frame could be today.

GPR scan shows reflections consistent with the airframe

The raw data from the GPR equipment gives a 2D representation of objects below the surface. In effect it is rather like an echo sounder in a boat, except echoes are visible all the way down whereas an echo sounder only shows the bottom (and perhaps some fish).

The second scan consisted of two overlapping 17m circles, which covered a large area in the vicinity of the estimated place of the air tractor. The overlap was where the air tractor could be. The next figure shows the GPR output after it had been filtered to reduce extraneous data such as the ground echoes, and enhance deeper radar reflections which have a tendency to fade out.

The features of this scan are the two bands at 1-1.5m and 2-2.5m. Within these bands can be seen recurring ‘bumps’. The repetitive nature of the echo is a feature of the spiral scan, since obviously every time it goes around again the radar unit will pick up the same feature. In order to put this together in a contour map, the trace at 2-2.5m was averaged and the result plotted as a 2D

map of the strength of the signal. What this does is in effect; gives a contour map rather like a topographical map, of the radar reflections.

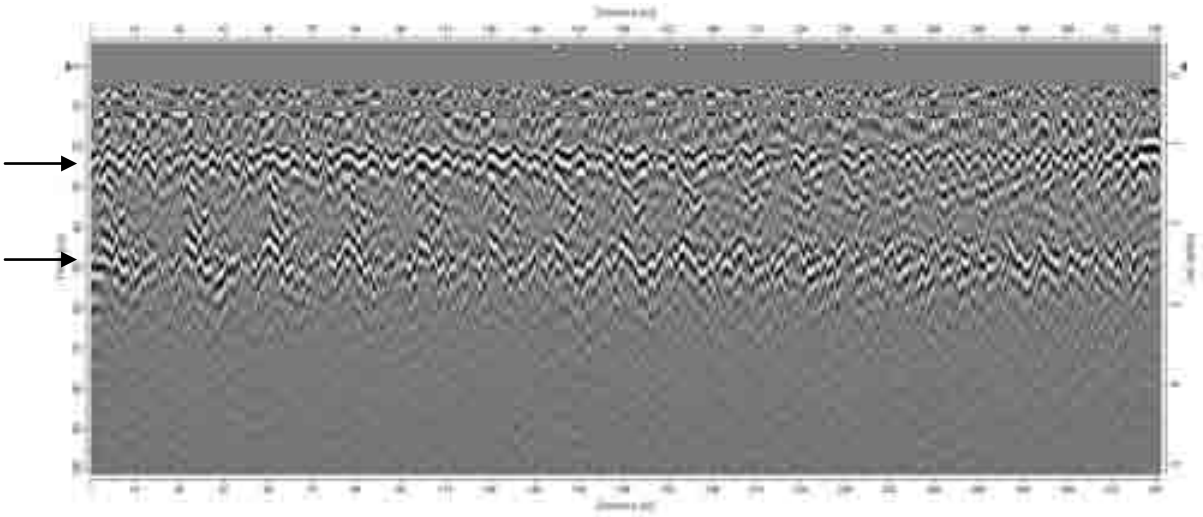


Figure 21: Processed GPR data showing two bands of significant radar echoes. The deeper one corresponds to the level the plane could be at, and showed features consistent with an elongated frame on the contour maps (see below).

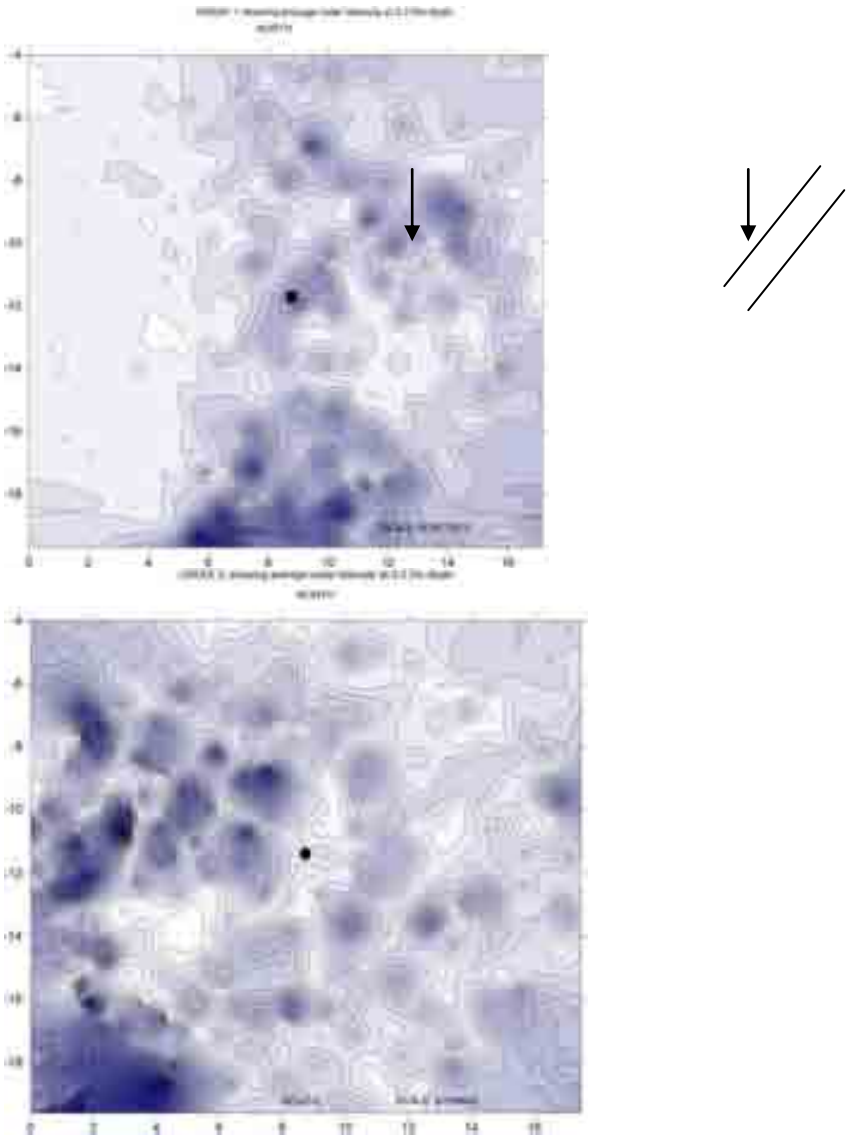


Figure 22:
Contour maps of two overlapping 17m scans provide a picture of the radar reflections at about 2.5m depth in the ice over a large area of about 25 m x 17 m. The point in the centre is the pole around which the rope winds in a spiral. The spot where the transects crossed (indicating the Air Tractors' position) is shown by vertical arrows. A 3mx 2.7m trench was dug at right angles to the main area of interest (shown approximately by the slanting lines).

Digging the trench

Having established the estimated position for the air tractor, and got what looked like a significant echo of about the right size, an exploratory trench was dug down to the level of interest.

Figure 23: start of second dig. The coats hang on the post at the centre of the circular search area. The small orange tag in front of the chainsaw (arrow) is the spot where the three transit lines cross and represents the position where the air tractor frame was until its last sighting in 1976. (Photo: David London)

Figure 24: end of the dig. The dig was stopped below sea level. These pictures give an idea of the final size of the hole. (Photo: David London)

Digging was done using an electric chainsaw (lubricated with vegetable oil), and a shovel and crowbar to lever out blocks of ice. (Chainsaws blades can be made for faster ice digging by filing off half the kickback tangs[6]). The dig took about 8 hours spread over two days. At about 1.25 m a layer of hard ice was encountered consistent with the melt of 2002, and shown on the radar scan.

Figure 25
Layer of clear hard ice encountered at about 1.25m which is shown on the radar scan (Figure 22:) and at a depth consistent with the ice level estimated from pictures of the 2002 melt.

Hard ice with seaweed found at the bottom of the trench implies a big melt

Near the end of the dig, at about 2.5m, another thick layer of hard ice was encountered. This layer continued down until the hole was abandoned at 2.7m when it was decided that the dig had gone below the layer at which the echo was seen. It was then thought that the echo represented variations in the ice layer which happened to look the right size and shape for the airframe.

It was significant that at this level the ice contained small fragments of faeces and bits of seaweed. The faeces could have been washed down from the southern hill, but the seaweed could only have come from the sea.

A surveyor's level was available, and the bottom of the hole was surveyed with reference to the benchmark AUS2030 which is at high tide level. The bottom of the hole was found to be at high tide level.

[6] http://www.icesculptingtools.com/modify_a_chain.htm

Figure 26: At the bottom of the trench a hard ice layer was encountered at about 2.5m (arrow). This layer contained seaweed and faeces and is at high tide level. The bottom of the hole shown above is at about 2.7m and consists of hard, greenish ice. The dig was stopped at this point as it was below the area of interest shown in the contour maps. (A metal detector, capable of penetrating a further 200mm showed no activity.)

This finding implies that, at some time in the past, a big melt had occurred, effectively removing the ice which contained the air tractor. The additional finding of a possible channel in the rocks is important, and is discussed next.

Sea surface at the edge of the scan

The large blank area filling the left third of the left hand contour map (Figure 22:) is interesting. The level of the contour map is at high tide level (established by surveying to the bottom of the trench), and hard ice with seaweed was found at this level consistent with the presence of seawater. Thus it is likely that the blank area represents smooth ice on the frozen sea surface.

The left hand edge of the contour map is hard up against the band of rock at the edge of the search area. If the area on the contour map represents the sea surface, then it suggests that the rocks go steeply down into the sea at this point. A photograph of these rocks taken during the melt in 2001 confirms this is the case.

Figure 27
The area of the search from the north looking across Boat Harbour. The white arrow shows the steep sides of the rock band which is consistent with the contour map in Figure 17, and suggests that the harbour dips down into a channel at this point. *(Photo: Ian Godfrey)*

Note also the melt creek entering the harbour at the same point. The estimated air tractor position is shown by the black arrow.

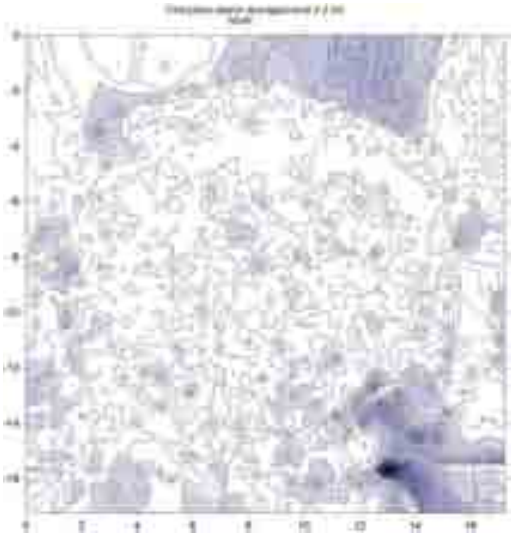
Putting the scans from the first and second searches together a hypothesis can be made regarding the topography of the harbour in this area. It seems likely that the air tractor frame was lying near a channel in the harbour which was close to its likely position should the ice melt down to the rocks. The significance of this is discussed later.

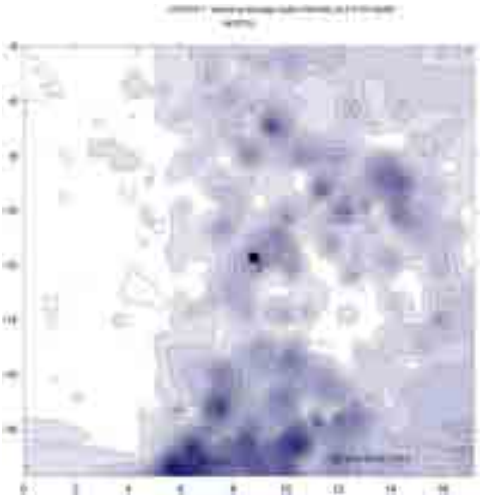
The scans from the first and second search are shown below in their approximate relationships. The interesting finding is that smooth ice seems to extend along the left hand border at a level which is known to be at high tide level.

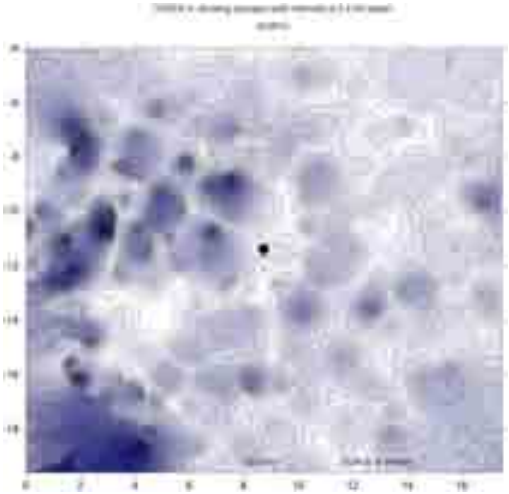
Figure 28: this page shows the three scans, which are averaged radar intensity data at 2-2.25m depth. They are in approximately correct relationship to each other, but not overlapping. The top scan is from the 500 Mhz aerial, so will show more detail than the two lower ones. The circular area in the centre of the upper scan is the actual scanned area.

Significantly at the 2.5m depth there appears to be a smooth ice surface extending to the left and northwards, and a rough ice surface to the right and southwards. This, when overlaid on the other two scans is consistent with a trench in the rocks covered with smooth ice. Rough ice is assumed to cover rocks to the right.

This is consistent with the shape of the rocks and ice seen in Figure 27.







The likelihood of a significant melt causing liquid water at the depth of the trench floor

This section is concerned with temperature data from Cape Denison and Dumont D'Urville in order to see if there is any evidence that temperatures were high enough to melt the ice surrounding the frame. It is known that a melt occurred in 2002, and it was assumed that the ice layer at found at 1.5m corresponds to this melt. Did a far bigger melt release the air frame from the ice?

Evidence was therefore sought from temperature records in East Antarctica, and specifically at Dumont D'Urville.

Temperatures before 1911

It is known that surface air temperatures over Antarctica have been rising during the past century, which has been attributed to global warming. The mean temperature increase is shown below[7]. Extrapolation backwards in time suggests temperatures were lower before 1960.

However, note that this finding refers to the entire continent of Antarctica, whereas the important temperature is the surface temperature at sea-level at Cape Denison, where no records exist except those from expeditioners and the installation of the Automatic Weather Station by the University of Wisconsin. Temperatures from 1970's and 1980's must largely be inferred from proxy records.

The following figure, taken from data about Antarctica as a whole, shows the gradual increase in temperature during the latter half of the last century. In reality it is not this simple however, because it is known that temperatures in parts of E Antarctica have been cooling since the late '70s and early '80s because of the development of the ozone hole (whereas they have been rising in W Antarctica)[8].

[7] Jones PD and Reid PA "A databank of Antarctic Surface temperature and pressure data" Climatic Research Unit, Univerisity of East Anglia, November 1999.

[8] Steig EJ et al "Warming of the Antarctic ice sheet surface since the 1957 International Geophysical Year" Nature 457, 459-462, 22 Jan 2009.

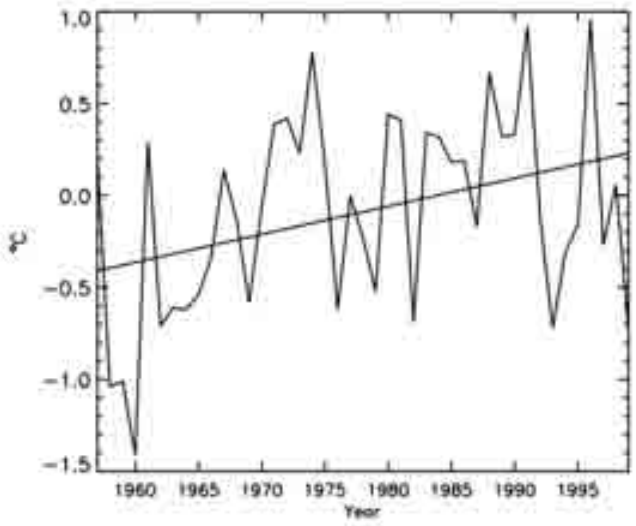


Figure 2: Time series of annual mean surface air temperature over Antarctica calculated as anomalies with respect to 1961-90.

Figure 29: Estimate of the rise in temperature over Antarctica during the last half of 20th Century.

Temperatures after 1976

In order to find out what the surface temperature at Cape Denison is likely to have been in the past 30 years, it was necessary to use data from Dumont D'Urville station, where records are available since the 1960s[9]. Temperatures over Antarctica tend to be recorded in different ways, mostly related to inland surface temperatures or vertical temperatures in the air column. Few records exist of sea-level temperatures, and the only data available is from Dumont D'Urville in the region of Cape Denison (see ref 2).

Temperature records from Dumont D'Urville are patchy up till about 1960, a continuous record is available from then onwards. This shows a marked increase into the 70's, and a slight falling into the '90s (*Figure 25).*

[9] http://cdiac.ornl.gov/ftp/ndp032/

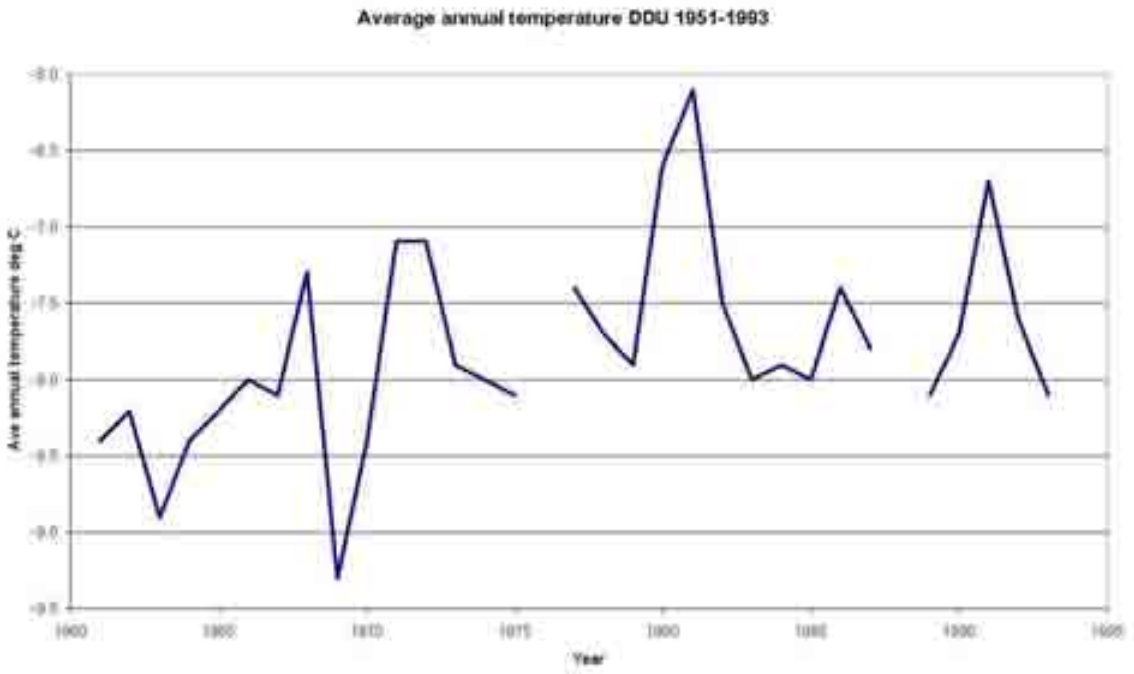


Figure 30: Average annual temperatures at Dumont D'Urville (ref 2 above) show that 1980 was a particularly warm year.

More important for melting of the ice is the maximum temperature found during the summer months of December and January. Records are available for those months from DDU 1955 – 1995, and this is shown in the next figure.

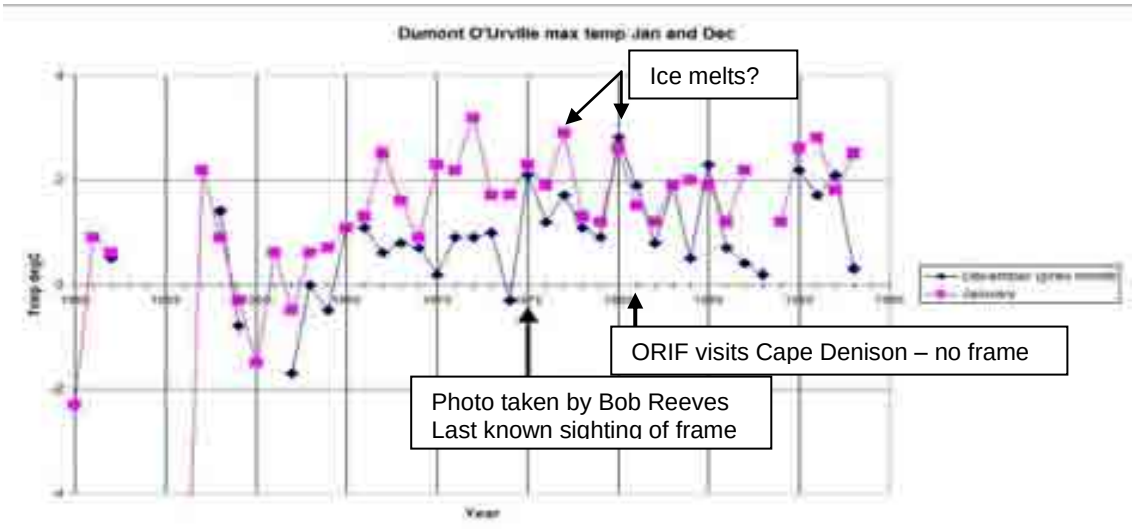


Figure 31: Maximum temperature in mid-summer for the two consecutive months of December and January at Dumont D'Urville 1955-1995. Note the temperatures are above freezing on a sustained basis from the early '70s. The visit by Reeves, showing the last known position of the air tractor, was in 1976 (arrow). Five years later, in 1981, the Dr Lewis ORIF expedition finds no air tractor. 1977 and 1980 have about 7 weeks of temperatures around zero at DDU, which means well above zero at Cape Denison.

The next consideration is how Cape Denison temperatures differ from Dumont D'Urville temperatures. Dumont D'Urville is situated next to the Astrolabe glacier, so will be expected to have somewhat colder temperatures than Cape Denison. There are two sets of data which show that this is the case. Records taken by Dr Ian Godfrey from this year[10] were compared with daily temperature records from Dumont D'Urville[11]

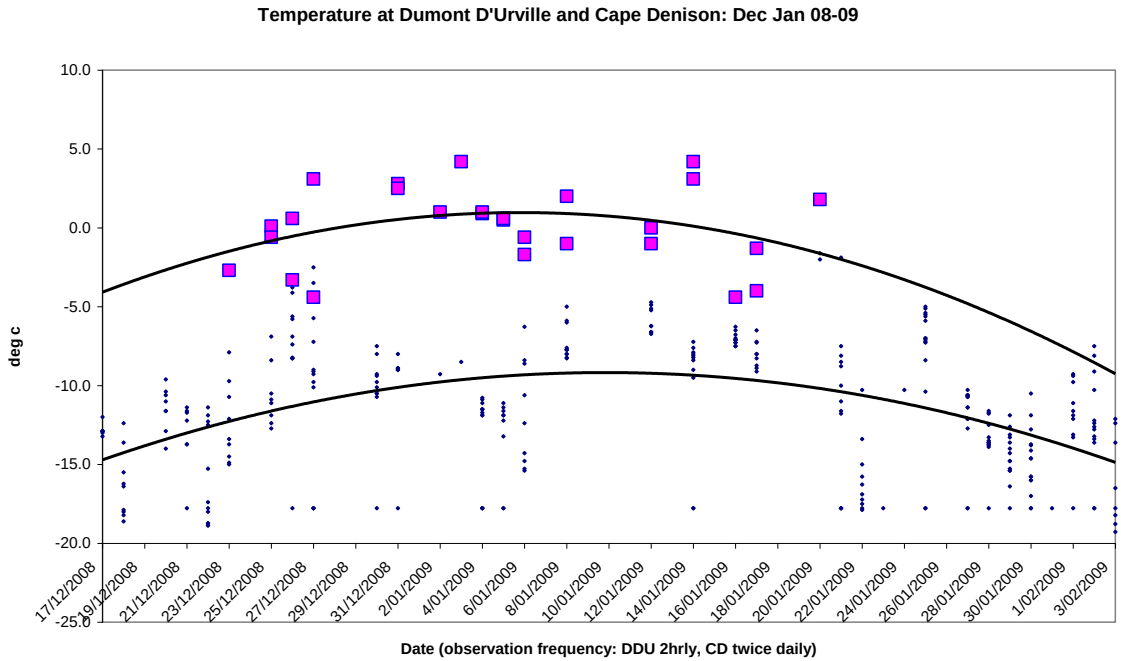
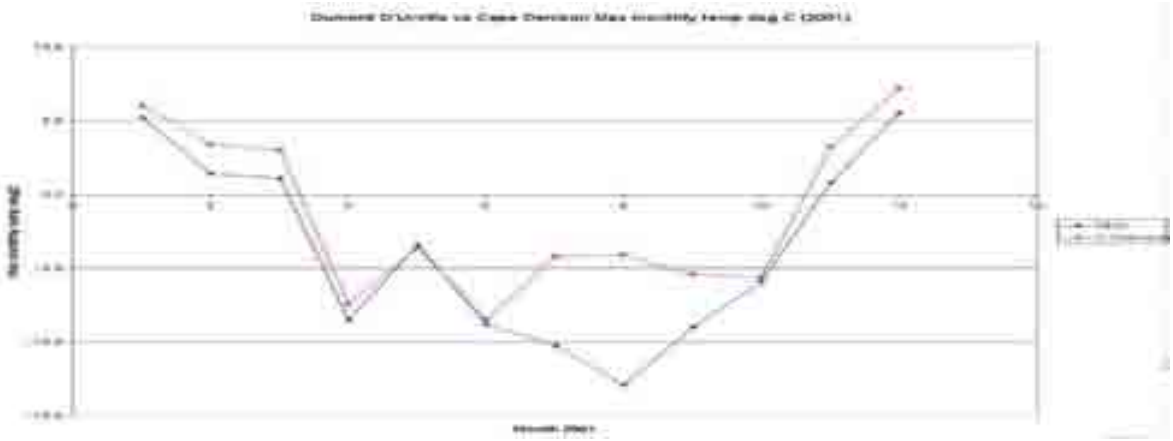


Figure 32: (above and below): Comparison of temperature records from Cape Denison (squares) with Dumont D'Urville (dots) shows that Cape Denison was up to 10 deg C higher than Dumont D'Urville. This is to be expected since DDU is on a glacier. A polynomial trend line has been fitted to both sets of data.

[10] http://www.mawsons-huts.org.au/cms/conservation-expeditions/blog/

[11] DDU daily records from;
http://weather.gladstonefamily.net/site/89642?tile=10;days=91#Data

Similar records for the whole year of 2001 from the AWS are shown below. The implication is that long term summer temperatures at Cape Denison are also higher, and in particular that temperatures in the late '70s could have caused a big melt.

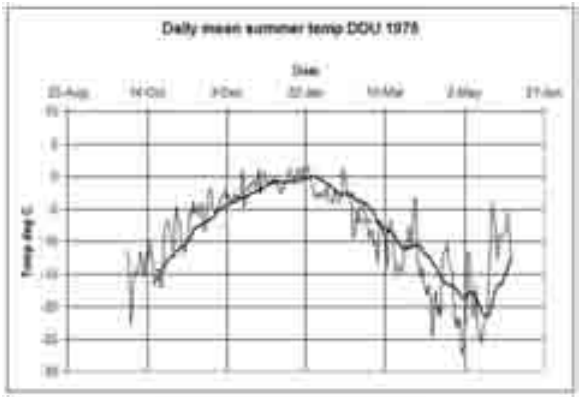


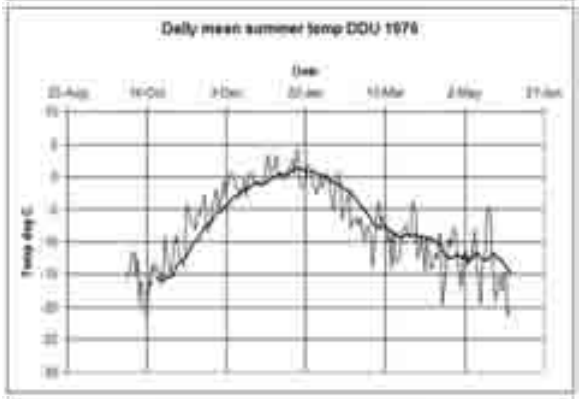
These data are consistent with the hypothesis that maximum temperatures at Cape Denison in the late '70s and early '80s were high enough to cause significant melting of the ice at some time during that period. It does not take long for temperatures above zero to start the ice melting, and in a couple days with temperatures around 5 deg the ice level sinks noticeably. A month or two may be sufficient to cause the air tractor to be released from the enclosing ice and be exposed to the wind and to gravity.

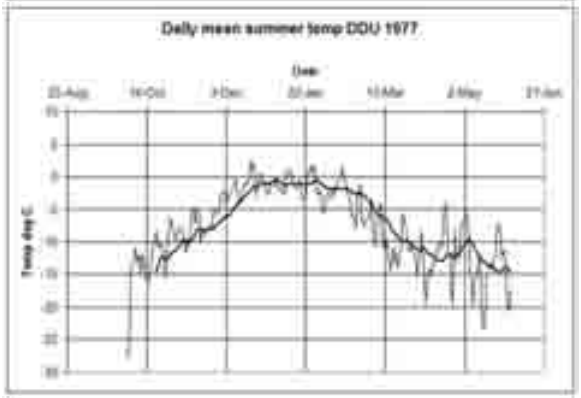
Temperature records from Dumont D'Urville suggest when the ice melted

Figure 33 (below) shows plots of the mean daily summer temperatures (1 October – 31 May) for the years 1975-1981[12]. It can be seen that a sustained temperature around zero was evident in 1977 and in 1980 for about 7 weeks, which would be enough to initiate a large-scale melt of the ice.

[12] Laurent Testut, via Antoine GUILLOT, INSU / Division Technique, Batiment Institut Polaire, FRANCE personal communication.


Daily mean summer temp DDU 1975
Date
Temp deg C


Daily mean summer temp DDU 1976
Date
Temp deg C


Daily mean summer temp DDU 1977
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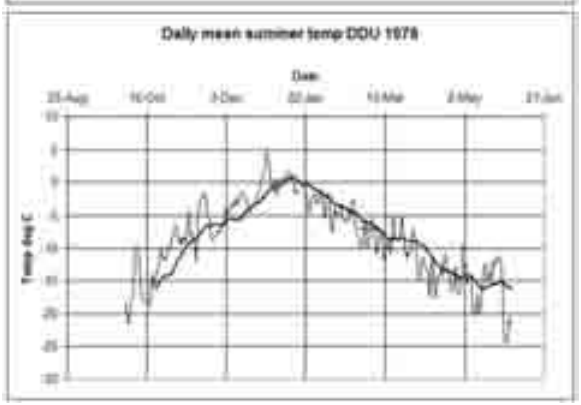
Temp deg C


Daily mean summer temp DDU 1978
Date
Temp deg C

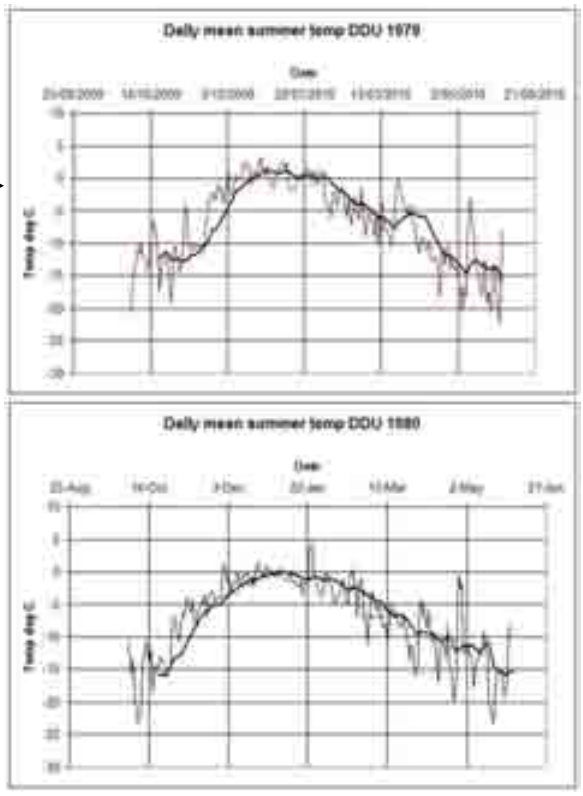


Figure 33 Daily mean summer temperatures from Dumont D'Urville station between 1 October and 30 May for the years 1975-1981. A 20 day moving average has been applied to the data (heavy line). Note that each year shows a peak around 22 January except for 1977 and 1980 when temperatures around zero are sustained for a period of about 7 weeks. Since Cape Denison temperatures are higher (by up to 10 degrees) compared with DDU this is evidence in support of the hypothesis that a large-scale ice melt could have occurred sufficient to free the air tractor from the ice.

Amount of ice surrounding the air frame

It is worth getting in perspective just how deeply the air frame was buried. The picture from 1976 shows about 500mm of the frame sticking out of the ice. When compared with the earlier picture it can be appreciated how much ice surrounded the frame.

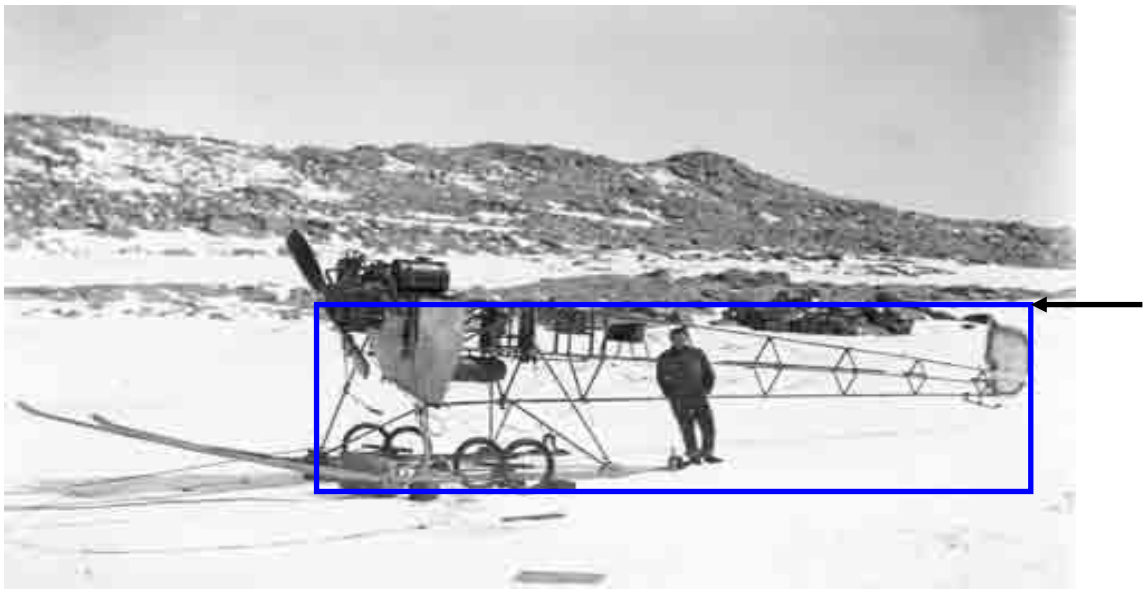


Figure 34: Comparison between the photo of 1911 and 1976 (arrow shows ice level) show the extent to which the air frame was buried in the ice. This is a huge amount of ice, roughly equivalent to the volume of a sea container.

The pictures from 1913 and 1931 show that the bottom of the frame was encased in ice. Essentially what this means is that the frame is not going to move unless it melts into the ice (or the ice is scoured away by the wind – discussed below), and furthermore, since the ice is not glacial, the only direction the frame is likely to go is downwards.

Comparison between the 1911 pictures and the 1976 picture give us an estimate of how fast the frame was sinking and overall it seemed to be travelling downwards at 50mm per year. This means that by now it would have theoretically travelled downwards about 1m deeper than in 1976. This is still well within the reach of the GPR scans, and, since it was not found, something must have happened between 1976 and 1981 when other visitors arrived.

The effect of wind on the frame

The winds at Cape Denison are the strongest ever recorded at sea level on Earth[13], and cannot be discounted as a factor in possible movement of the frame.

The tractor frame was relatively light – it was, after all, designed to fly, but the frame had little wind resistance since it was made of struts. If it had been freed from the ice by melting, or by the ice being scoured away, and was exposed to winds of the sort of strength recorded at Cape Denison, there are two possibilities:

[13] ***On the extraordinary katabatic winds of Adélie Land Wendler, Gerd; Stearns, Charles; Weidner, George; Dargaud, Guillaume; Parish, Thomas Journal of Geophysical Research, Volume 102, Issue D4, p. 4463-4474*** *http://adsabs.harvard.edu/abs/1997JGR...102.4463W*

a) It could have blown some distance into the harbour. It would then be likely to have been scoured out by the next years' ice breakup.

b) On the other hand the prevailing direction of wind during the summer months is about 120 degrees, which could have blown it north-westward, in the direction of the probable channel in the rocks. It could therefore still be stuck in that channel, or among the rocks.

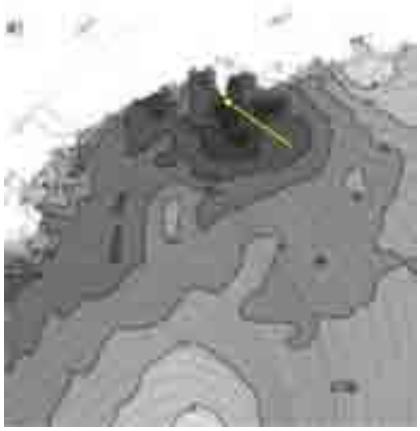


Figure 35: Wind speed estimates at Cape Denison. Arrow shows the estimated position of the air tractor frame and the direction of prevailing summer winds. The air tractor would be in the path of this wind if it were exposed in a summer melt. The air tractor happens to be in the area of the strongest sea-level winds ever recorded on Earth. If the ice melted and deposited the frame on the rocks, or if all the ice were scoured from the frame, and it were free to move, then the wind may have moved the frame.

Despite this possibility it should be remembered that the frame had been sitting on the ice at Cape Denison since it was abandoned in 1913. It is unlikely that all parts of the frame would melt out of the ice at once, allowing it to be blown in the wind at least 10m, more like 20-30m to the edge of the harbour. It would also have to fall into deep water which would freeze in the winter, trap the frame, and blow out to sea the next spring. Melting ice usually frees objects unevenly, so that something is always stuck. According to the report of Neil Young the ski attachments were seen and then disappeared, so the frame could not have skidded on its skis if freed from the ice.

Nevertheless, if somehow the frame did enter the harbour, and was encased in winter ice, it is very unlikely any trace of it remains, since all the ice in the harbour blows out to sea in the spring.

The behaviour of ice in Boat Harbour

The harbour ice reportedly forms from the bottom up as well as top down, and when the ice breaks up in summer it tends to take the whole lot with it and scouring the bottom of Boat Harbour. This has been reported to happen very quickly - within 3 hours[14]. This implies that the air tractor frame could have gone out to sea in a block of melting winter ice.

This could not have happened unless the frame was blown 20-30m from its 1976 position into the harbour.

The sudden breakup of the ice and scouring of the harbour does not happen with the ice around the edges of the harbour. This ice is slowly eroded by

[14] McIntyre D and M "Two below zero" p 189

seawater from the bottom up, leaving large overhanging shelves that eventually break off. If the frame is resting on the bottom, perhaps in a channel or on the rocks it is likely to still be there, protected from the scouring effect by the surrounding rock.

Figure 36: While the body of ice in Boat Harbour disappears quickly, scouring the bottom, the ice round the edges behaves differently. It erodes from beneath forming large overhangs which break away during summer. This picture was taken on 2nd Jan 2009. The air tractor search was behind the rocks, arrowed. If the frame had melted down to the harbour bottom in this location it would not have been taken out to sea in the early ice breakup. (Photo David London)

Position of the trench

The position of the trench was accurately measured by Peter McCabe and Ben Burdett (carpenters) with respect to the proximal corners of Mawsons Huts in order that it may be found again if necessary:

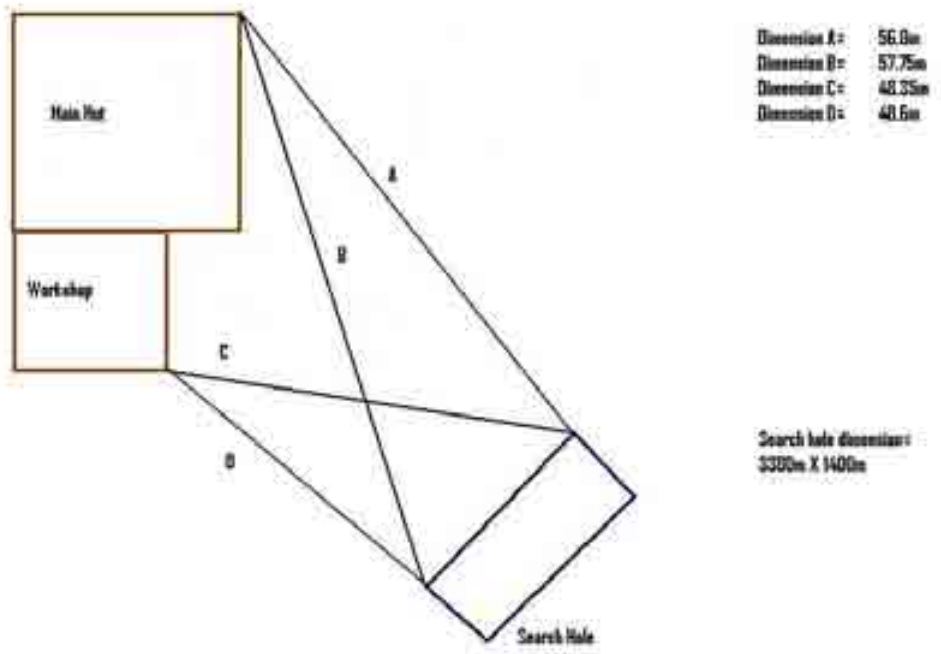


Figure 37: measurements of the trench referred to easily recognizable fixed features at Mawsons Huts.

Location of search areas

Figure 38: This shows the location of the search areas superimposed on a Google Earth picture from 295m. The total area searched amply covered the possible position of the air tractor. The circle closest the harbour was the first search, the two lower ones the second search. The cross at the intersection of the two lower circles is the estimated position of the air tractor frame. The exploratory trench we dug was approximately where the diagonal line is.

The channel found on the radar scans and discussed in the text runs approximately in the area of the long rectangle.

What happened after Bob Reeves' visit in 1976?

The last picture we have of the air tractor was in 1976. There was another expedition by Dr David Lewis in 1981/2 (Oceanic Research Foundation) in Dick Smith Explorer. Dr Don Richards, who was First Mate and Radio Operator on the 1981/2 expedition cannot remember any sign of the air tractor, and was sure they would have seen it, since they were well aware of the history of the Mawson expedition, and examined the area closely[15]. The Project Blizzard expedition in 1984 found no sign either.

The cameraman on that expedition, Mal Hamilton[16], conferred with Don Richards, and between them they were certain there was no trace of the air tractor when they visited. A picture taken by Mal of the area where the air tractor was in 1976 clearly shows unbroken ice (below).

Figure 39: Dick Smith Explorer in Boat Harbour in summer 1981/2. Note the level of the ice in 1981. It is roughly the same as in 1976, and the frame should have been visible in 1981. Dr Don Richards, the First Mate and Radio Operator on the Explorer, and Mal Hamilton, cameraman, both report that there was no frame visible in 1981/2. (Photos Oceanic Research Foundation 1981, R image from National Geographic April 1983 p554)

The air tractor disappeared from view sometime between 1976 and 1981. The data supports the hypothesis that the air tractor sunk in the ice significantly faster, and perhaps the surrounding ice disappeared entirely, some time in that 5 years. Absence of proof is not proof of absence of course – but the GPR findings show that the frame was certainly absent in 2008.

[15] Dr Don Richards, personal communication.
[16] Mal Hamilton, personal communication.

SUMMARY OF RESULTS

1. Two trenches were dug down to 1.7m and 2.7m. The first position was too close to the sea. GPR showed a promising shape, which turned out to be a hard ice layer at 1.5m.

2. After the first hole came up empty the original pictures of the Air Tractor, taken by Campbell in 1931 and Reeves in 1976 were examined. From these 3 transit lines were constructed, based on easily visible, well separated points. All 3 lines met at one spot, and all were sensitive to translation and therefore useful. It seems likely that this is the spot where the frame rested since at least 1931, and possibly 1913, until 1976. The last known photograph is by Bob Reeves in 1976.

3. The expedition by Dr David Lewis in 1981 did not find any sign of the Air Tractor. Project Blizzard in 1984 found no sign either. Reeves, in a second visit in 1987, did not find it.

4. Pictures were taken by Dr Ian Godfrey of a melt in 2002, where a lot of rock was exposed. With the help of a professional photographer (David London), photographs were taken of the landscape from the same positions and the pictures superimposed. This established that the Air Tractor was sitting on ice near a melt creek, and not on rock.

5. Pictures from 1931 and 1976 confirm that the ice in the shore area is not glacial, so the frame has not gone into the sea with ice movement.

6. The GPR was capable of reaching to about 5m below the surface, and should pick up a tubular steel frame 6m long by about 1m wide.

7. In the second search two overlapping scans were done, each of 17m radius over the spot where the frame was estimated to lie. A significant feature was seen at a depth of 2.5m in the place estimated for the plane, and a 3m x 1m trench was dug down to 2.7m. The previous hard ice layer at 1.5m was found, and another layer was uncovered at 2.5m. A metal detector was used in the hole but no signal returned. The dig was abandoned.

8. The floor of the trench was surveyed and found to be at high tide level, and ice containing seaweed fragments was found at this depth. This means that liquid water was present at some time, and that it was likely to be seawater.

9. A study of the temperature records from Dumont D'Urville (DDU), the French base 200km away, show a significant rise in summer temperature to around freezing in the 70s and 80s with a peak about 1980, and a sustained temperature for about 7 weeks in 1977 and 1980. Comparison between DDU records and those taken by MHF

expeditioners suggest that Cape Denison temperatures are up to 10 degrees centigrade higher, but otherwise follow a similar pattern.

10. The result from radar scans at the level of high tide – the bottom of the hole – suggest that there is a channel in the rock close to where the air tractor frame would lie if the ice were to melt.

11. If the frame were freed from the ice it may be subject to wind forces and may move north and west toward the harbour.

12. The main body of ice in Boat Harbour can break up and blow out to sea quickly, taking any debris with it. However the ice round the shores is eroded from the bottom and forms protruding ledges. If the air tractor frame is in the harbour at the edge of the bay it is unlikely it will be subject to movement of the main body of ice. It is probably still in place.

13. The Air Tractor seat was found about 100m away on rocks at the other side of the bay and catalogued in 2008 by Anne McConnell. This was a home-made seat in addition to the two existing seats in the plane. It was clear from the photographs of the abandoned frame that the third seat had been cut from the frame, so its discovery does not imply any movement of the main frame.

Discussion

The frame of the Air Tractor was not found despite the precision and reliability of the transit lines, and the depth of radar scans extending to well below high tide level. The search area was certainly large enough to cover any translation of the frame in the years since 1976.

GPS error

Errors in the GPS readings would have affected the results, but the Trimble GPS provides an accuracy of 13 decimal places. This does not mean the GPS was accurate in terms of its position on the land, but it means it was capable of reading the satellites to that accuracy. As long as the readings were self consistent within the search pattern, any ‘dither’ was acceptable. It would have been preferable to use Differential GPS, but this was not available.

Ground Penetrating Radar

The radial search technique was developed to allow the operators to concentrate on handling the cart and the equipment in the conditions. This is in contrast to the standard way of searching a grid, which was soon discarded as being cumbersome and unworkable during trials in Hobart. The central pole was a piece of heavy duty plastic agricultural pipe whose diameter of 150mm gave spacing between the spirals of 470mm, matching the resolution of the radar and providing optimal search parameters. Smoothing the ice surface avoided any error caused by displacement of the aerial due to the sastrugi.

The radar aerial used was 250 MHz which has a resolution of about 45cm, but a depth penetration of about 5m. It was thought that the frame contained enough metal, which is radar reflective, at varying angles to the beam and thus likely to be seen. No tests were done to confirm this assumption, and it may of course have been that the radar simply could not visualise the frame. Neither was the radar unit placed at the bottom of the trench, which would have considerably extended its downward scan, albeit over a very small area.

Subsurface topography at the position of the scans
The scans show clear evidence of flat ice at around 2.5m abutting the rock band next to the search area. The second trench was dug to high tide level, and contained seaweed consistent with the formation of sea ice. This suggests that there is a channel entering the rocky promontories between which the search was carried out.

If the air tractor frame were to be deposited downwards in this area due to a significant melt, it would lie very close to a channel in the harbour. It would be possible for the frame to fall (or be blown) into the channel, and it would therefore be possible that the frame is currently resting at the depth of Boat Harbour sea bottom (about 6m), which is below the level at which the present radar equipment can penetrate.

Melting of the ice beneath the frame
The temperature records at Dumont D'Urville were used as a proxy to Cape Denison. Cape Denison temperatures are significantly higher. It is possible that a big melt between 1976 and the first visitors in the early 80's exposed the frame of the air tractor. When the temperature rises above zero the ice melts very fast in the area, and in a few days the whole surface of the ice sinks noticeably. If Dumont D'Urville experienced temperatures around zero for about a couple of months, then Cape Denison would be around 10 deg C higher, which would easily melt most of the ice on the harbour foreshore. This occurred in 1977 and 1980.

Ice melts out of the centre of the harbour, though not at the edges, so if the frame was deposited among the rocks it should still be there.

Wind blowing the frame into the harbour.
It must not be forgotten that the winds at Cape Denison are incredibly strong. The winds did not shift the frame in the 63 years between the departure of Mawsons' expedition and the 1976 photograph of Reeves. However, it remains a possibility that the wind scoured all the ice down to the bottom of the frame, and simply blew it out into the harbour.

The most likely outcome however, is that there was a big melt in 1977, which freed the frame from its enclosing ice; the frame then fell into the sea and remains at the edge of Boat Harbour, deeper than the GPR can penetrate.

Figure 40 If the reasoning in this report is correct, then the Air Tractor is still in the ice, probably in a channel in the rock, at the edge of Boat Harbour in the area shown by the arrow on the left and similar to the one illustrated on the right, which is at the base of the rocks near Granholm Hut (photo Don McIntyre 'Two below zero').

CONCLUSION

It is likely that the frame stayed in one place for at least 63 years (1913 – 1976). The fact that the plane was not found this year suggests three scenarios of decreasing probability:

1) A significant melt occurred sometime between 1976 and 1981, probably 1977 or 1980, which freed the air tractor from the ice. The frame then fell into the sea at the edge of Boat Harbour, where it remains encased in ice.

2) The frame was not detectable in the areas searched using the Ground Penetrating Radar, either because it is deeper than 4m or GPR is not the right technology to use.

3) Strong winds scoured the ice from the frame, which was then blown onto the harbour ice and subsequently taken out to sea in the summer melt.

Suggestions for a further search

- It is likely that a magnetometer would be a preferred option for a renewed search. Expert advice should be taken on its suitability for this purpose. The equipment should be well prepared and tested before deployment.

- If nothing is found scanning from the surface, then the search should include digging a trench in the most likely place for the frame (perhaps the 'channel' area). The trench dug this year could also be re-excavated (it should be relatively easy to do). By digging two trenches and using the scanning device inside the holes, the search capability is brought 2-3m deeper and thus closer to the likely position of the frame.

- If the frame has moved then it is unlikely to have gone anywhere but down and/or into the edge of the harbour. It would therefore be useful to make a sonar survey of Boat Harbour, which is about 6m deep. A visual scan could also be made in calm water using either an underwater viewing tube or an underwater camera.

- If divers are available (perhaps in conjunction with the French – it was after all a French aeroplane), then a full visual search of the harbour can be made.

6 MEDICAL REPORT 2008-2009 by Dr Chris Henderson, Medical Officer

I joined the expedition only two weeks before departure, so there was little time to prepare or attend any refresher courses. I did attend ED at the Royal Hobart Hospital on two occasions and did some intubations in an operating theatre. Obviously this was by no means ideal, but since I had spent many years in remote practice I felt comfortable with the isolation at Cape Denison and the medical kit supplied by AAD.

Backup, always essential in a remote area, is provided by AAD Medical team. Communication is by voice or email via satphone, of which we had two. An HF radio was taken, but we did not have time to deploy it – perhaps we should have, since it was the only effective backup communication, but the Sat phones always worked.

Tourist ships visit Mawsons Huts – we had 3 visits during our stay, and L'Astrolabe from the French base at Dumont D'Urville was in the area once. All could have provided help if a serious condition had arisen, and all have helicopters.

General health

There were no serious medical conditions treated at Cape Denison only minor conditions. A tourist on the voyage down developed a cardiac condition and I was asked to help the voyage doctor. We considered evacuation, but the ship was too far from land at the time. He stabilised after treatment and the voyage continued.

AAD screened the expeditioners, some of whom had significant prior medical conditions, but none were outside my capacity to treat.

Cold, tiredness, lack of food and fluid predisposes people to exposure, which they rarely recognise by themselves. In normal life this usually just means getting tired and grumpy, but extra care has to be taken at Cape Denison. On a couple of occasions I suggested someone stop and go back to the hut, and this advice was followed.

Seasickness

The voyage down on the Marina Svetaeva was pretty calm, but on the way back L'Astrolabe lived up to its reputation. Expeditioners suffered seasickness on both trips, but on the way back my management was more proactive. The trick to treating seasickness is to take maximum medication right from the start, lie down, wait for the brain to sort it out - and avoid vomiting. This worked well enough, with adaptation developing within a day or two.

Personal behaviour and Hygiene

Occasionally expeditions in remote areas have major trauma or serious illness to deal with – these events hit the headlines. But in reality the disruptive medical problems are most often due to moderate trauma or general infections such as gastroenteritis. Both of these are preventable to a certain

extent - by the personnel being extra careful with how they handle themselves and equipment, and by strict hygiene around food and faeces.

Everyone was safe with themselves, and handled equipment sensibly, which paid off.

We all used alcohol gel hand wipes, and I noted that hygiene measures were generally well followed, particularly around food handling. Nobody got vomiting or diarrhoea.

Washing is a bit difficult in the cramped, cold conditions. Several (including me) elected to stay dirty – which is fine up to the point when the smell gets too bad. Two people took enough underclothes to keep changing them, which is a good idea since clothes washing is a bit of a production. Two people got fungal foot infections caused by sweaty feet – the boot liners absorb sweat and keep the feet damp. The liners should be taken out and dried off each night.

Medical equipment and logistics

The medical equipment is comprehensive. Its purpose is to stabilise someone prior to evacuation (up to intubation and hand ventilation), but the limit would probably be around 48 hours. Minor, and initial major, trauma can be handled, but surgery is excluded. Splints and plasters allow stabilisation of a long bone fracture.

Care was taken with the instructions regarding storage of drugs – both freezing and heating damages some of them.

I took the cabin box and the Thomas Pack on the ship in both directions, the latter to be on hand for helicopter operations (potentially dangerous).

The space in the hut is very cramped, eight people living on top of each other, with very little personal storage space, and little bench space (none unoccupied). The medical kit takes up a lot of room. In practice access to the kit was difficult, and the only solution was to have the 'cabin' case in another room and try to work out of that. If I needed anything else, I had to clear people and gear out of the way, then pull out the appropriate box(es) and search through it. This can be made much easier with better labelling (see below).

I elected to keep the equipment in the hut rather than a tent or the apple, which has been done in the past.

The following suggestions are made for improvement to the existing setup:

1) The list of contents by box is good, but only if you know which box something is in. It would help to have an alphabetical list of the contents, not by box but by item (listed by trade and also chemical name), in order to be able to find the appropriate box. There is an

Excel spreadsheet, but it is seldom practical to turn on the computer to find something. A printed list would be very handy.

2) The boxes are only labelled with a small handwritten number. A brief description of the contents on the top, front and end would be much appreciated. And a bigger number.

3) The packs are not labelled. It would help if a large label be attached to each pack – for example "Trauma pack" (Thomas Pack), "Oxyviva", "Cabin Box", "Spine splint" etc. Frequently you need to refer to a box when asking someone to help, and they don't know what to pick up.

4) All the packs and boxes are stuffed full of gear. In practice this makes things hard to find, and harder to repack.

General mood

Most problems on isolated trips come from interpersonal conflict and personal difficulties – which to some extent are the purview of the medical officer in consultation with the team leader. This group was excellent, with everyone getting along well. Inevitably there were minor problems, but people were mature enough to handle these quietly – there were no prima donnas and no egos to feed. I would happily go back again with the same group, and I think the rest would too.

People can change when isolated – a trip that seems like a good idea can suddenly look like a bad one when the last boat sails away. Everyone on this trip had been in that situation before, and I did not come across any isolation effects.

To a large extent the ease of email and phone calls this time prevented personal problems, and I would recommend this service remain a priority.

Alcohol

Alcohol often causes more problems than it solves. However, it was drunk in moderation – there was no skylarking, no aggression, and no risky behaviour. As a non-drinker I can, however, attest that the quality of humour and the clarity of thought does not improve with alcohol, contrary to what the drinkers think!

7 **COMMUNICATIONS AND COMPUTERS** by Dr Chris Henderson

Communications: Dr Tony Stewart, the 2007-8 doctor and communications guru provided the essential home-base backup for this year's expedition. Refer to his report in the previous Expedition Reports 2007-8 in conjunction with this report – all important detail is there.

Email and satellite voice-phone is an essential part of the expedition, providing much appreciated contact with friends and loved ones, as well as the ability to keep in contact with business matters. Expedition blogs and media releases were a constant feature of our work. In fact in many ways our days revolved around the ability to communicate with the outside world, and the daily contact was often discussed among us.

Suppliers of the phones (Renta 2-way) and email service (UUPlus) are detailed in last year's report, and Tony sourced the same services this year. There were 2 satellite phones – one for data and one for voice.

Satellite phones worked well, and the 20 min a week allowed call time was appreciated by all. The puck aerial was fed through the roof ventilator in the lab allowing a good connection and privacy when calling home. On occasions when this was not possible, satisfactory reception was obtained using a big rock as a ground plane. It is necessary to keep an eye on the phone battery charge, which decreases faster than you think. One trick – not in the manual – was to make sure the phone is set off call-forwarding – we lost quite a few calls this way initially.

UUPLUS email service: www.uuplus.com and tel +1805 534 1425 was a friendly and helpful service specialising in robust communications to isolated places. The software works well, and is highly error tolerant. The only problems arose during a blizzard and on L'Astrolabe where the rolling in bad weather made communications difficult. One of its greatest recommendations is that I could pick up the phone and talk to one of the owner/operators any time during US business hours, and they sorted the problem then and there. Full instructions for setting up the service are in the UUPlus help files, and from the operators as needed.

The server software was installed on a dedicated comms Toughbook laptop, with client laptops connecting wirelessly. Messages can be sent and received on the comms laptop if necessary. There is a WebFetch function which allows web pages to be downloaded, but we did not use it after the novelty had worn off and it was ceased. The daily Casey met reports however, were of great use, though rather gloomier than reality.

It is helpful to back up the UUPlus directory from time to time since it contains all the emails and current settings. The comms computer failed with a Windows boot problem and had to be re-imaged, so the backup came in handy, although the up-to-date files were retrieved using Fedora Linux OS instead of Windows to access the failed hard drive.

A second computer was installed with the working UUPlus setup and run for a few days to operate as a backup. This proved useful when the main computer went down, since the backup could be installed immediately and the email service continued seamlessly. It was only necessary to change the fixed IP address of the new computer to the old one.

Wireless router: It is possible to set up computers to communicate with each other in a network although clearly without the signal strength a dedicated router provides. (www.microsoft.com/windowsxp/using/networking/epert/bowman_02april108.mspx) this was tried for the first 3 weeks. However, after endless problems and frustration with connection dropouts the system was switched to a wireless router which proved simple, robust and problem-free thereafter.

Personal email accounts: Provided the client computers can access the router, they can use their own email software. Accessing the router is no more difficult than on any other network, but I encouraged all users to know how to set up their own email programs and to help each other in case of trouble. There were some quirks in the various combinations of machine, OS and program – as always – which took time and frustration for all before they were fixed.

One thing which was a problem, and should be sorted out next year before departure, is that some ISPs reject email from the .aq domain (Antarctica). What this meant was that two or three people were hoping for emails from home, and did not get any for a week. A phone call usually fixed it, but not without some angst regarding the relationship in the meantime. I suggest users have a time to check they can send and receive emails to all their significant contacts before leaving – departure is an emotional time, and faulty email doesn't help.

Email addresses were a problem initially. There was two, one being related to the UUPlus account, the other the .aq domain. In practice this just became confusing and we stuck to one – the @mhf.aq address. The other had the value of allowing broadcast email among us without external transmission – but it is possible to set up an alias within the program using the .aq address which had the same effect.

Email size: There is a restriction on size of email sent, initially at 50k except for media reports. However, this proved a bit difficult as people wanted to attach pictures to blogs, and there was always pressure to increase the limit. It might help next year to have a good idea of costs and guidelines for email size so people know what charges are being accrued to MHF. People also need to know how to cut down image sizes for web posting. Emails are supposed to be sent in plain text format without echo, and it is worth checking each account to make sure this is set properly, as not everyone understands what this means.

Radio communication

Communication is by handheld VHF. It is worth remembering that in a small area like Cape Denison it is often more effective to have the main set transmitting on low power than high.

An HF set was taken, but never deployed because there wasn't time. It should have been at least tried, since it is the only alternative to satphone.

Laptops were used by everyone, plus two MHF Toughbooks, a tide gauge computer, and two of mine (12 in all).

This put a big drain on the power system (see the Sorensen Power Supply report), and I strongly suggest that the whole laptop power situation is addressed differently next year. Laptops will work very well off DC-DC converters, external hard drives can run off USB connections (or direct to 12v batteries). Much power saving can be had by turning off Bluetooth (unless it is used – we did for file swapping), dimming the screen etc using the inbuilt power saving functions. I can't see computer use

getting any less in future, and 240v-12v is an inefficient way to supply power to a laptop.

Viruses, worms and Trojans: There was no anti-virus on the two PowerBooks and the Dell MHF laptop, or on two personal computers (the three Apples being immune). Worms/Trojans were discovered on one of the flash drives on the voyage down, and thereafter found on all flash drives despite repeated scans (win32.autorun.end, win32.small.dn, win32.Cn911.bb). Since returning I have found that win32.autorun.end is a fecund and pervasive little thing which uses the ubiquitous Auto play function to spread via flash drives. It appeared in the computer community just before our departure, and someone obviously picked it up and spread it to the rest. All expeditioners have been notified and will have to take steps to remove it from their own equipment (see http://autorun.synthasite.com/).

Next year I strongly suggest all computers have up-to-date anti-virus on them, and that the latest software update be loaded just before embarking. Anti-virus scans should be done regularly, because we all tend to share files.

Registry cleaners, defragmentation etc: Inevitably computers slow down as they load more software, and free registry and drive cleaners effectively release space. Expeditioners should be advised to get rid of unnecessary programs and free up disc space before departing, since it is hard to get rid of data once away – not to mention time consuming. The appropriate cleaning software should be loaded.

Most people had external hard drives and were aware of the importance of backups; those who were not soon learned.

Bluetooth: is a simple and effective way to share files. We used it often, and it would help if everyone understood how to set it up on their personal computer.

Power surges: the use of power tools on the Sorensen generator line can send potentially damaging spikes on the power line – it is likely that the Powerbook failed because of this. The subject is treated more fully in the Power Setup report, but next year expeditioners should be advised to bring protected power boards. Connecting to 12v directly via a DC-DC converter will remove this danger.

8 SORENSEN HUT ELECTRICAL SUPPLY by Dr Chris Henderson

SUMMARY:
The Sorensen Hut has two power sources: 12v batteries with solar power; and an external Honda 240v generator. The generator supplies power to the electrical power sockets, while the light circuit is attached to an extension lead which can either plug into the power socket if the generator is working or a 12v-240v inverter if it is not.

Despite increased battery capacity, a bigger charger and a large inverter, the Sorensen power supply was clearly close to its limit this year. Next year its capacity should be increased, but a decision needs to be made whether it should be predominantly a 12v or a 240v supply in the next few years. 12v would be far more energy efficient.

If the generator is to run daily, then this would develop sufficient power to charge the batteries, and additional solar panels will not be needed. However, two extra batteries will be needed whatever the charging source.

Some changes have been made to the electrical supply at Sorensen this year. Refer to Mawsons Huts Expedition report 2007-8 page 143 for details of existing installation.

PROBLEMS ON ARRIVAL:
A wind generator had been installed on the toilet roof, (originally to power Sorensen but then transferred to power the French GPS installation), and solar panels connected in the 2007-8 season. However on arrival it was found that the wind generator mount had sheared off and the generator body had blown onto the ground some metres away.

The solar panel cable had become detached from the connections inside the plug because the wires were attached by domestic screw clamp fittings and the cable to the solar panels was unsupported. So presumably the wind had worked the wires free from the connections. With no charging, the batteries were flat at about 5v.

The batteries were replaced by 2 x 120ah deep cycle batteries, but the existing Sonnheim ones (remarkably) came up to, and held 13v on charging. They were reinstalled on departure, since the larger ones are RTA for the winter.

The solar panel wires were terminated with soldered donut lugs which were screwed into the plug fittings, and the cable was fixed to the hut wall with half-saddle fittings and supported by spiralled rope back to the panel assembly.

NEW INSTALLATONS: The existing small battery charger was replaced by a much larger ‘intelligent’ one which has been wired directly to the batteries rather than through the solar regulator. It provides its own inbuilt regulation and a direct installation is much simpler.

A new inverter was installed. This is an 'intelligent' 600W unit, which has low and high battery cut off, overload protection, and produces pure sine wave for safe computer supply. Again this has been wired directly to the batteries rather than through the solar regulator as it provides its own regulation.

The radio has been wired directly to the main batteries for safety reasons – the radio provides emergency help to expeditioners and it is important that there are as few interruptions in the lead to the power supply as possible.

The upshot is that the solar panel regulator switchboard now has only two active switched circuits - the solar panel input and the car-socket output (used for the shower pump). The inverter, radio, & battery charger go direct to the batteries, while the wind generator input is not used.

There is now provision for 4 extra inputs to this switchboard.

FUTURE POWER NEEDS AT SORENSEN

It is clear that in future the MHF expeditions will need increased power. There has been a marked increase in requirements this year compared with last year, and it is likely that this requirement will increase in future. Solar panels could provide this power, but the solar equipment will need to be significantly upgraded if this is to occur. There is plenty of sunshine, which makes a sustainable system a likely success should this option be chosen[17].

However, it may be easier to use the existing solar setup for the lighting (and some power in the evening and morning), but use a generator for the main power source during the day. This will mean increased use of fuel (for example we used 325L in 4 weeks), and MHF may consider that setting an energy-efficient example is more acceptable than over-reliance on fossil fuels.

INSTALLING A SOLAR SYSTEM

Solar systems are very simple, robust and easy to install. This section discusses the basics and the likely upgrade path for Sorensen. The good thing about a solar system is that, provided the basics are right, it is hard to get it wrong. If there is a mistake in estimating requirements it just means there are either too few panels/batteries - or too many (which means unused capacity). Currently Sorensen has too few panels/batteries.

It pays to buy into a solar system in stages, because the technology of solar panels is changing rapidly, and waiting a couple of years to add another panel or two is likely to allow access to better efficiency.

Essentially a solar system consists of a battery charged by a solar panel. If the panel supply gets big enough a regulator is needed to control the power and stop the battery being damaged. An estimate is made of how many

[17] At Cape Denison in summer it is approx 0.5kW/m^2 /day: http://aom.giss.nasa.gov/srlocat.html

panels and batteries are needed. The regulator size depends on this estimate, but nothing is lost by getting a bigger regulator, because generally requirements increase. The expense of a solar system is in the quality of the panels and batteries, and how sophisticated the regulator is.

Current solar system consists of 2 x 75W BP panels.

Power requirements at Sorensen:
There are three main areas where power is required:

1) Laptop use. This year everyone brought their own laptops, and the comms equipment worked off a dedicated laptop. Laptops are not particularly efficient, their batteries do not last long and they were often run from the 240V power supply via an inverter. Turning 12v power into 240v and then back to about 18v is wasteful, and it would be much more efficient to use a 12v 'car' converter for each laptop (these are easily obtainable and cheap). In addition, all laptops have a power management system allowing the user to change the screen brightness etc. Considerable savings in laptop consumption can be made with this system – for example cutting the screen down can save 20% of power use.

The following table shows measurements made on 3 laptops – dual-core, single-core and netbook. The netbook uses a power-conserving strategy that makes it less directly comparable to the other two, but look at the % savings using a DC-DC converter in both the ASUS and the Toshiba laptops. The figures in bold show that up to 25% power can be saved this way.

	Asus	*dual-core*		*Toshiba*	*single-core*		*Acer*	*netbook*	
	Inverter	*DC-DC*	*%*	*Inverter*	*DC-DC*	*%*	*Inverter*	*DC-DC*	*%*
startup	*9*			*3.6*	*3*			*1.3*	
HDD	*8.5*	*8*	***6%***	*4.4*	*3.3*	***25%***	*2.9*	*0.85*	*71%*
Disp bright	*8.4*	*7.1*	***15%***	*3.9*	*3.1*	***21%***	*2.6*	*0.85*	*67%*
Disp dull	*7.6*	*6.4*	***16%***	*3.4*	*2.8*	***18%***	*2.5*	*0.7*	*72%*
charging - off	*4.5*			*4.7*	*3.2*		*1.3*		

Table 1: Current measured in 3 laptops – ASUS dual-core, Toshiba single-core, and Acer netbook. 5 conditions were measured (left column), and two power sources – 12v – 240v Inverter and 12v DC-DC converter. Note the % saving by using a 12v DC-DC converter.

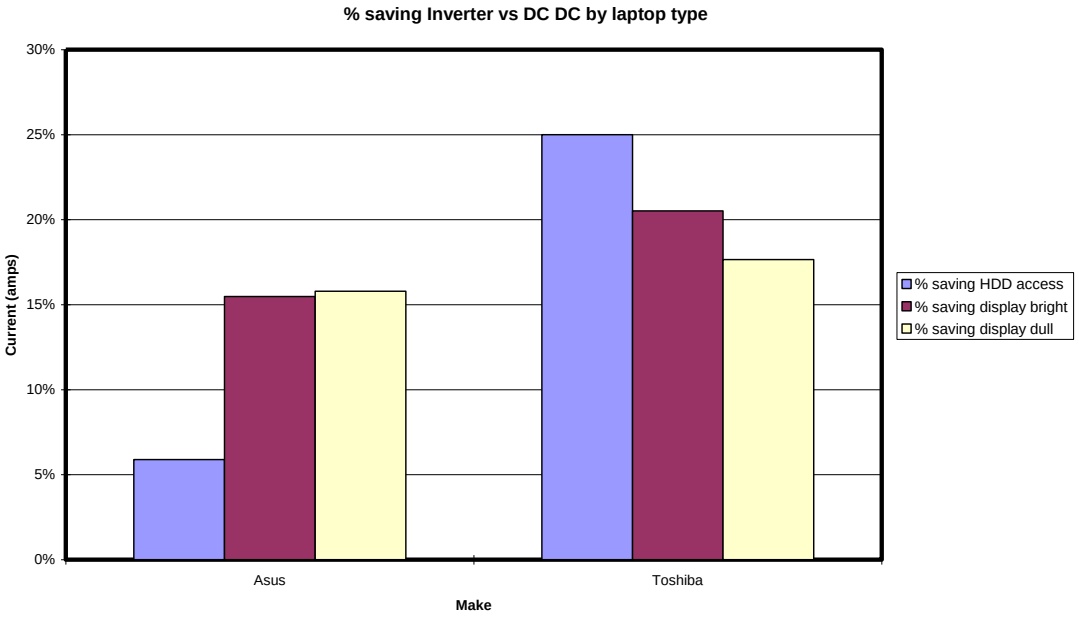


Figure 41: Chart showing the above results (except for Acer netbook, where the power supply system is different to the other two).

2) Battery charging for cameras etc. This is now a large requirement both in terms of space and power. Many batteries were on charge at once, creating a permanent clutter of wires and power boards. Not only did this render useless the bench space along the wall of the living room, but it put a significant drain on the 12v supply. A rethink is needed of how and where the charging takes place. It is recommended that a separate battery charging area be set aside from the living space and 'universal' 12v chargers be used.

3) The new lab uses significant power equipment, and will not be able to run off batteries. It is likely that it will operate for several hours per day. During our stay a video editing suite was used, also needing external power. In future no doubt other equipment will need 240v. The 240v generator is essential, and will provide a means of charging the 12v batteries, supplementing the solar panels.

Measured consumption:
Power consumption and supply figures are available in the 2007-8 Foundation report. This year I measured the current from the batteries on an evening when 3 laptops were in use. The current drawn was 8A, which means about 100AH per evening drained from the batteries.

The solar panels perform well with a decent current maximum (6-8A) at midday on a sunny day, and an open circuit voltage around 21V.

A data logger would help to pinpoint the needs. This device is put in the power lead of the battery and records exactly how much power is stored and used for the summer. An external one can be purchased (or made), but the existing PL20 solar regulator has the capacity to act as one, and could be used as such with a bit of re-wiring and the appropriate software.

Number of solar panels needed:
Solar panels work better in the cold – the power increasing by something like 0.5%/deg C, so a nominal 100W panel at 25 deg C will provide 112W at 0 deg C. Actually panels overall usually give less than their rated output, so the cold effect helps, but not much in practice. Batteries perform less well in the cold.

A useful rule of thumb is that 1 x 80W solar panel for 1 hr = 1 x laptop for 1 hr. (Thus 1 panel for 8 hours supplies 8 laptops for 1hr). If you suppose that 8 laptops are used for 2hrs a day, then you will need 2 solar panels (80W size). This is theoretical, and a bigger margin would be wise – ie 3 solar panels for the laptops.

The fluorescent lights take about 40W each, which means another panel; and extras such as battery charging, means another.

So, given the two existing panels, another 4 would be sufficient, which means a bank of 6 panels should be enough to supply the needs for the next few years.

However, inevitably the generator will be run daily, and this supplies a lot of charging power, so at present adding 2 more panels would be sufficient (ie 4 panels in all). If the expeditioners use power efficiently (discussed below), this should work for the present.

Regulator size:
The regulator protects the batteries by limiting the energy put in by the solar panels, and limiting the energy taken out by the users. It typically also allows monitoring of the system, while several other functions are incorporated in the more expensive ones like the one at Sorensen (where the functions are not used).

The solar system has a PL20 regulator, which can be interfaced with a computer via a free program downloaded from the manufacturer's website. The PL20 has a simple display, and comprehensive data can be obtained via the program. If the PL20 is retained, then the software would be a handy addition for next year, and I have downloaded all the appropriate programs and instruction manuals from http://www.plasmatronics.com.au/downloads .

However, it is probably time to upgrade the PL20. If the number of panels increases to 4 as recommended, then the maximum current delivered will be 24A, which exceeds the capacity of the PL20 (20A).

In fact the PL20 does a lot of things which are irrelevant to Sorensen such as having the ability to automatically switch on lights, watering systems and other equipment. It is probably worth getting a less sophisticated but more powerful regulator – say the 40A regulator from Todae http://www.todae.com.au which costs about $250. If the Foundation wants to stay with the same manufacturer, then the PL60 would be appropriate (about $600).

Battery requirements:
The power failed once or twice on batteries this year, which is a sure sign that the battery capacity is too small. Another one or two batteries are needed.

It is fairly easy to work out how many batteries are needed, given an estimate of the typical power consumption. The calculations are not critical because in the end we buy either one or two more batteries (to give 4 in total). At Sorensen, with regular charging by the generator, nothing much is lost by having too many batteries except cost, and wasted capacity.

The estimate is as follows:
The power requirement is based on the average power use. Suppose a laptop draws about 4 amps, and is used for two hours – then the power used is 4 x 2 = 8 ampere-hours (Ah). If there are typically 6 laptops used for 2 hours a day, then power used is 6 x 8 = 48Ah. Add 16Ah for lights, and 8Ah for camera battery charging etc. The total comes to 72Ah. Add a 25% margin to this and the power requirements are about 100Ah per day.

The 2 batteries have 120Ah capacity each, giving 240Ah total. In the cold, only about half of this is available before the voltage drops off, so the existing two batteries are theoretically already at the limit which is what happened at Sorensen. Another two batteries (of the same size and make) should provide adequate extra capacity.

Inverter size:
A new 600W inverter was installed. This sounded the alarm on a few occasions when the power requirements were exceeded. The reason for this is that each laptop draws about 75W, the lights 100W each, and the battery charging perhaps 20W each, the iPod loudspeakers about 80W. Add all this up and it is not hard to see that 600W is only just enough.

What this means is either buying a larger inverter or reducing the power used.

Reducing power use:
Rather than installing increasingly bigger power systems, a better approach would be to encourage the use of power conservation measures. Like the current water crisis (if people just turn off the taps the problem gets less) then anything which reduces the power consumption will help conserve energy.

The biggest energy drain comes from laptops, followed by lights, and battery charging.

1) Laptops are presently plugged in to the 240v inverter. This is inefficient because 12v is converted to 240v and back to 18v in the laptop, wasting power at each step. 'Car' converters, designed to run off 12v batteries are better. Against this must be balanced the ability of expeditioners to understand and use the equipment. External hard drives run on 12v and can be directly connected to the battery. Better is to use USB external hard drives plugged into the computer.

Laptops use a surprising amount of power – and this is controllable by the user in the 'power settings' program. If every laptop can be set to use minimal power, then the overall consumption will fall considerably. Cutting down systems use helps – such as turning off Bluetooth adapters.

2) LIGHTS[18]: The main lights are fluorescents, which are efficient provided they are T8 tubes with electronic ballasts[19]. This reduces the load on the inverter. A good solution is to use direct 12v LED down lights which work well in situations where a spotlight is needed.

Compact fluorescents are efficient too, and should also be considered for future installation.

There are many standards and ratings, but what counts is the current drawn, the power consumed and the light output. A simple test was done where measurements were made of the current drawn via a 300W inverter from a standard 12v car battery for various lights:

Type	Watts	current amps	lumens	lumens/amp	lumens /watt
	rated	measured	rated		
fluoro 36W	36	5.15	3150	612	***88***
Phillips TL-D 36W/840					
100w incandescent	100	7.8	1120	144	***11***
Compact fluorescents:					
12w	12	1.4	700	500	***58***
14w	14	1.66	950	572	***68***
18w	18	1.86	1200	645	***67***
24w	24	1.58	1600	1013	***67***

Table 2: Using a 12v battery and an inverter, the measured current for various light globes vs rated watts and rated lumens output. Note that the fluorescent strip lights are more efficient than the compact fluorescents (last column). A 100W fluorescent is shown for comparison.

3) Battery chargers for camera etc batteries are a little different – the lithium batteries used nowadays must not have too much current or voltage or they can (and do) explode because highly reactive metallic lithium is plated out on the electrodes. Nor must they be discharged flat or they will not work again. The real problem with Sorensen is space, and the numerous chargers and cords need a large area of bench to work. Universal Li-ion chargers would be a practical and energy efficient way of managing the charging needs. They are not expensive, and run from 12v.

[18] http://en.wikipedia.org/wiki/Luminous_efficacy
[19] http://www.lightingtaxdeduction.org/technologies/t8.html
http://www.lrc.rpi.edu/programs/NLPIP/lightingAnswers/t8/02-t8-light-output.asp

Wind generator:
Given the almost certainty of daily wind at Sorensen, a wind generator would seem attractive[20]. However, the downsides make it less attractive: They are noisy, and could not be mounted on the structure; they are also expensive, and more efficient in strong winds. But the biggest problem is that the wind may reach high velocity in a blizzard, which could destroy the installation (as happened this year). Cape Denison is on record as the windiest place on earth[21], and sudden wind events can occur in East Antarctica with little warning[22]. In summary it is probably not worth it – unless someone comes up with a good solution to the above.

QUALITY OF THE POWER SUPPLY

The generator is supposed to give out a 'clean' sine wave, as is the 240v inverter. However, power tools used from the same generator during our stay can cause problems for laptops because of a large spike on the power line when the tool is started and stopped. The comms Powerbook operating system failed, probably due to a corruption of the boot record, which is often caused by such a spike.

I contacted a high voltage consultant with Antarctic wintering experience (Andrew Hill) who works for Hydro Tasmania (the state power supply company) as to whether we need surge arrestors on the generator supply. His reply follows:

The Generator Supply shouldn't need one, because the laptops use a "chop-mode" power supply and the ouputs are usually well filtered, as these type of power supplies create transients themselves. Modern electronics can usually deal with reasonably large transients, unlike the Mosfets of yesteryear.

However the large power tools may create very large transients (sparks on the commutators) due to the back EMF when starting and stoppping, so it would be prudent to use a surge arrestor on all electronic equipment.

I would think the main problem would be "brown outs" or dips in the supply voltage when using the larger power tools, these would affect desktop computers not laptops, as laptops use the battery as the primary power source supplemented by the charging circuit.

Use power tools only on the generators, with a surge arrestor (if available) but also make sure the generator circuit is well earthed,

[20] Guichard A "Potential for exploiting wind power in Antarctica" www.latitude.aq/public/energy/publis/scalop96.pdf

[21] Wendler G and Radok U "Cape Denison, Eastern Antarctica, the windiest place on Earth" http://antarctica.gi.alaska.edu/paper152.htm

[22] Murphy B "Prediction of sever synoptic events in Coastal East Antarctica" http://ams.allenpress.com/perlserv/?request=get-document&doi=10.1175%2F1520-0493(2003)131%3C0354%3APOSSEI%3E2.0.CO%3B2

remembering ice or frozen soil need a larger earth then usual due to the higher resistivity of ice compared to water.

(The Sorensen power supply should be earthed to the supporting frame, which is set in the rock in many places, and so will provide as good an earth point as you can get. The earthing system should be checked)

USE OF THE POWER SETUP

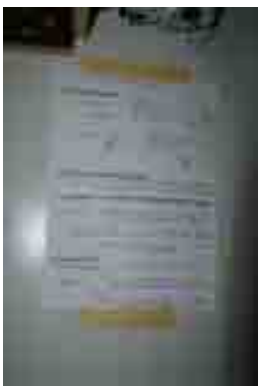
It was clear that most of the expeditioners did not fully understand the power setup, even though this was necessary to be able to operate it effectively. For example, the light circuit needs to be unplugged from the inverter and plugged into the power board when the generator is running. There were no signs to help them, so I made up some clear labels on masking tape – next year they could be tidied up with a labeller.

Most people neither know nor care how their power arrives, but in this situation a little knowledge is essential to the smooth operation of the hut.

The comms area, medical supplies, and electrical supply.

The 240v external supply enters under the 'Canon' label, the battery and solar supply is on the left wall.




Various labels in the power supply area

RECOMMENDATIONS:

- Decide if 12v is to be the main power supply for the next few years.
- Increase the number of solar panels from 2 to 4.
- Increase the number of batteries from 2 to 4.
- Upgrade the solar controller to capacity at least 40A (in and out)
- Ask everyone to bring 12v DC-DC converters for their laptops
- Use direct 12v power for hard drives if possible.
- Use USB hard drives where possible.
- Install banks of 12v 'car' and 12v sockets for laptop use.
- 'Power condition' laptops so they use minimal energy
- Use appropriate fluorescent and spot LED lighting.
- Get the software for the PL20 controller off the internet to monitor solar input.
- Make proper labels for users of the power supply
- Ask everyone to bring surge protectors for their equipment
- Make a separate, organised, battery charging area to free up the bench
- Check the earthing of the Sorensen supply

9 **Photography and Video Report** by David London

I must start by thanking the Foundation for inviting me to be part of the 2008/2009 MHF Expedition team. It was my first visit to Antarctica & accordingly I now have a good understanding of how to live & work in such an environment thanks to the other team member's support.

I found the whole team a superb selection of different personalities & skills, able to work & live together well, get work done as a team, have lots of laughs & all able to give & take where required.


Team with Emma McEwin (Mawson's Great Granddaughter)


Official 2008/2009 MHF Expedition team photo

Having been involved with the Mawson's Huts Foundation since it's inception in 1997, producing & editing numerous videos to assist in promoting the Foundations work, it was particularly important & informative for me, as it has given me an insight & better understanding of the condition of the huts, the Cape Denison environment encompassing climate & wildlife & the Foundations works programme.

VIDEO & STILLS DOCUMENTATION

My role was to document the works programme carried out by the expedition team on both video & still photography. I managed to capture over 4,000 still photographs & 30 hours of video. This was considerably more than I had anticipated, as I was quite transfixed by the wildlife & scenery. I found that when there was no work being carried out by other members of the team, I would take the opportunity to capture shots of landscapes, Adelie penguins, Weddell seals, and bird life & weather conditions.

In documenting the works programme comprehensively, this would often require me being in more than one location at once on some days due to unforeseen circumstances of multiple works or events occurring simultaneously. This did create minor problems by not being able to get shots of everything as it happened.

In my role as photographer, I managed to cover most of the tasks set by the Foundation in my brief, however I did find that having to document work & events on both stills & video it was a very demanding task to video a scene in moving footage & cover the same scene on stills.
On some occasions I had to make a quick decision whether I covered a live scene first with either stills or video, as there may not have been the chance to re-enact it for the other medium. There are a couple of main reasons for this:

1. The set up for a still photograph often requires different lighting to a video shot, angles or positioning of the subject matter can vary plus sometimes it requires the person involved as the subject to stop what he or she is doing & re-enact the action for the purpose of the camera.
2. The set up for a video shot has similar problems as stills however it also requires sound to be set up & in windy conditions this became often impossible. Wherever possible when a team member had to speak on camera I would wire them up with a radio microphone hidden suitably under their clothing to alleviate the wind & extraneous noise. On windless days or inside the confines of the main hut & workshop, the camera top mike was often used to capture sound, which is not perfect sound but will suffice.

STILLS

Nikon's role as a sponsor this year involved lending one Digital D700 SLR, a 14-24mm wide-angle lens, a 70-300mm lens & a 24-120mm lens. They also supplied two P6000 compact cameras for use by the conservators & our journalist Peter Boyer. Two days after leaving Hobart, the automatic lens on one P6000 jammed open & was unable to be closed or used for the entire expedition. Peter Boyer, Chris Henderson & I attempted to fix it however to no avail. The second P6000 was used extensively by Peter Boyer often as back up when I was unable to stake still photographs due to my commitments with video footage. The quality & ease of use was excellent.

Nikon supplied another Digital SLR, the D300 to the MHF artist in residence on board the Marina Svateava Angus MacDonald. This camera was retained by Angus for the remainder of the sea voyage & was unavailable for us to use at Cape Denison.

I found the Nikon D700 & the three lenses quite superb to use, however it has so many functions I don't believe I managed to use it to its full capability. I am very pleased with the results I did achieve.

I was advised prior to the expedition that waterproof housings for cameras would not be required as it seldom rains in the Antarctic. Unfortunately this was unwise advice, as it prevented me from getting some shots at sea in salt spray, heavy snow & blizzard conditions. I did take with me Petrel rain cover for both video cameras however these are totally inefficient in windy conditions. A fully waterproof stills camera should be included in the future & a suitable 'underwater' video camera housing should also be considered.

Following is a list of stills & video equipment taken to Cape Denison. All camera equipment was taken in either Pelican or Storm Case all weather hard cases. I have used these for many years & found them invaluable protecting the contents from salt spray, snow & moisture & travelling as cargo on the ship deck.

VIDEO

Two identical Sony HVRZ1P 1080i DVCAM/HDV Digital Cameras were taken to cover video documentation of the expedition. One was purchased ex-rental in 2007 by MHF & one that was hired at the last minute due to my camera being delayed in service due to a focusing problem. Problems were encountered with both units involving tape damage resulting in dropouts occurring towards the last 15 to 20 minutes of a sixty minute tape. The reason for this is still not known & I will be having them checked by Sony to ascertain the reason. There are three possibilities that I can currently only assume.

1. They were affected by cold.
2. Affected by moisture or humidity.
3. Qantas may have dropped the camera Pelican camera cases containing the cameras heavily in baggage on route to Hobart.

The MHF camera was used on the Marina Svetaeva sea voyage while the other camera was stowed in cargo. Problems were encountered in the first few days of the voyage & some footage was lost due to these recurring dropouts. This resulted in only recording onto about two thirds of a tape before changing to the next tape.

This did not prevent me from taking approximately 30 hours of video & editing a twenty one minute video media release to supply TV networks on return to Hobart. I set up my equipment in the computer office on the lower deck of L'Astrolabe on the return journey where I continued logging video footage & edited the media release.

The footage gathered will also be used to:

1. Produce a 30 minute documentary on the conservation work which can be given to a free to air channel to promote the work of the Foundation. Peter Boyer will again provide the script for this.
2. Edit an update of the Foundation's promotional video.
3. The production of a proposed major documentary on the Centenary of the 1911 AAE Expedition to be completed in 2011.
4. Supply the Orion, Aurora & Heritage Expeditions footage of their tourists ashore & visiting the huts at Cape Denison.

STILLS & VIDEO LOGGING & EDITING

Due to the quantity of stills & video footage, I made a point of logging & backing up all my material on a daily basis. All stills were sorted, logged, named every day onto my Apple Mac book Pro & then backed up for safety to a separate bus powered LaCie Rugged 320GB hard drive.

All video footage was logged into Final Cut Pro every few days using a Sony HDV HVR-M15AP tape deck, & backed up onto a Western Digital 1 Terabyte hard drive (requiring 240v). The only hiccup here was if the generator cut out while logging there was the chance of losing all data on the back up drive. The generator did cut out on one occasion & the hard drive was not affected.

My brief from the Foundation was to cover work carried out by the expedition team; the results are as follows:

MHF BRIEF	ACTION
1. Fit-out of the conservation laboratory	Stills & video of materials being transported from Hobart & construction/ fitting out shots. Small official opening ceremony with all team members.
2. Location of & digging for the Vickers fuselage "Air Tractor"	Stills & video of Air Tractor search using ground penetrating radar. Digging of both the 1.2metre & 3 metre excavations, plus analysing results.
3. Removal of ice & recovery of artefacts inside in the hut	Stills & video of hoar frost removal, clearing of snow & ice from ceiling & floor of Mawson's cubicle, Murphy's & J. H. Close, C. F Laseron's bunks.
4. Conservators working on these in the laboratory	Stills & video of all three conservators Ian Godfrey, Michelle Berry & Megan Absolon working in laboratory.
5. Repair work being undertaken by the heritage carpenters.	Stills & video of Peter McCabe & Ben Burdett documenting & working repairs to Transit Hut. Documenting workshop & main hut including measuring & assessing rusted & damaged shelf brackets for replication & replacement. Protective brace constructed for North Wall exterior verandah of workshop.
6. Updated landscape & wildlife shots & of course all main hut & other buildings & the cross.	Stills & video of Adelie Penguins, Weddell seals, some bird life, Cape Denison landscape shots & shots of all five huts in various weather conditions.
7. Perpetual donated funds for the fit-out of the laboratory to show their patch, the microscope being used, artefacts being collected etc	Stills & video of 'Ledingham" artefacts being taken from main hut to laboratory, logging & restoration work in laboratory & subsequent return to main hut.
8. Tourist visits	Stills & video of tourist visits by Aurora Expeditions Marina Svetaeva, The Orion & MV Bremen.

ADDITIONAL TO MHF BRIEF	ACTION
Search for 'Air Tractor'	I spent many hours working with Chris Henderson in studying, comparing, retouching and marrying old photographs of the 'Air tractor' to assist in locating it beneath the ice.
Mawson's Huts first day covers	Stills & video taken of 'Postmaster' Dr Chris Henderson & team stamping & franking first day covers on Marina Svetaeva, Macquarie Island, Cape Denson on January 8 plus at the French base Dumont Deville.
Marina Svateava sea voyage	Stills & video of various aspects of sea voyage Hobart to Macquarie Island to Cape Denison & unloading of cargo by helicopter.
Lake mapping	Stills & video of ground penetrating radar being used to map lakes, data analysis & results.
Documenting huts	Documentation by conservators of all five huts.
Data Loggers	Stills & video of collecting data from data loggers using Panasonic Tough Books.
Corrosion & rust samples	Collection & removal of rust samples from kitchen in main hut.
Memorial Cross	Documentation of Memorial Cross.
Hut Antennae	Removal of aerial & antennae from workshop.
Benchmark surveys	Stills & video of setting up benchmark & survey work. Also document plaster cast of Mawson's benchmark made in 1912.
Tide gauge	Still & video of tide gauge deploy in Boat Harbour. Plus assisting the French in their tide gauge work.
Air tractor seat	Video of documentation of Air tractor seat by conservators Ian Godfrey & Michelle Berry including debate resulting in it's removal & planned restoration.
Sorensen Hut	Some coverage of day to day life in Sorensen Hut.
AWS Reboot	Documented repairs & rebooting of the AWS
360 degrees stills of Workshop & Main hut = 36 stills in 10 degree increments. Requested by Peter Morse for use in his 3D programme.	Due to dramatic ground level fluctuations the results are not perfect. The height of the north wall from ground to roofline is approximately 7 feet & the south wall the roofline is below ground level. Getting each shot at 90 degrees to the hut's vertical was impossible with the current snow cover.
Expedition team photos	Numerous team photos were taken as a record in various locations.

AERIAL PHOTOGRAPHY

In October 2008, the Mapping Officer of the Australian Antarctic Division Henk Brolsma, requested I take some photos of the approaches to Boat Harbour if possible for Admiralty sailing Directions - Antarctic Pilot. This was unable to be done due to poor weather on our arrival at Cape Denison using the Marina Svetaeva helicopter. If the weather had improved, we had planned to use their Jetranger helicopter with the side door removed for both stills & video footage however the weather & visibility prevented us from doing so.

I had also planned to get new video footage of the approach from Commonwealth Bay over Boat Harbour & revealing the huts, this was not possible due to poor weather & time restraints on the day of our arrival at Cape Denison.

SPONSORS

We were supplied with two large Mawson's Huts logos to stick onto the "Spirit of Denison" sled to replace the RMIT University stencils. These stencils were removed from the Sled by Ben Burdett, however the MHF stickers would not fit & we assessed that they would not have lasted the winter.

Removing RMIT University stencils

Placing Kordia stickers on "The Spirit"

It was therefore decided by the team to use the MHF stickers in the laboratory. One was placed on the Fume Cabinet & one on the south wall above the workbench.

MHF sticker above bench

MHF sticker on Fume Cabinet

SPONSORS BADGES

Sponsors logo patches worn on the sleeves of our Ventiles & Carhartt jackets were of equal size however the individual logo sizes on the patches I feel were not consistent. The Nikon & Kordia logos were both in large bold type, were as the Pitcher Partners & Reuters logos had quite small type & not easy to identify.

Visual comparisons of different logo type sizes.

I am currently considering retouching some of the still photos as required to give prominence to a particular sponsor prior to giving them their photographs.

It is our feeling that the possibility be looked at to have Velcro sewn onto the jackets & then a sponsors badge with Velcro on the back could then be stuck on as required. This would then focus the attention to the one logo as opposed to a logo with larger type attracting the viewers' eyes away from the logo with smaller type. In consultation with future sponsors, consideration should be given to sponsors logos on patches each being made in a similar type size.

The other problem I constantly faced while documenting work & featuring sponsors logos was that it is often not suitable or impractical to wear either the Ventiles or Carhartt jackets that featured the logos due to manoeuvrability or to warm to wear inside while working. This was particularly the case with the carpenters working or conservators working in the huts or the lab. It should be considered for future expeditions to have logos on such clothing items as beanies, goggles, work shirts, polar fleece tops, and brimmed hats & possibly on the bib & brace overalls which are all commonly worn.

All these sponsors' badges issues should be taken into consideration for future expeditions.

MHF SPONSOR REQUIREMENT	ACTION
Nikon would like their cameras seen in action & their patch featured.	Nikon patches featured prominently & stills & video taken of work featuring Nikon.
Panasonic would like their Toughbook notebooks in action. They are also providing shirts & hats for the team to be photographed in outside the hut.	No Panasonic shirts or hats were supplied. The Toughbooks are featured being used for data logging inside the huts plus used for satellite email retrieval.
Kordia who assist with communications had two laptops with their logo & also shirts & hats	No Kordia shirts or hats were supplied. Kordia logo featured prominently on some clothing. We also placed Kordia logo stickers on "The Spirit of Denison"

	sled.
Pitcher Partners (MHF accountants & auditors) will have an arm patch & require a good selection they can use for in house magazine & use.	Pitcher Partners logo on clothing quite small & hard to read, however stills were taken featuring their logo.
The chairman of British American Tobacco Steven Walker (also president of PHGC & strong supporter) is travelling on Orion's first cruise & I would like a shot of him inside the hut looking at the tin of Capstan tobacco which his firm supplied the AAE.	The Orion's first cruise arrived a few days before we arrived at Cape Denison therefore we were unable to meet up with Steven Walker.
Thomson Reuters, which provides MHF office space, will have a clothing patch & will require a selection of shots showing these.	Thomson Reuter's logo on clothing quite small & hard to read, however stills were taken featuring their logo.
Coverage (still & video) of passengers arriving from the cruise have ships visiting Cape Denison this summer I would like to provide them with a small selection of pix. Both are wonderful supporters.	Stills & video of tourist visits by Aurora Expeditions Marina Svetaeva, The Orion & MV Bremen. These include tourist visits to the main huts, interviews with Alasdair Macgregor, Don McIntire, Greg Mortimer, Diana Patterson, Qantas pilot John Dennis, Emma McEwin (Mawson's Great granddaughter) & Estelle Lazar. Various short 'vox pops' (i.e.: on camera comments) from selected tourists from each tourist ship.

ADDITIONAL SPONSORS	ACTION
Sir Peter Derham (Red Hill Wines)	Stills taken of Sir Peter Derham's framed portrait with bottle of Red Hill Wine inside & outside main hut.
Musquito Creek Wine	Stills taken of Peter Maxwell's bottle of Musquito Creek Wine inside & outside main hut.
Eumarrah Muesli	Not actual sponsor, however I understand they looked after MHF & gave good deal. The muesli was excellent. Still of Eumarrah Muesli taken in kitchen inside main hut.
Various other brands	Have taken stills & video of other logo'd brands in use in case the need arises for future expedition support. Honda, Makita, Dewalt, Green seas Tuna, Mars Bar, Goulburn Valley Canned Fruit, Olympus & Wallabadah White Box Wines (made & supplied by David London & family)

SKYLIGHTS & LIGHTING in MAIN HUT & WORKSHOP

When taking stills or video inside the workshop or main huts, one problem that often arose by trying to avoid the sunlight streaming in from the skylights. As generally inside the huts are dark in sections, the sunlight from the skylight had to be avoided as photographically the light they project gives a major exposure difference to the non-lit areas.

Part of my equipment included two Photo flex Multidisc 5 in 1 light reflector which double as a light diffuser. By simply placing this on top of the rafters in the ceiling in the path of the sunlight, it diffusers & disperses the sunlight through the hut, breaking down the sunlight into a soft even glow, similar to the effect of a modern skylight. With the Photo flex diffuser in place, I took light measurements in Hyde Park Corner & Murphy's bunk & the exposure 'f' stop increased by one f stop. This made more light available throughout most of the interior plus areas that were normally quite dark & was more even for the conservators & for taking photos.

Photo flex diffuser in place in workshop

I also became aware from the conservators, that during each expedition, the skylights are always exposed, allowing sunlight & UV rays to shine into the huts, possibly causing harm to the timber & artefacts. This practice may be temporary relief, however I propose that a temporary similar diffuser cover be investigated to be fixed to the underside of the skylights during each expedition.

OBSERVATIONS

BLOGS
All reports are that the blogs were a great success & I would like to suggest that these could be printed & made into a 'Diary log of the 2008/2009 MHF Expedition' & may make an excellent memento & possible saleable or auction item for the MHF.

CASH
On the Marina Svetaeva sea voyage there was the opportunity to purchase drinks & souvenirs & these could be paid for by credit card. We had the fortune of visiting the French base Dumont Deville, were we spent between $150 & $250 each. As we could only use cash to purchase souvenirs, it may be advised that team members take some cash on future expeditions.

In summary I feel the expedition was extremely worthwhile for the continued works programme by the MHF, even though not all projects were completed due to time restraints & weather. I would be more than happy to go on future expeditions knowing that I can apply some of the lessons I have gained from being part of the 2008/2009 Expedition.

STILLS & VIDEO EQUIPMENT

VIDEO, LIGHTING, SOUND & EDITING
Storm case iM2300 Sony HDV Video recorder/player HRV-15AP Sony HDV Video firewire & power cables (requires 240v) 7” LCD 12v colour preview monitor QM-3772
"Mini plus" 12V LED Flood Lite panel kit with 12V Lite panel battery, cables & connectors
2 x Photoflex Multidisc 5 in 1 light reflector Miller DS-10 Solo DV2 Tripod, fluid head & soft Miller carry case Manfrotto MONOPOD W/357 QL plate Miller DS5 tripod, fluid head & soft Miller carry case Manfrotto 051NB black light stand Manfrotto Lite disc stand
PELICAN 1520 weather proof Camera case 2 x PELICAN 1600 weather proof Camera cases 2 x Sony HVRZ1P 1080i Digital Camera (one owned by MHF & one owned by D. London) 5 x NP-F970 & 1 x NP F960 Info lithium batteries 2 x NPF970 battery charger 2 x Petrol Rain cover for SONY ZP1 Sony "Sun Gun" camera light 2 x Rode directional Condenser microphone 30 x 40 minute rolls DVCAM/HDV digital tape stock
Lavalier wireless microphone kit with: Sony Radio microphone receiver Sony Radio microphone transmitter Sony Lavalier mike AA Eneloop rechargeable batteries & 10 pack charger
STILLS Nikon D700 (supplied by Nikon) with 4GB card 14-24mm wide angle Nikon lens (supplied by Nikon) 24-120mm standard zoom Nikon lens (supplied by Nikon) 70-30mm long Nikon lens (supplied by Nikon) 2 Nikon P6000 compact cameras (supplied by Nikon) with 1GB card & spare batteries Accessories including Sunpak flash, remote shutter & 2 spare Manfrotto base plates. Nikon D50 Digital SLR + 1Gig flash card Nikon 18-105 lens Tamron 70-300 lens 4 x lithium batteries & batter charger Pelican 1550 hard camera case, cables filters & accessories Manfrotto stills camera 3 way head tripod Back up second batteries & memory cards for all cameras as memory cards not supplied by Nikon
COMPUTER Pelican 1500 hard case Apple 17" Macbook Pro 2.5GHz Intel Core 2 Duo with Final Cut Pro editing software Western Digital 1 Terabyte portable hard drive & cables (requires 240v) Microsoft Optical Mouse 3000 Lacie Rugged 320GB fire wire hard drive (Bus-powered) assorted video & audio connecters/adaptors, firewire, USB & power cables

10. BASE CAMP REPORT by Peter Boyer

1 Scope of report

This report covers the management of the field camp at Sorensen Hut during its occupation by the 2008-09 Expedition team from 22 December 2008 to 20 January 2009. It is focused mainly on food, the most important aspect of camp management, but also touches on other activities, supplies and needs, notably management of waste.

2 Role of food/base camp manager

Each Foundation expedition to Cape Denison is distinguished and defined by conservation and conservation-support work and, to a lesser extent, other projects such as promotion of the Foundation and data-gathering for the Australian Government. A food supply, like clothes and transport, underpins those major tasks, but gets little mention except where there's significant failure.

As with many servicing functions in this and other Mawson's Huts Foundation expeditions, this role was not clearly defined at the outset and evolved over the course of the summer at Cape Denison. This is a reasonable situation given the size of the 2008-09 group and the need to select for more front-line functions than food management. In my case, I was selected as a journalist-writer ahead of whatever cooking skills I have, and this was borne out in the food I prepared. (My main meals were barely average; my bread-baking was more successful.)

The absence of a trained food manager or cook was not a major problem overall. All members of the team, to varying degrees, stepped into the breach. There was sufficient cooking skill in the group to ensure excellent meals most nights and a good supply of food for the other two meals. Another contributing factor to this was that the food supplied seemed appropriate, was in more or less the right amount and was of acceptable quality.

The fact that I've had no training in cooking or catering made my contribution in both ordering food and cooking more hit-and-miss than it would otherwise have been.
So far as ordering was concerned, I was greatly helped by the comprehensive report from 2007-08, notably the provedore's "shopping list" and the list of items left behind at Sorensen Hut on the team's departure. With that in mind I prepared a full list of ordered items and (with help from Megan and Michelle) a fairly complete inventory of items left behind which I hope will help the next team.

Cooking and catering were more problematic for me, showing up my lack of experience in this work. I found the first week or so quite stressful, a result of my uncertainty about the food ordered and lack of confidence in my cooking abilities. My burden, real or imagined, eased off in the last couple of weeks as others contributed some very fine cooking and gave good support in the kitchen.

While every year's team can be expected to be helpful and accommodating and to provide the sort of support I enjoyed in this role, in the absence of a trained cook future teams will benefit by having, at the outset, a more clearly articulated role for the nominated cook and a clearer understanding throughout the whole group of the support that can be expected from others.

3 Food supplies

The value of the lists provided by Anne McConnell of the 2007-08 Expedition has already been mentioned. This provided a very useful guide in ordering food for this year, taking account of the food left behind in January 2008.

The aim in ordering food was to avoid duplication and eliminate or greatly reduce the amount left over at the end of our anticipated five weeks. So far as fresh, chilled and frozen food was concerned, this was largely successful. Meat, vegetables and fresh fruit lasted well (though potatoes were in short supply). We used up all frozen and chilled meat products except for some salami and only a few packets of frozen vegetables were binned on departure. A not-too-large amount of surplus cheese, butter and fruit juice (along with beer) were provided to *L'Astrolabe*.

However, for other categories of food and other supplies, notably certain kinds of snack foods, there was a large surplus (see Appendix 2). For instance, current Sorensen Hut stocks include 61 packets of "Cup-a-soup" (each containing four sachets), 18 packets of Jatz crackers, 47 packets of Vita Weat biscuits, and 155 rolls of toilet paper.

The reasons for this surplus include the following: (1) our time at Cape Denison was shortened by a week; (2) I misread the information about the snack food available from last year; and (3) eating patterns that formed early on in the month ashore determined that some kinds of food that were popular in previous years were hardly touched.

This problem would have been exacerbated by the fact that most of the food remained out of sight, in Nally bins, throughout our time ashore. People tend to go for the food they enjoyed yesterday unless an alternative is on clear show. This "out of sight, out of mind" situation demands that the person managing the food has a good handle on what food is where, something I wasn't always up to the mark on.

The next Cape Denison team will need to make better use of food available from previous years than we did, which will mean noting the items in Appendix 2 and rigorously avoiding any purchase of items (or similar items) where there is sufficient quantity remaining. Also for the next and future expeditions, in the absence of a trained cook more time needs to be given before departure to consultation between team members and collaboratively working out menus. This should be coordinated by the nominated cook (or camp manager, the term I'd prefer) who should have paid time allocated – perhaps a day, maybe two – to complete this task properly.

4 Fresh food

In ordering food for Antarctica it's reasonable to rely mainly on preserved, chilled, frozen or vacuum-packed food (or some combination of these), which is what was done on this occasion. Even with the average temperature near or below zero degrees, fresh food can go off. This was the policy adopted for the 2008-09 expedition.

We did take some fresh food: carrots, potatoes, oranges and apples, and – thanks to the generosity of the *Marina Svetaeva* cook – two pumpkins. We were careful where possible to store the food at or near floor level, where it's coldest, and in the case of the pumpkins, mainly in Nally bins outside, where the temperature rarely rose much above zero. The potatoes were kept in a dark container until , with just a few days left, the last remaining were put on the open shelf where they did start to turn green, so it's advisable to keep potatoes in a box away from light.

All the food survived well over our four weeks ashore, and I think would have been good for another two weeks, or longer in the case of the carrots and potatoes. Although fresh green vegetables are not viable, we could have taken more fresh vegetables – onions and garlic come to mind; these are much better fresh than

frozen or crushed up in jars and based on their keeping qualities in Australia would easily have survived a month or two at Cape Denison.

I would especially recommend liberal quantities of fresh potatoes, carrots and onions; also a couple of pumpkins. Potatoes are an excellent staple (along with pasta and rice) and like carrots, are always a welcome part of any meal. Similarly for onions which go with practically any recipe. Pumpkin is not my personal favourite vegetable but is excellent as a soup and scone base and very good in a roast meal.

5 Frozen and chilled food

Ian Godfrey and Pete McCabe organised the excavation of ice in the blizz-tail uphill from Sorensen Hut, close to the rear of the hut, to serve as a freezer for the duration of our stay. This involved chain-sawing ice to make a rectangular hole in the side of the blizz-tail, providing space for four Nally bins side by side, and covering the bins with iceblocks. The hole was covered with a door which had been stored beneath the Hut.

The freezer served our purpose well: food remained mostly frozen and except for some discolouration in some of the frozen vegetables ("chow mien" packs) it kept for the duration. While there was some thawing it was short-term and did not affect the quality of the food. The door covering the hole was essential as the front of the freezer was in sunlight for most of the day. It was necessary to add snow around the door every few days to keep sunlight away from the Nally bins.

Chilled food (bacon, salami, cheese, butter, cooking cream etc) was kept in three Nally bins on the ground near the freezer, each covered with ice blocks. Initially we used bins with standard black-coloured lids but replaced these with white lids half-way through our stay because the black lids absorbed radiant heat from the sun. All-white bins should be used for this purpose.

6 Kitchen equipment

Cooking containers are barely adequate, although we managed well enough. Saucepans are probably a decade or so old, aluminium with what seems to be a Teflon coating inside (much of it gone), and nearly all of them are missing a lid. Some new different-sized stainless saucepans would be a good addition to the kitchen.

The kettle has seen better days; the handle is shaky and it lacks its whistle (which would have been handy as the kettle was sometimes left boiling). A new stainless whistling kettle would be welcome.
Other kitchen equipment was acceptable.

7 Other tasks including water and waste management

As mentioned above, cooking of main (evening) meals was shared around the group. It became established practice that the cook for any main meal was exempt from washing up, which was the responsibility of all others on an ad-hoc basis. This sort of informal arrangement worked well enough. As the acknowledged camp manager I made sure the kitchen was tolerably tidy (which often involved extra washing up) and took on the bread-baking role, which involved baking three-loaf batches most days.

The established regimes for water collection and the disposal of rubbish/recycled material, kitchen slops and human waste seemed to me to work well, despite (or perhaps because of) a lack of formal organisation. A small group such as this should be able to work these tasks out on an informal basis. While these tasks will never be equally apportioned, as many expedition functions take people away from Sorensen Hut for extended periods of time, the informal approach seemed to work well enough.

I took on the role of water-collector without any major hassles, although I'd probably have needed more help if the weather had been less kind.

Our toilet arrangements changed during our time ashore. The time-honoured poo- and pee-buckets were the arrangement for the first two weeks or so. In using them we benefited from the presence of three people who'd used them before, and no significant difficulties were encountered.

Then we migrated to a chemical toilet, which had the advantage of eliminating the need for a faeces bag and streamlining handling of the waste – except at the point of emptying, when it was much less pleasant than using the bag system. This involved tipping the contents into the sea from rocks and rinsing out the container in salt-water, preferably some distance from the "tipping point". Even on calm days there was a fair chance of getting faeces on clothes; no emptying was attempted on windy days.

In operation, the chemical toilet worked reasonably well with manageable teething problems, but despite this most members of the team (six or seven out of eight) preferred the old system, with some minor modifications to improve hygiene in Delaney's Dunny. The major reason for the preference was the problem of emptying into the sea.

So far as retaining the old system, the main sticking point was on an environmental question – the bio-degradability of the bags used. If these bags have nil environmental impact, then the overwhelming opinion of the group is that the old system is preferable to the chemical toilet. If the chemical toilet is found to have a lower environmental impact and becomes the preferred option, then a lot of attention will need to be given to the emptying process to make it a much more comfortable procedure than at present.

8 Personal note

Throughout my time at Cape Denison, and since, I have been very aware of what a privilege it has been to be a member of one of the Foundation's Cape Denison expeditions. So few people get to visit the Cape, which besides being a wonderful historical site is a truly beautiful natural place – yet I was paid to be there.

If the weather had been terrible, the living conditions barely tolerable and the social life difficult, it would still have been a privilege. But all these things worked in our favour: the weather was balmy for the most part and the living conditions are now first rate, as was the company of my fellow-expeditioners.

I take this opportunity to thank David for his tireless leadership of the Foundation, Rob for being so wise, tolerant and effective as the expedition manager, and Ian and Pete for being first-rate field leaders. I have been very fortunate to have enjoyed such a summer in such a place.

9 Recommendations

9.1 Where an expedition team lacks a trained cook, the way the nominated "camp manager" works within the team, and the role of others in support, should be articulated and understood by all well before the expedition departs.

9.2 In the absence of a trained cook, allow more time before departure for consultation between team members and collaboratively working out menus, coordinated by the nominated camp manager in paid time.

9.3 To make full use of food available from previous years, rigorously avoid any purchase of identical or similar items where there is sufficient quantity remaining at Cape Denison.

9.4 Future expeditions to note that with care in transport and storage, certain fresh vegetables and fruit, notably potatoes, carrots, onions, garlic, pumpkin, oranges and apples, will remain perfectly edible for six to eight weeks ashore.

9.5 At least four all-white Nally bins should be provided for chilled food which may be exposed to sunlight. All food would benefit from storage in white or light-coloured bins.

9.6 Purchase three different-sized stainless-steel saucepans and a whistling stainless-steel kettle for the kitchen.

9.7 Retain the old system of human waste management unless there are environmental reasons to abandon it. If a chemical toilet is preferred, such a system must allow emptying in all conditions, including high winds, without risk of contamination by flying faeces.

9.8 Acquire the items identified in Appendix 3 as needed for the next expedition.

11 SCIENTIFIC AND OTHER REPORTS by Dr Chris Henderson

11.1 GPS POSITIONS OF CAPE DENISON LANDMARKS

A request was made from AAD for measurement of GPS positions of prominent landmarks around the Cape Denison area. Accordingly a number of points were recorded, each being photographed as well. A handheld (GARMIN GPSII) reading WGS84 datum was used. There was satellite coverage of around 9 satellites for each spot, and 10 minutes or so was allowed for the position to stabilise before recording the information.

GPS positions were (Deg,Min,Sec):

Feature	*Image#*	*South*	*East*
Penguin Knob	1	67 00' 16.7"	142 39' 31.5"
Magnetograph	2	67 00' 22.1"	142 39' 47.5"
Memorial Cross	3	67 00' 29.5"	142 39' 19.1"
Hill Mem ridge	4	67 00' 33.6"	142 39' 23.7"
Mawsons Hut	5	67 00' 31.2"	142 39' 39.4"
Proclamation mast	6	67 00' 33.3"	142 39' 51.6"
Hill nr Weather Sta	7	67 00' 33.7"	142 39' 50.4"
Hill nr Round Lake	8	67 00' 30.7"	142 39' 54.5"
Cairn nr Round Lake	9	67 00' 26.9"	142 39' 52.2"
Hill opp Sorensen	10	67 00' 30.0"	142 40' 01.4"


1
2
3
4
5
6
7
8
9
10

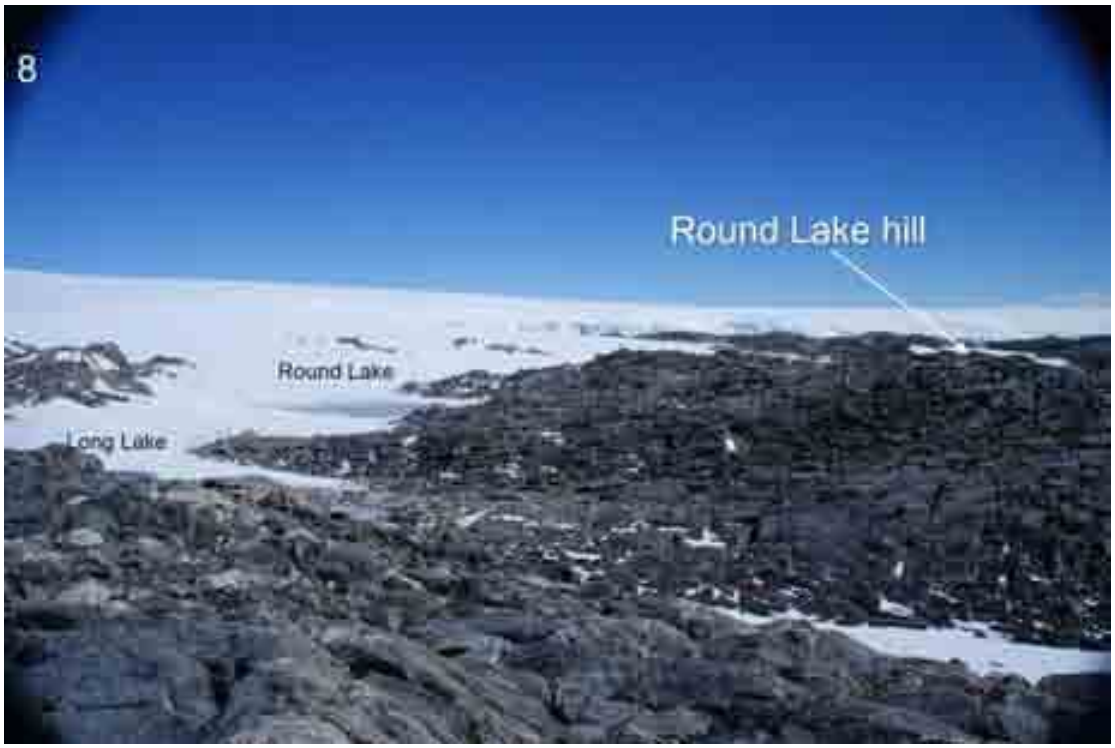

1
Penguin
Knob


2
Magnetograph Hut


3 and 4
Hill
Memorial Cross


5
Mawsons Huts


6 and 7
Wireless Hill
Proclamation Pole

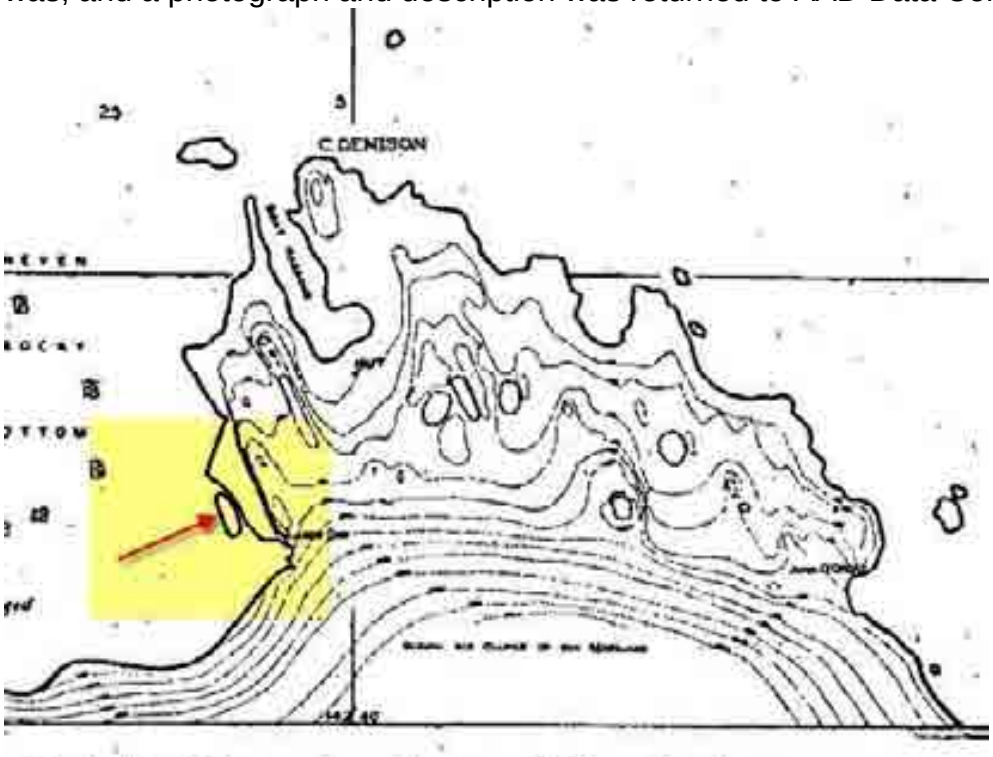

8
Round Lake hill
Round Lake
Long Lake


9
Cairn on Round
Lake Ridge
Sorensen Hill


10
Sorensen Hill

PICTURES OF LANDMARKS WITH GPS POSITIONS NOTED:

A further request was made to identify whether an island existed off Lands End, as mapped by Mawson in his AAE report. Apparently it was not possible from the satellite images to tell whether an island existed or not. Clearly there was, and a photograph and description was returned to AAD Data Centre.



Mackellar Islets and anchorage off Cape Denison.

11.2 TIDE GAUGE DATA RETRIEVAL

On 17 Jan 09 the French came with divers to download their tide gauge data. The plan was to give us the opportunity to get our download by placing our recording coil around the apparatus, and to level the apparatus to the shore benchmark by holding a marked steel pole in the locating hole in the centre of its top. We provided a Zodiac, while the French brought their 9Hp outboard. This procedure had worked well in the past - but on a sunny calm day in Boat Harbour when the boat remained still and underwater visibility was good.

This year it was not possible to retrieve the tide gauge data. The following is an account, written the day afterwards, of why.

It took some hours for the French to organise their dive, retrieve their tide gauge, and give us a window of time while their data was downloaded. By the time the divers were ready for us it was after midnight, very cold, with a 20kt wind blowing. The dinghy needed steadying to a shore line as well as the use of the outboard, since it was veering in the wind.

The divers put inductive ring around the gauge but the program would not download. I had downloaded the barometric data earlier that day from the instrument in the Sorensen Hut without problem, and went through the same procedure in the boat. I tried the program 3 times to get the data, all with the same negative result (using the Windows, not DOS program). I checked the port connection, the modem, and the physical connections, all of which were apparently working. The computer was running off an external battery via the DC-DC converter.

At this stage it was not possible to proceed further and the attempt was abandoned. The computer had taken a couple of waves (despite being in a Nally bin which didn't give much protection), the seawater was freezing on the screen, my gloves were frozen solid, and I was soaked (for the ventiles certainly aren't waterproof).

The French had offered to help us with the height measurements using their electronic level, but Pete McCabe and I judged it too risky to be out in the conditions with an 8m steel pole. If nothing else, holding the pole still would be impossible for the boat was veering almost uncontrollably in the wind. But it was twilight, and seeing the measuring scale would have been unlikely. The results would have been suspect at best.

The computer was given a quick wash in fresh water on return to the hut, and dried slowly, but not surprisingly did not work – although it did start up back in Australia 4 weeks later.

GPS float line: We had a problem with the line securing the GPS float, which illustrates the way equipment needs to be secured properly. The float was deployed on a calm day, but the wind blew hard that night and the anchor rope was cut by a sharp corner of the frame in two places. The unit blew out to sea, and only landed on some rocks near the entrance to the harbour by good luck.

A second attempt was successful, using stronger rope and a chain and shackle. The French, using similar equipment, probably did it better.

Our first attempt, note two knots attached to frame – these knots were cut by sharp edges of the frame, and the frame blew away

Second attempt – stronger rope, chain and shackle. This worked.

The French solution, which seems much better using a bigger spliced loop centred using lashings.

11.3 AUTOMATIC WEATHER STATION (AWS)

The AWS is owned by the University of Wisconsin, and MHF does occasional maintenance. Each year the weather station needs rebooting by taking out and replacing the battery plugs. This year the anemometer head was replaced.

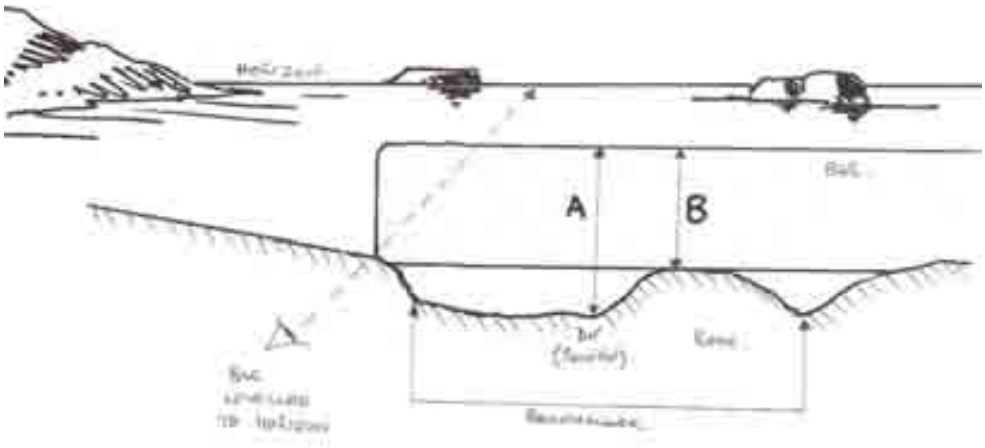
battery box and plug which needs to be removed and replaced.

Re-booting the weather station.

Replacing anemometer head at top of weather tower.

11.4 MEASURING THE HEIGHT OF MAWSONS BENCHMARK

Peter McCabe and Dr Chris Henderson



Method of measuring the height of raised area of Mawson's Benchmark.

Mawsons Benchmark is cut into a rock next to the workshop. It has a central dip and a raised area of rock within the circular mark. The raised area is accessible for the base of a surveyor's pole, but the bottom of the dip is the actual benchmark.

The height of the rock above the dip was measured as shown above and in the photo (taken by David London). An aluminium bar touched the top of the rock. It was levelled with the horizon, and the distance between the top of the bar to the bottom of the dip (A), and the top of the bar to the top of the rock (B), was measured using the height gauge of a high-quality digital caliper. Five measurements were taken and result (A-B) averaged.

A	B	Height = A-B
67.43	50.02	17.41
66.72	49.80	16.92
66.02	49.70	16.32
66.87	50.07	16.80
66.54	49.87	16.67

Mean height = 16.82 mm

(1 sd = 0.397 mm)

11.5 GROUND PENETRATING RADAR IN MAWSON'S HUT

SUMMARY

Ground penetrating radar (GPR) was used in Mawsons Huts as a 'proof of concept' to see how easy it was to operate, and to see what information could be gained about the structure of the ice on the floor, and the presence of artifacts.

A method of using GPR was developed which is easy and fast. The data processing technique is relatively simple, and apparently reveals the structure of the ice layer and shows what look like artefacts. The present study was able to show the ice structure down to about 1.25m below the level of the surface, which includes the sub-floor region.

There was no opportunity to explore the ice to calibrate the technique, and this needs to be done if the technique is considered useful.

METHOD

Unlike the radar scans on the lakes and looking for the Air Tractor, this application of Ground Penetrating Radar could not use GPS, since it was done on small areas inside Mawsons Huts. A way of making position information available was needed, and this was done using a grid.

A gridding device was made using two pieces of form ply, one in a T shape, the other a straight piece with holes drilled at exact distances of 25mm apart, and of a width to exactly fit a tent peg without lateral movement.

The straight piece was screwed to the ice using large (100mm x 12g) screws, and the T piece used as a guide for the 800Mhz radar aerial which slid along its edge. At the end of each run the T piece was moved one hole along the straight piece.

As the aerial was moved along the T piece, the distance wheel triggered a recording. The frequency of recording was every 1cm. Each line of the grid was done in the same direction, and each line formed a separate file.

Depending on the space available the number of grid lines varied from 21 to 40.

Figure 42: The equipment ready to scan an area of about 0.8m square near the table. The 800Mhz aerial and trigger wheel is run along the guide bar. The guide bar is moved along the fixed bar which is screwed to the ice (the bar is shown top left with registration holes). The guide bar (T piece) is held in place by the tent peg.

Areas chosen for scanning:

The hut floor is packed ice crystals to a depth of about 500 – 600 mm. It is relatively smooth, but undulating. Four areas were chosen where the surface was flat enough to fix the guide bars to the ice, and to run the aerial freely in the grid lines.

Figure 43: Scanning next to the bunk of J. H. Close. The floor was undulating but relatively smooth. Four areas were chosen where the guide bars allowed easy movement of the aerial. (Photo David London)

The areas scanned are shown in blue in the floor plan below. The areas near the bunks and the table were chosen because they were likely to contain artifacts. The area near the workbench in the workshop was known to have been cleared to the floor previously, so acted as a 'control' area.

Aerial parameters

The 800Mhz aerial was used, sampling frequency 8991Mhz, time window 30ns, trace interval 0.010m, stacks 8, samples 268, traces varied depending on scanned length, but around 80. A ground velocity of 190m/s was assumed (but not calibrated).

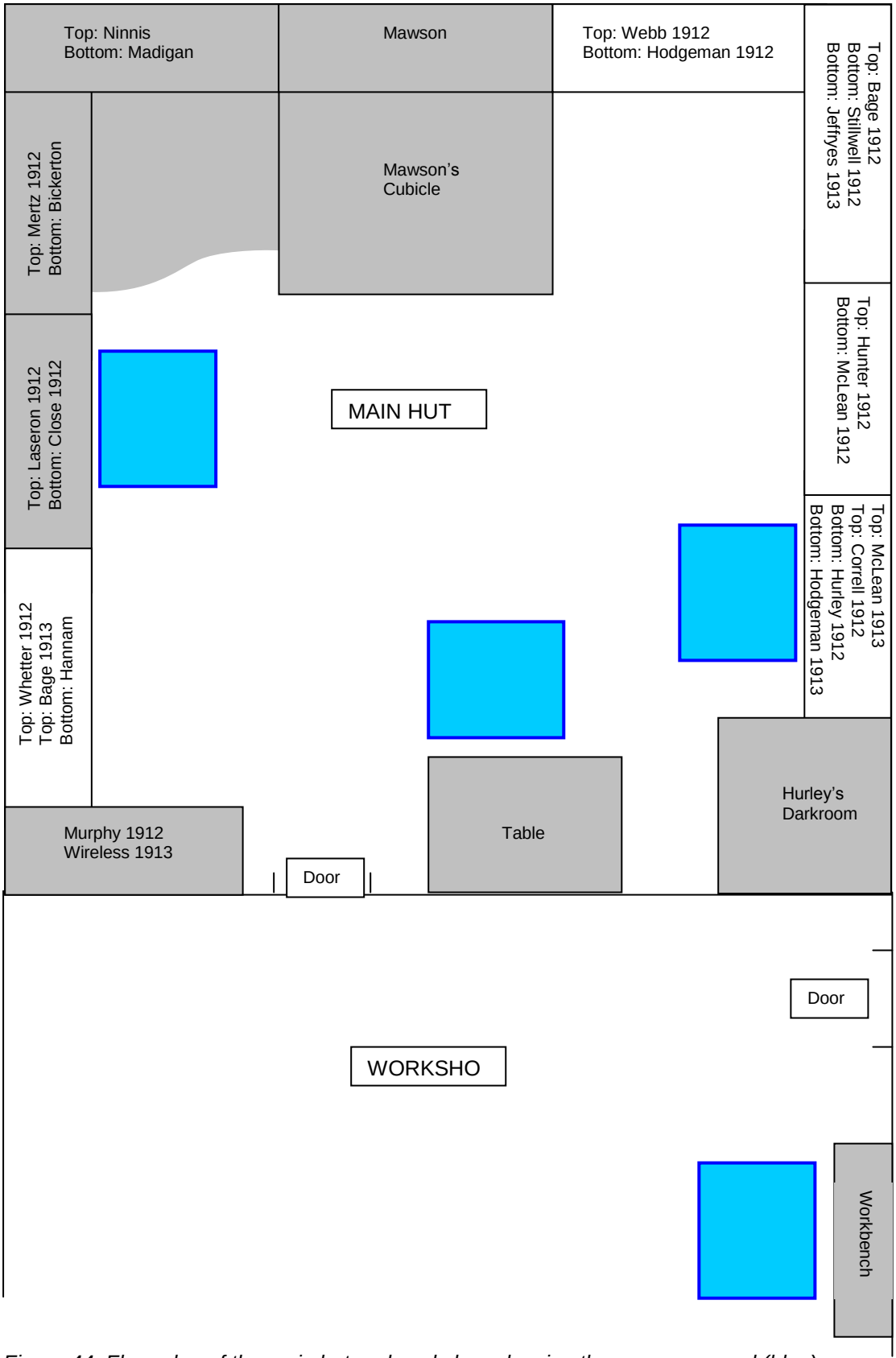


Figure 44: Floor plan of the main hut and workshop showing the areas scanned (blue).

DATA PROCESSING AND RESULTS

DATA COLLECTION:

The area scanned generated a large number (around 600,000) of data points, each representing the amplitude of the radar reflection at a defined position. The data was either dark or light depending on the peak or trough of the reflected radar wave, and its strength was indicated by the intensity in a grey scale. The radar equipment was able to penetrate through the floor and down to about 1.25m below the floor, though the strength of the reflections dropped off rapidly.

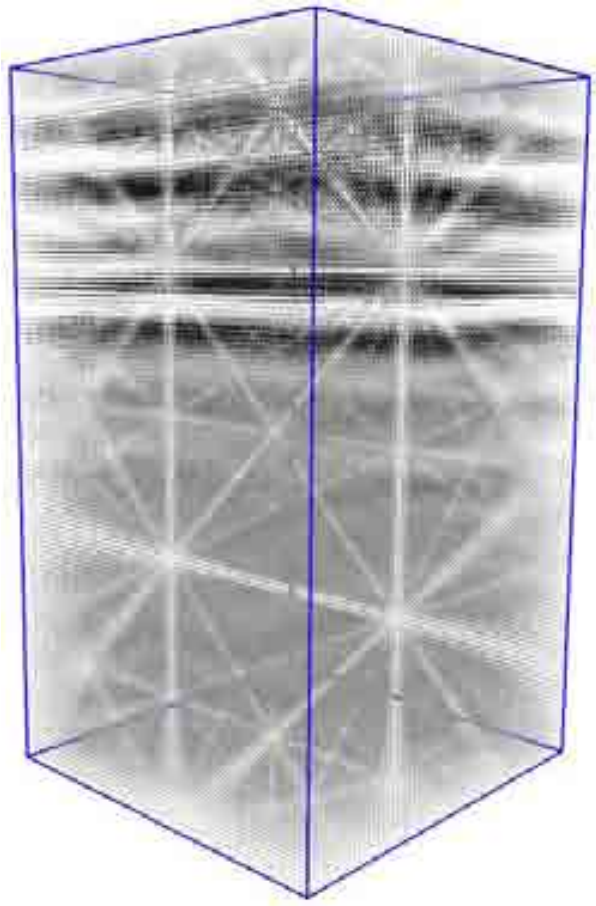


Figure 45
Shows the density of data points used to make the images. The dots, which are almost too small to see, fill the scanned volume. Approximately 600,000 points were recorded for each scanned area.

At each line of the grid a 2D image of the radar reflections was recorded. A series of images therefore represented a series of slices through the ice, as shown in figure 4 below.

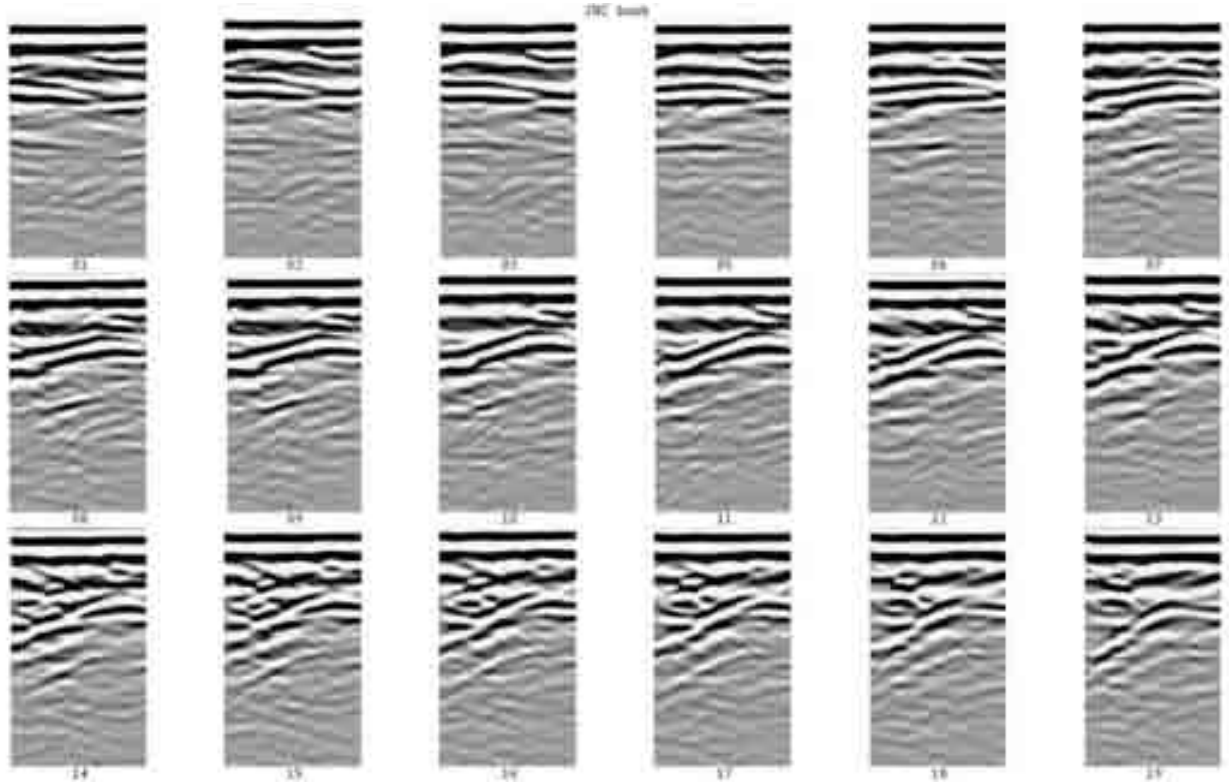


Figure 46:
A series of vertical slices represents the radar reflections from the ice below the 800Mhz aerial. Each slice is a line of the survey grid. These slices are put together to form a 3D picture of the ice and its contained objects. The arrow shows the level of the floor. Reflections may indicate ice layers and suspended artifacts. (images produced by Groundvision from Mala[23] Geoscience).

DATA PROCESSING:
The data from the hut was processed in a different way to that in the search for the air tractor, where it was appropriate to average radar reflections at an area of interest; and different from the lakes where the strongest reflection represented the depth of the lake bottom. Averaging would conceal, rather than reveal, the shape and location of artifacts, while the areas of interest lay within the sample volume and not at the bottom. Therefore a method was developed which emphasised the shape and position of the radar reflections.

The presence of anomalies in the reflections suggest the presence of artifacts, and the data processing is designed to make the anomalies more visible. It was not possible to dig into the ice to confirm the nature of the anomalies, so the present study is confined to developing a method of demonstrating their presence. If the procedure is to be used again it would be necessary to calibrate the images.

[23] www.mala.com

RESULTS: 3D demonstration of anomalies

The method of showing the data developed here uses the following programs: Mala Groundvision program to show the greyscale images, Irfanview[24] image processing, Snagit[25] image capture software, and Voxler[26] from Golden Software (Boulder, Colorado, USA) who partly sponsored the research. Image processing was as follows:

1) The images shown in Figure 46: above were captured from the Groundvision software screen by Snagit, and processed into identical pixel sizes using Irfanview.

2) A series of images was then input to Voxler, which built up a 3D stack. The software could rotate the images in any direction, which makes features readily visible. They can only be seen here in 2D, but perspective lines are used to enhance the 3D appearance.

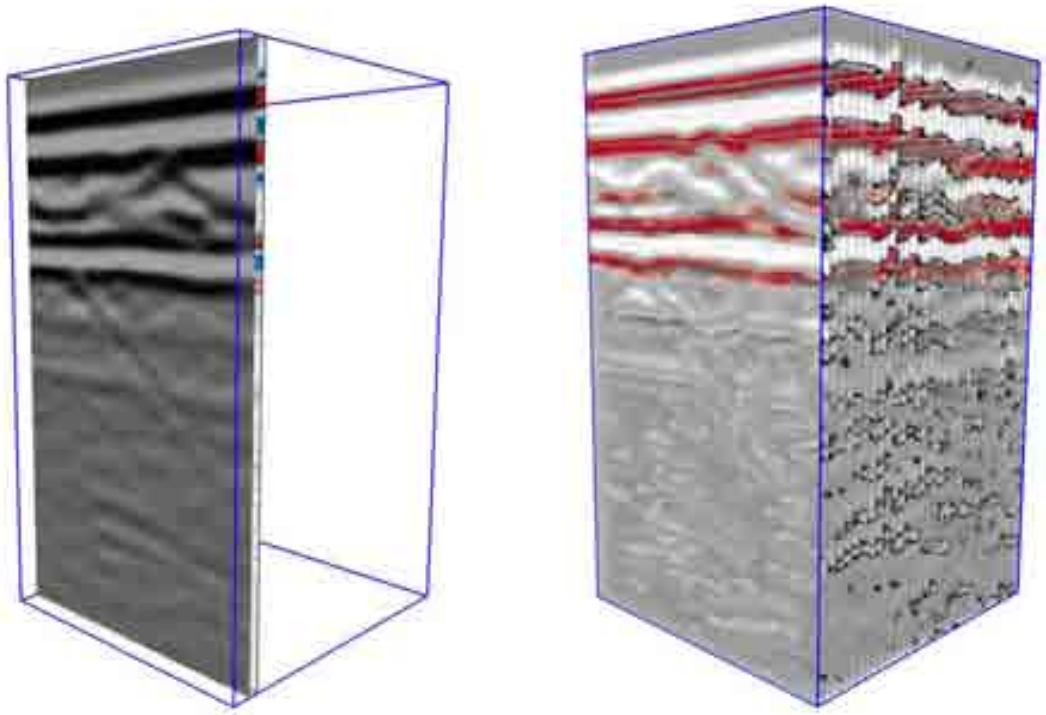


Figure 47

The image of each 2D slice is imported into Voxler (left) until a stack is built up of all slices to make a 3D representation (right). False colour is applied to make features more readily visible.

[24] www.irfanview.com
[25] www.techsmith.com
[26] www.goldensoftware.com

3) Contour lines were applied to each slice to enhance the anomalies. The contour line map could be moved independently of the colour map.

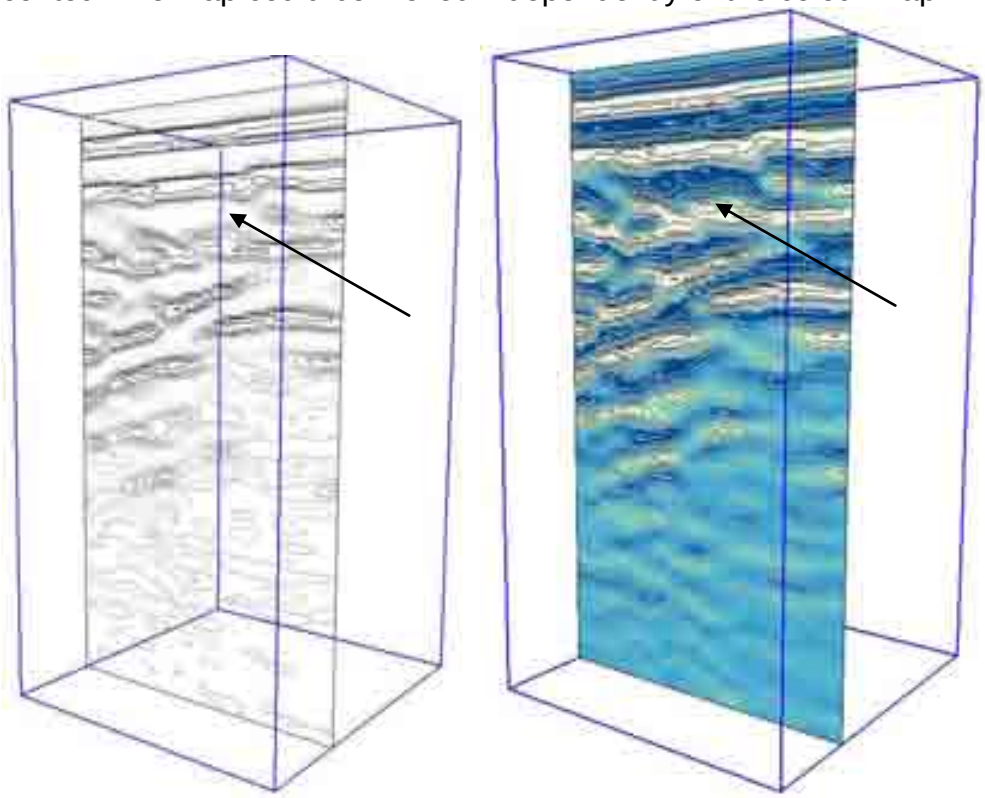
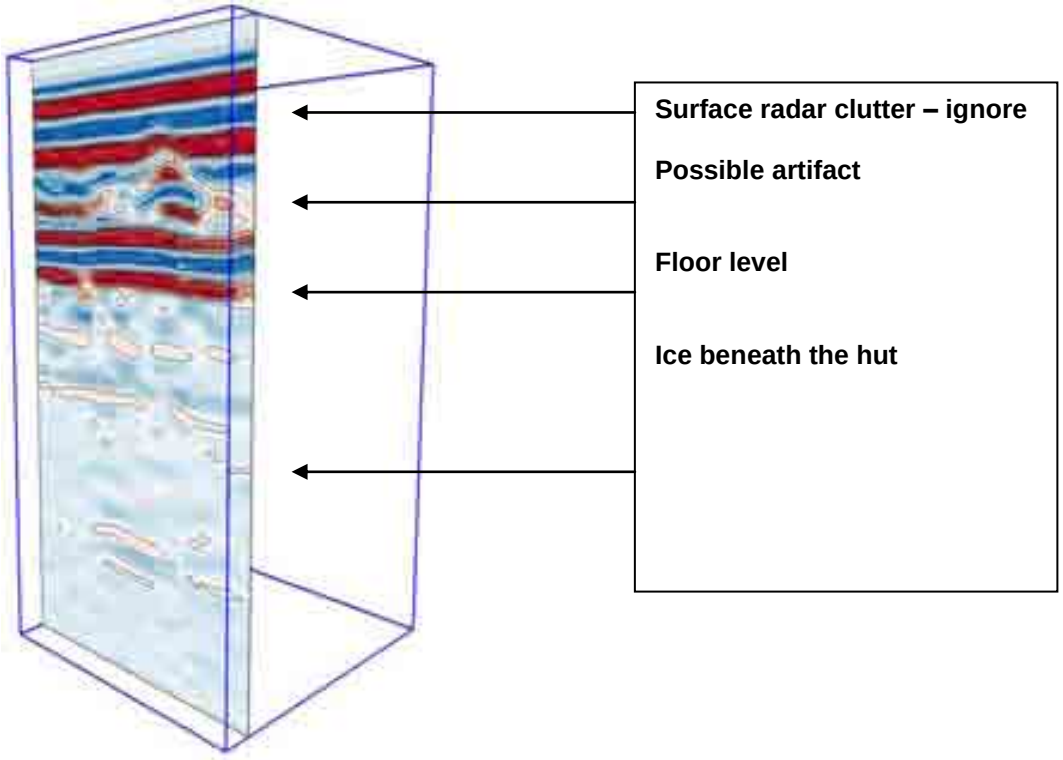


Figure 48

Contour lines applied to the image slices, were made more visible by applying a backing coloured slice. Above shows a region from JHC bunk area with possible artifacts below the surface (arrow).

Below is a region from next to the table with an obvious anomaly in the ice.



4) Other 3D effects can make the relationship between objects more visible. For example

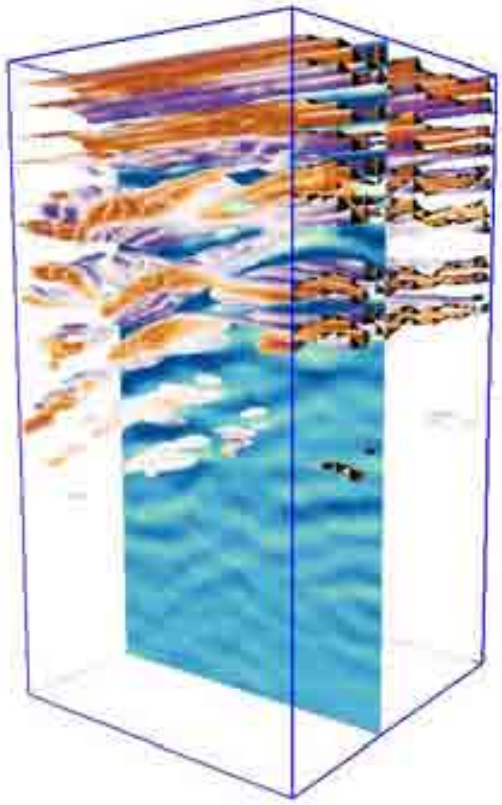


Figure 49
This shows the ice layers and possible contained artifacts in a 3D representation where the layers seem to float in the study space. The blue background enhances the effect.

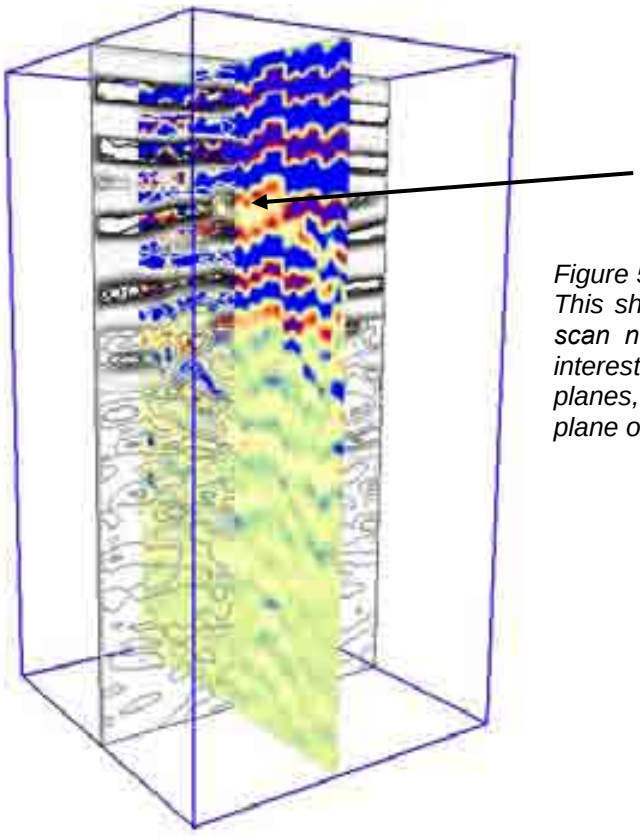


Figure 50
This shows a more complex image from the scan near JF Hurley's bunk. The area of interest is arrowed, and is seen in two planes, one a contour map, the other is in the plane of the edge of the stacked images.

DISCUSSION:

The purpose of this study was to investigate if it is possible to find out what is beneath and within the ice in Mawsons Huts. Clearly GPR works in this situation, and the results show that the images show structures within the ice both above and below the hut floor.

It was not possible to excavate any of the ice to find out what the observed structures actually were. If the technique is to be used again, then trials should be done on a similar ice structure with known buried objects.

Performing the recordings is easy and fast (about an hour per area), while data processing takes about 20 minutes. The equipment is portable and simple to use.

Suggestions for further study include using a higher sample frequency to enhance resolution and limit penetration to the floor ice only. The images should be calibrated against known objects buried in a ice layer of a similar composition.

Rougher areas of the hut could be scanned by removing surface ice to a flat surface, or by filling defects with packed ice or snow.

11.6 RADAR MAPPING OF LAKES

SUMMARY:
Ground Penetrating Radar (GPR) has been used extensively to measure the thickness of ice[27] on the surface of lakes, for lake bathymetry and to study the depth of lake sediment. The present study was essentially a feasibility study for the use of the GPR equipment. The aim was to see if GPR could be used to form a contour map of the bottom of ice lakes at Cape Denison, and to measure their sediment. As such the investigations done this year constituted a 'proof of concept' study for GPR with a view to using the technique in other areas of Antarctica such as the lakes in the Vestfold Hills at Davis.

The results show that GPR works well in mapping lake contours, and the technique for collection of data is simple, practical, and effective. It was found that sediment depths were different in the lakes studied, and it may be of interest to collect samples of this material in a subsequent expedition.

METHOD:
Equipment: The cart used to hold the equipment has been described in the Ground Penetrating Radar Theory report. The cart provided both a secure protected environment for the various items necessary to record data, and a simple method of transport, including the heavy 12v batteries used as a power source.

Power sources are a problem in the cold – laptop batteries lasted only a short time, as did the batteries supplied for the radar units (even with new battery packs). Accordingly the computer was run directly from a 12v battery, while the radar units were run from 12v – 8v converters. The Trimble GPS unit was run off internal batteries, which proved a problem, and on one occasion the batteries failed, invalidating the data, while on other occasions the batteries, and the spares, had to be warmed up under the operator's clothes in order to work. (It is possible to run the Trimble from an external source but this was not done here).

The frozen lake surface was thick enough to walk on (300mm of ice), but the top surface was very rough, being serrated like an egg carton with serrations up to 75mm high (figures 1 and 5). This not only made the cart hard to pull, but the vibrations unscrewed its nuts and bolts. It was found that attaching skis solved this problem and made for a smooth ride and easy pulling.

[27] **An introduction to ground penetrating radar (GPR) in sediments**
Charlie S. Bristow and Harry M. Jol
Geological Society, London, Special Publications 2003; v. 211; p. 1-7

Figure 51: Surveying Round Lake. Note very rough ice surface. The process was much improved by using the ski attachments to the cart. (Photo David London)

Figure 52: Ski attachments make the cart much easier to push on a rough surface. Penguins found the whole exercise fascinating.

Measurements were made on days when there was little or no wind, and clear skies. Generally they were done between 0900 and 2100 hrs.

Recording method: The method of recording data was to set the software to trigger from the distance wheel. At each trigger a GPS position was recorded.

Data collection patterns:
The data was collected by following a rough spiral track starting with the lake perimeter and working toward the centre. The width between successive tracks was approximately that of the cart wheels. This data was used to form contour maps of the lake bottom.

Additionally two grid patterns (without GPS) were done on each lake using the 500 MHz aerial. The grids involved up to 13 transects, about 1.5m apart. There was no intention of making a contour map from these grids, rather to compare the qualitative difference in the appearance of the recordings using the 250 MHz aerial.

Data collection:
Data was collected using the MALA Groundvision program, interfaced with a Trimble 5700 GPS, and MALA RAMAC GPR equipment via a Toshiba Satellite computer running Windows XP.

Radar penetrates different materials at different velocity. This means that the same thickness of ice, water and rock will not show up as equal on the recording. It was therefore necessary to calibrate the data. Holes were cut in the ice and the depth to the both the sediment layer and the bottom surface was measured. (It was found that the simplest and quickest way to make a hole was to use a crowbar to cut through the ice, and a shovel to clear the ice chips from the hole.)

The position of the holes was known. Observations were made on the thickness of the ice, the clarity of the water, and the thickness of the sediment at each hole.

The depth to the sediment was measured using a piece of C channel light framing steel 150mm long, which sank readily but sat on top of the sediment. The depth to the bottom was measured using a 6m x 25mm steel bar. The bar was moved up and down a few times to ensure it was seated on the bottom properly.

Data processing: Each scan (one continuous record) was stored in MALA .rd3 format, along with three supplementary files recording the parameters of the aerial, the GPS positions, and the position markers.

Six programs were used to process the data. The MALA Groundvision[28] and GP_workbench[29] programs were used to filter the data, removing horizontal components and enhancing deeper readings. Microsoft Excel 2003 was used to convert the GPS position data into meters. Programs were written in Turbo Pascal 7.0[30] to combine the position and filtered data into files for Surfer and Voxler[31] which produced surface and 3D maps.

Part of a data recording is shown in figure 3 below. This is a composite of about 300 sequential traces, lined up side-by-side to give a 2D picture of subsurface features. Data has been processed using two filters: *averaging* to remove horizontal components which cuts out the surface ice layer and emphasises the rock layer, and *time varying gain* which compensates for the attenuation of radar energy with depth.

The maximum reflection arises from the lake bottom. The depth to this surface was measured in units of 1ns for this study (left axis).

The GPS position of each trace was converted to distance in metres from an arbitrary origin defined as the most westerly and northerly of the GPS data.

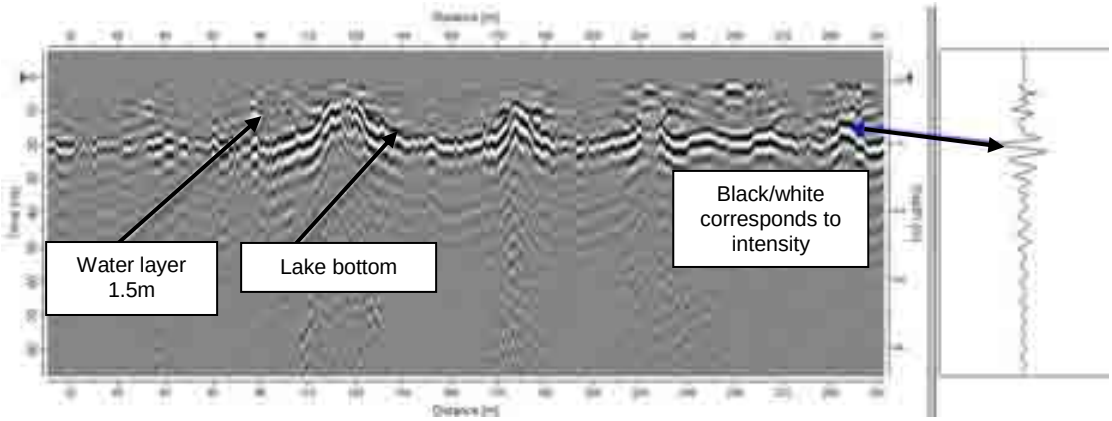


Figure 53: Recording from Low Lake. The 2D picture is made up of individual traces (like the one on the right) representing the intensity of the radar reflection. The water layer is compressed into the top of the trace because it has virtually no reflective properties. (The depth scale on the right is therefore incorrect, which is why calibration measurements were made of the depth of each lake.) The trace on the right also shows how radar energy is attenuated with depth.

Finally, using the position (XY coordinates) and the depth (Z coordinate) for each trace, a contour map was made of the lake bottom.

[28] www.**mala**gs.com
[29] http://pubs.usgs.gov/of/2006/1365/
[30] www.**borland**.com
[31] www.**goldensoftware**.com

Lakes scanned:
Two lakes were studied – Round Lake and Low Lake. Both were at least 40m across, and both appeared reasonably deep. Other lakes in the area were obviously shallow, except for High Lake, which looked too dangerous to walk on.

Since the depth of the lakes was not known the 250MHz aerial was used, having a theoretical penetration of about 4m in ice, and much deeper in fresh water. Resolution was compromised by the lower frequency, but this was less important than depth.

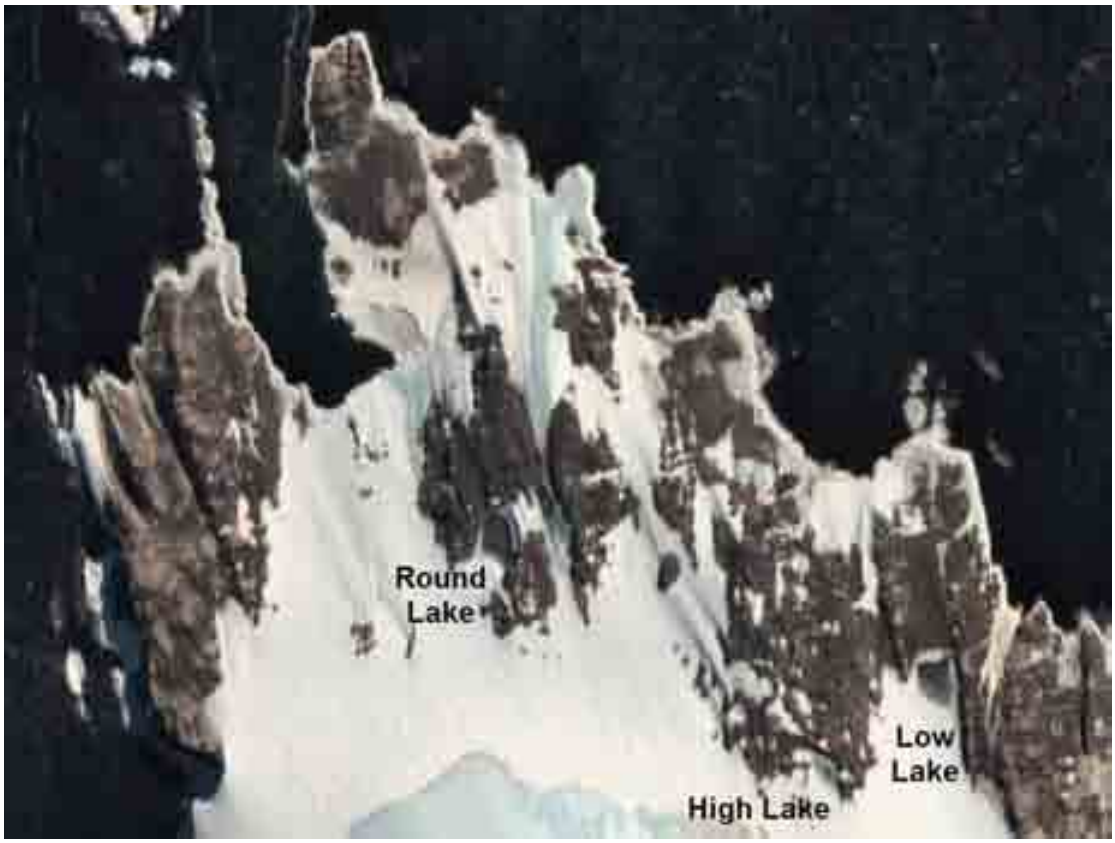


Figure 54: Aerial view of Cape Denison showing the position of the deeper lakes. High Lake w as not safe to walk on. The bottom of Round and Low Lakes were mapped.

Both lakes were scanned in roughly spiral tracks, using the larger 250 MHz aerial and GPS in a similar way to that in the Air Tractor search. Both lakes were also partially scanned using the 500 MHz aerial in a backpack configuration (without GPS). The main purpose of the latter was to investigate a qualitative difference in the radar images between the two aerials – theoretically the higher frequency 500 MHz should show more detail, and perhaps show the sediment layer.

ROUND LAKE:
This lake is just below the weather station, and is about 50m across. The ice surface was about 300mm thick.

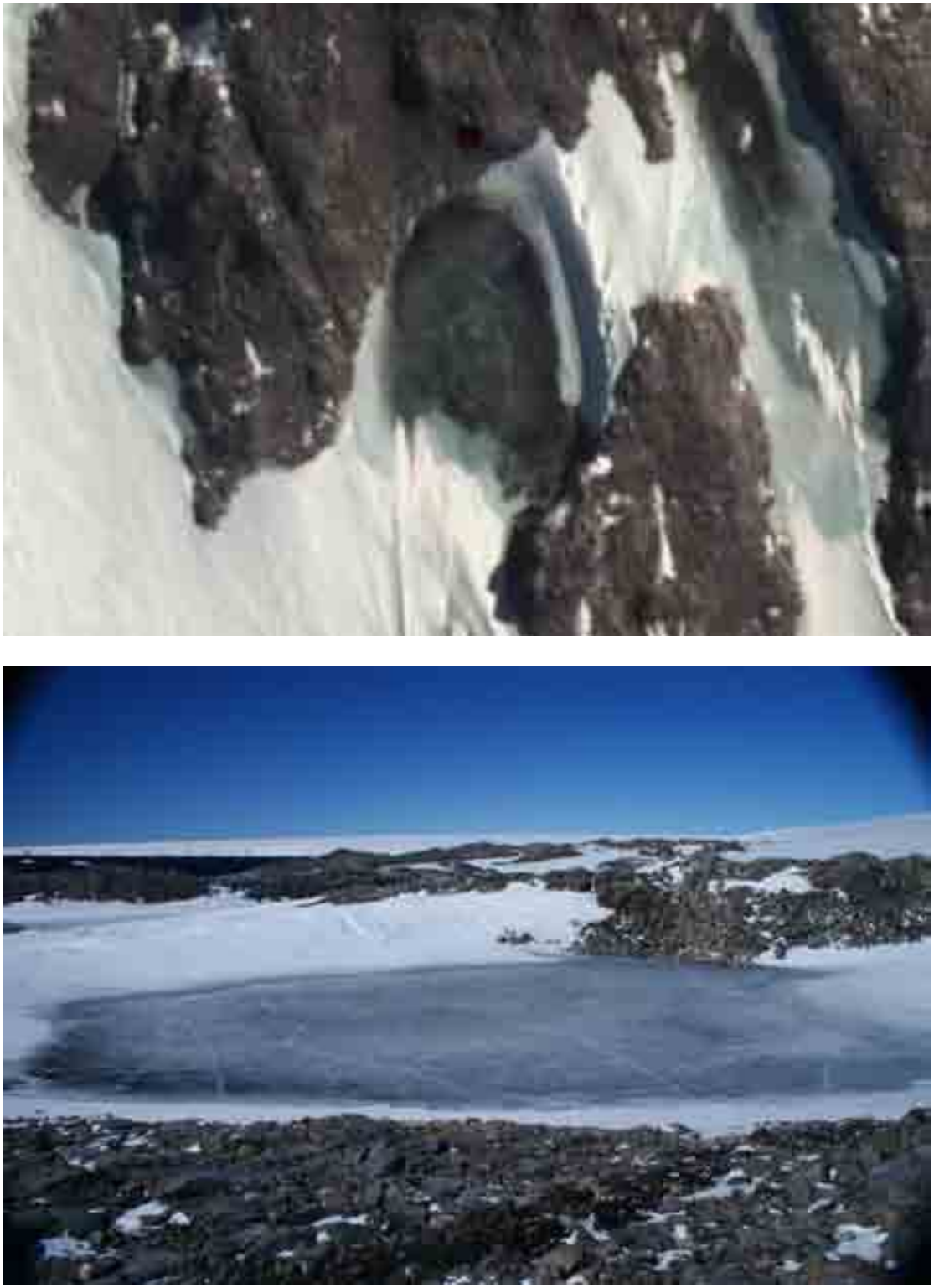


Figure 55: Round Lake aerial view from 80m and from ground level.

Figure 56: Ice surface and thickness Round Lake. The rough surface of the lake is well shown here. The surface ice was 300mm thick.

Sediment in Round Lake:

In Round Lake, where the water was crystal clear photographs were taken of the sediment. It consisted of buoyant 'blobs' of greenish material.

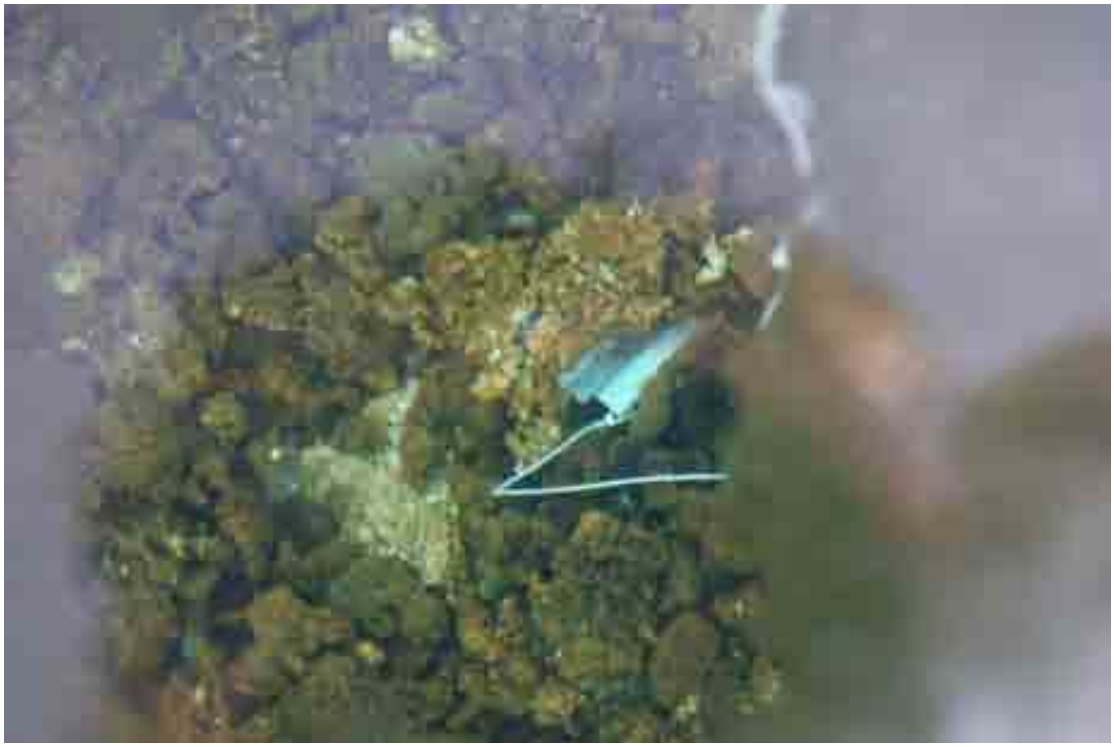


Figure 57: Picture of sediment in Round Lake. The sediment is 1m thick and consists of fluffy green/brown masses. The water is clear – this picture was taken through the ice hole and 2.5m of water. The 150mm metal C channel is seen on the sediment surface.

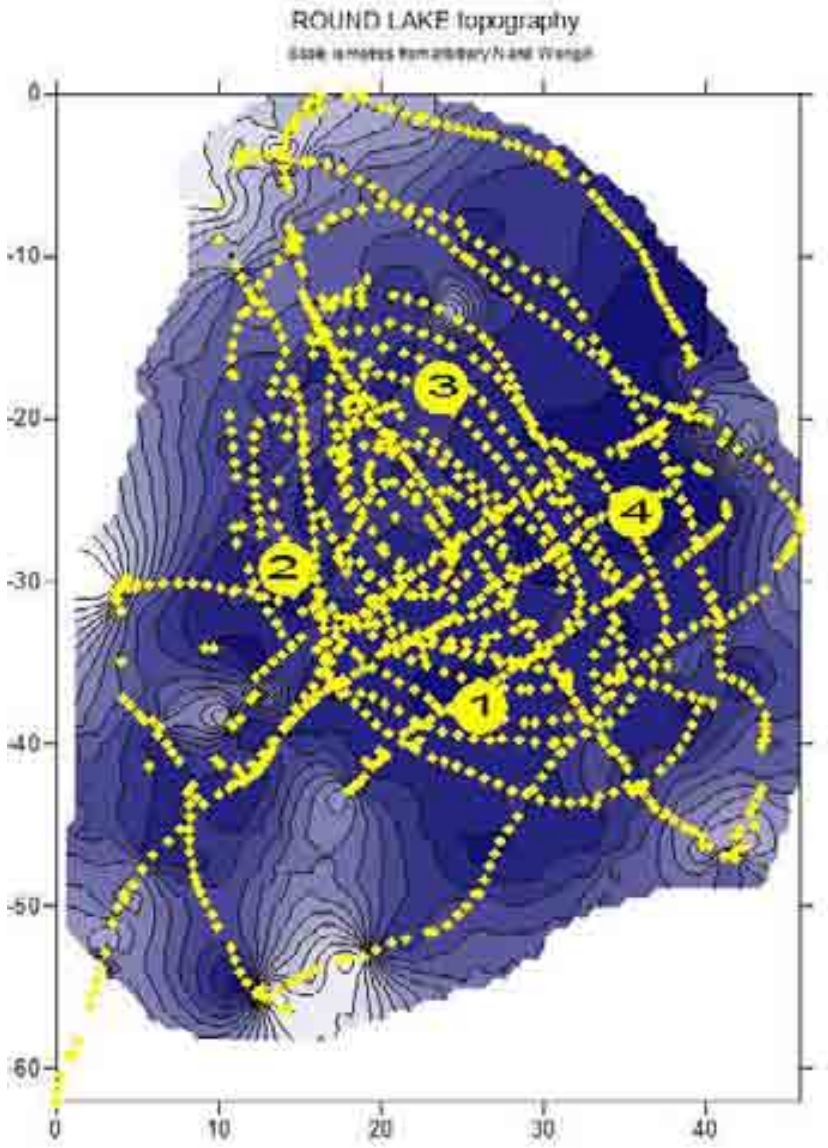


Figure 58: Round Lake showing bottom contours, with an overlay of the track of the radar unit, and 4 calibration holes.

Round Lake Depths

Calibration holes were cut in the lake surface at the the points shown in Figure 6 above. The depth to the lake bottom and the sediment surface was measured as follows (metres):

ROUND LAKE CALIBRATION: sediment and bottom depth (m)

HOLE NO	SEDIMENT	BOTTOM	DEPTH OF SEDIMENT
1	2.8	3.4	0.6
2	2.9	3.1	0.3
3	2.8	3.2	0.4
4	2.5	3.0	0.5

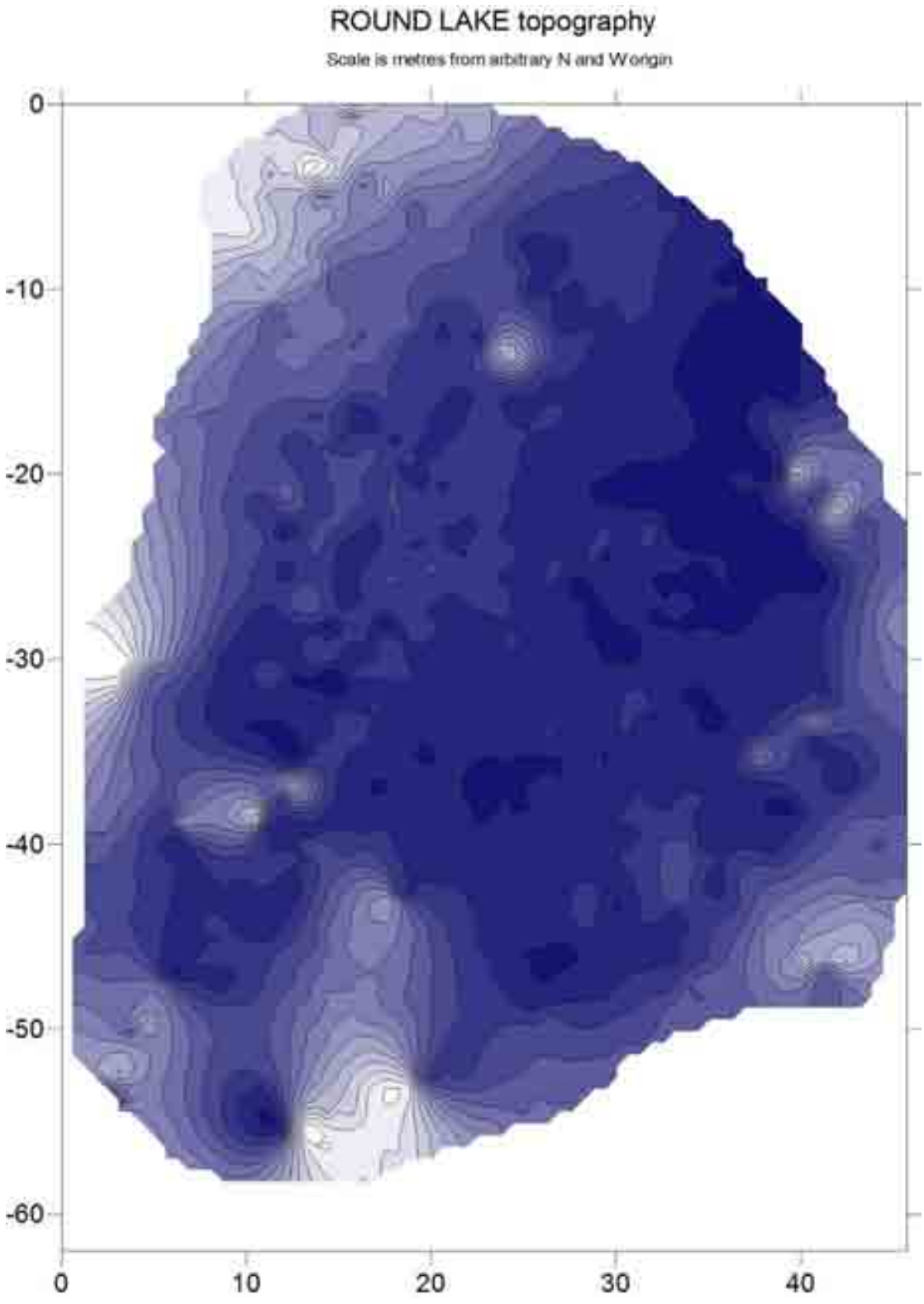


Figure 59: Round Lake showing bottom contours (depth units are in 1ns time slices taken from the recording. Physical calibration using the holes cut in the ice means the deepest contour is 3.4m). Darker areas are deeper.

LOW LAKE

Figure 60: Low Lake aerial view from 80m and from ground level. Light patches on surrounding rocks (see top picture) are penguin rookeries.

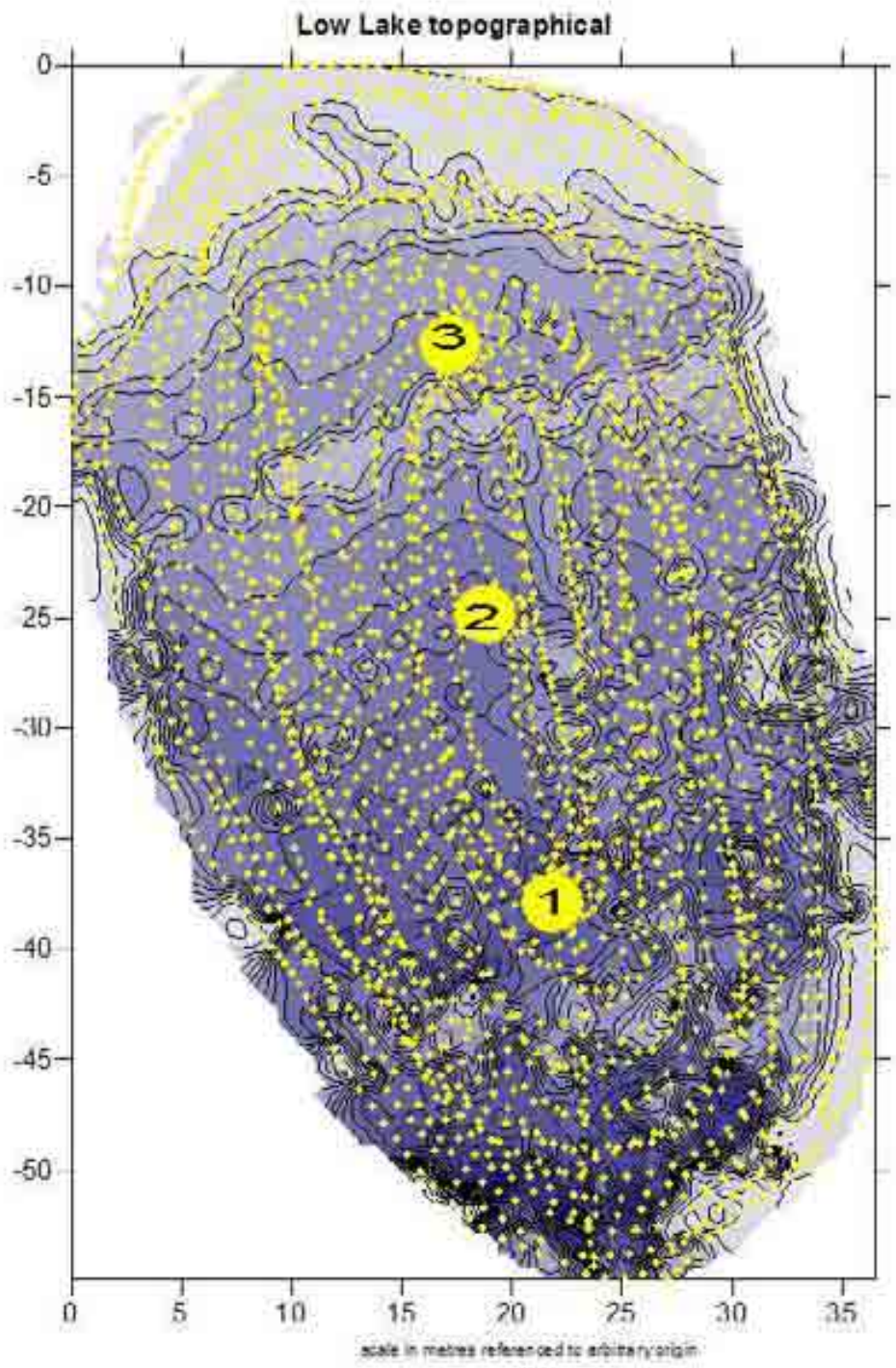


Figure 61: Low Lake showing bottom contours, with overlay of track of radar unit, and 3 calibration holes.

LOW LAKE CALIBRATION: sediment and bottom depth (m)

HOLE NO	SEDIMENT	BOTTOM	DEPTH OF SEDIMENT
1	1.9	2.2	0.3
2	1.7	1.8	0.1
3	1.3	1.5	0.2

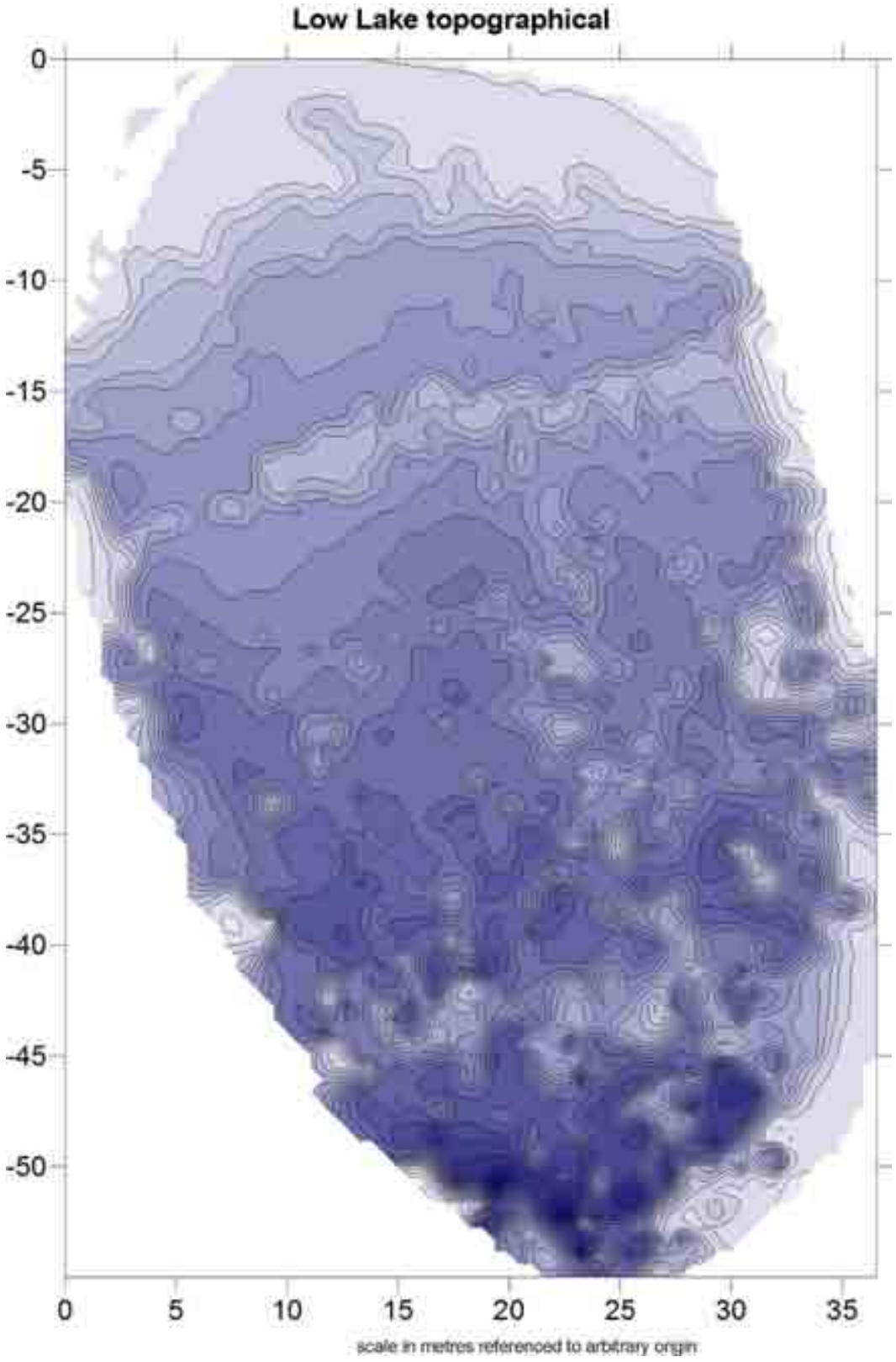


Figure 62: Low Lake showing bottom contours (depth units are in 1ns time slices taken from the recording. Physical calibration using the holes cut in the ice means the deepest contour 2.2m). Darker areas are deeper. Note the two distinct bands of rock at -20 and -45m.

Difference between 250 MHz and 500 MHz aerials:
The recordings were made with the deeper-penetrating but lower-resolution 250 MHz aerial. This has a penetration of around 5m in ice, but much deeper in fresh water. Since the depth of each lake was not known, it was thought that the 250 MHz aerial was a better choice. In fact both lakes were relatively shallow, so a further study was done using the 500 MHz aerial to see if there was any difference in recording at that frequency.

The equipment was used in a backpack configuration (which was how it was supplied) where the computer was held on a frame on the chest, with the electronics in a backpack, and the radar aerial being towed by hand. With the 12v batteries slung over one shoulder this made a very cumbersome setup, which was both uncomfortable and tiring to use.

The lakes were traversed in a grid fashion, skirting each of the calibration holes. The setup did not allow recording of an accurate grid sufficient to make a contour map, but enough data was collected to allow comparison between the two aerials.

Figure 13 shows a comparison between a section of the scan of Round Lake using the 250 MHz aerial, and selected gridlines using the 500 MHz aerial. The top 1/3 of the scan in each picture contains the important information about the depth and shape of the lake bottom.

Each of the data sets has a filter applied to remove horizontal elements and emphasise deeper reflections. Contrast levels vary between the images.

It can be seen that the essential features of the 2D pictures – the shape of the lake bottom and its depth – is much the same across all images. It must be remembered that the lakes are shallow, and that a lot of strong reflections are received from the uneven lake bottom, so detail is likely to be obscured. Not surprisingly therefore, the sediment layer is not readily seen, even though it is 600mm deep in parts.

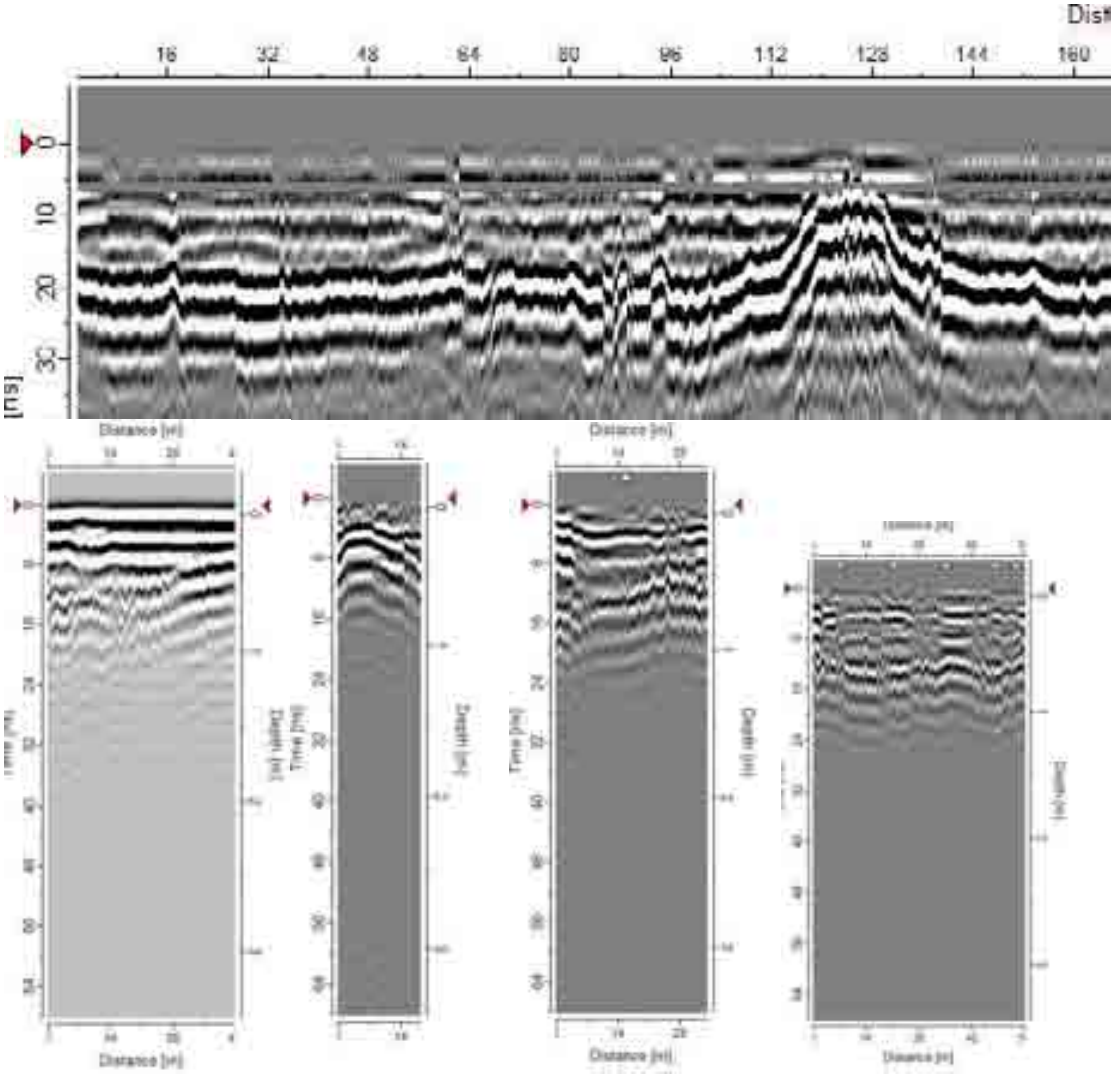


Figure 63: Round Lake: Comparison between a section of the scan using the 250 MHz aerial (top) and 4 lines of the grid using the 500Mhz aerial. The significant part of the scans is the top 1/3, and it can be seen that – allowing for different contrast levels – there is no essential difference in the profiles of the lake bottom between the two aerials. The sediment layer is not clearly seen using either aerial.

DISCUSSION

1. The sediment layers – particularly the deeper one in Round Lake, may warrant further study. Round Lake water is crystal clear, and the sediment is thick (600mm), consisting of brown/green masses. This may be a type of algae, and samples could be taken for analysis. Round Lake is situated among rocks and is virtually undisturbed with little penguin activity, whereas Low Lake is surrounded by extensive penguin rookeries and has turbid water with 200 mm sediment.

2. There is no qualitative difference between the 250 MHz and 500 MHz aerials when used in these lakes, possibly because strong reflections obscure detail at the shallow depths found. The sediment layer is not seen in these recordings.

3. There is a difference in the shape of each lake bottom. Round Lake is higher than Low Lake and bounded by rocks. Its bottom has a relatively smooth 'scooped' appearance. Low Lake is bounded on the N side by a moraine, and shows two ridges at -20 and -45 metres, perhaps reflecting glacial movements. Low Lake is half the depth of Round Lake.

4. The primary aim of this project was to trial the technique of gathering and processing data in Antarctic frozen lakes. This has been successfully achieved. The methods which have been developed here for operating Ground Penetrating Radar equipment - using the cart, deploying the equipment, and processing the data are simple, quick and effective. It is clear that this technique could be applied to other areas in Australian Antarctic Territory.

11.7 MAWSONS HUTS FOUNDATION FIRST DAY COVER

Dr Chris Henderson (Postman)

Mawsons Huts Foundation 2008-9 Expedition issued 500 numbered and 150 non-numbered first day covers franked with a special commemorative stamp designed by Australia Post. The stamp is dated Cape Denison January 8 2008, which is the 97th anniversary of Douglas Mawson's Australian Antarctic Expedition.

The details of the numbered covers were:

1. Se-tenant[32] 55c pair Nos **1-100**

2. Se-tenant 55c pair Nos **101-166** with French stamp/ship cancellation & cachet
3. Se-tenant $1.10 pair Nos **167-266**
4. Se-tenant $1.10 pair Nos **267-333** with French stamp/ship cancellation & cachet
5. With both 55c and 1.10 se-tenant pairs **334-433**

6. With both 55c and 1.10 se-tenant pairs Nos **434-500** plus French stamp/ship cancellation & cachet

The 150 non-numbered covers were used to affix stamps left over from the numbered batches. All Australian postage stamps were affixed before departure, while French stamps were purchased and affixed at Dumont D'Urville.

Commemorative stamp.

All envelopes contained inserts describing the members of the expedition, and signed by them.

(All photographs are by David London)

[32] Se-tenant means two or more different designs on one sheet of stamps.

Cachets were stamped on the back of the envelopes from the ships Marina Svetaeva and L'Astrolabe, and from Macquarie station.

Stamping the envelopes was very much a team affair, and also dependent on the goodwill of our hosts wherever it was done. Here at Macquarie station the team takes over the mess table. Emma McEwin, Douglas Mawson's great-granddaughter (left), lends a hand.

French TAAF stamps were bought at Dumont D'Urville from the postmaster, and affixed to all the envelopes.

At Dumont D'Urville the postmaster kindly provided space in the cramped post office for the team to affix stamps.

The Dumont D'Urville cachet was applied to the back.

11.8 SEASICKNESS

CAUSE:

- Seasickness is caused by an overload of the brain's ability to handle motion.
- We can handle any motion such as running or walking, but when we are put in a place where there is too much motion we feel sick.
- The brain gets its sense of motion from the eyes (mainly), the balancing organs of the inner ear, the joints, and pressure on the body.
- The amount of motion is much greater than you think. Think about one movement of the ship: for example if a cabin moves, the brain sees the walls move, and it thinks the body is moving in the opposite direction, because the brain is not used to rooms moving. Then if the room drags the body with it then the brain feels the movement, but the walls become still. So the brain sees (with the eyes) that the body is still, but feels (with the joints) it is moving. So one movement of the ship will give the brain the idea that the body has gone backwards, then still and forwards at the same time (or up and down, or side to side – or all three). This happens every time the ship moves – thousands of times a day.
- We are just not designed to handle this – even one sudden movement (in normal life) will set off reflexes such as the falling reflex, and the startle reflex. Many of our reflexes are designed to protect us.
- Vomiting is a very basic, primitive response to danger. We vomit if there is too much unwanted input – fright, pain, blood, bad taste, bad smell etc.
- We also have a learned response to danger – and vomiting is a very powerful stimulus to learning. Think of eating bad food – for a long time later you will not be able to taste or smell that food without feeling sick.
- A lot of seasickness is learned – once you have been sick on a boat you are likely to feel sick every time you go on a boat.

HOW TO HANDLE SEASICKNESS

1. don't fight it.
2. don't vomit.
3. do everything to stop the motion your brain sees and feels.
4. be patient, the brain will work it out for you if you give it time.
5. be aware that a lot of seasickness is learned, from previous experiences.

So:
DON'T FIGHT IT:
There really is no point in pretending you don't get seasick if you do. Sometimes it will help if you concentrate on something, but it is best to treat it first, and then enjoy the voyage.

DON'T VOMIT

- If you can avoid vomiting, then do. Because once you vomit you are likely to keep vomiting, and it is very hard to stop it. But if you can treat the seasickness then you will probably avoid vomiting.
- Eat light meals, don't eat fatty foods, don't eat too much, don't drink much alcohol.
- Keep drinking plenty of water – when you are going to be sick your intestines stop working. You don't need food, but you will get much worse if you dehydrate yourself.
- Don't drink a lot of coffee or tea – you will increase the brains tendency to start vomiting.

STOP THE MOTION YOUR BRAIN SEES AND FEELS

- The best way to do this is to close your eyes, lie down, and fix your head and body in the bunk.
- Your eyes are very important, the less motion you feel the better you will be.
- You might find wearing dark glasses helps – especially ones with side panels because the eyes are very sensitive to motion at the sides.
- When you lay in your bunk, put bags either side of your body to hold it still, and make a dish in the pillow for your head. Try not to rock when the boat moves.
- Hold on to the walls and the rails when you move around the boat – it helps tell your brain what is solid.
- Look at the horizon when you can – it helps your brain interpret the confusing motion it sees and feels.
- Don't watch movies until you feel better – there is too much motion without seeing more in a moving picture.

BE PATIENT

- Your brain will adapt to the motion. Some people take half a day to get over it, some take three or four days. Nearly everyone will overcome it given time.
- Don't try to fight it, just take seasickness medicine, lie down and let your brain do the work – it will do a great job if you treat it properly.

MEDICINE

- Take your seasickness medicine as soon as the ship leaves the dock, or even an hour or two before.
- Take plenty of medicine and take it as prescribed– it does not help to reduce the dose. You won't get better any quicker, you will probably get worse.
- Calming medication may help at the start to reduce the anticipation of vomiting.

SUMMARY:
If you are a person who is seasick, take plenty of medication, lie down, reduce your body's motion, don't eat much, and drink plenty. And be patient.

Dr Chris Henderson, January 2009

11.9 WEBCAM

This year it was decided that a webcam would be placed such that a daily image of Mawson's Hut could be uploaded to facilitate planning for the next expedition.

The equipment as supplied comprised a security camera in a normal housing, solar panel and controller, 12v battery, garden timer with external Li batteries and an ordinary meter box. In addition a sat phone/modem was to be used, which became surplus when removed from Mawsons Hut monitoring system.

It was thought that the unprotected camera would not stand up to the Cape Denison blizzards, so a Perspex cover was made which provided a clear thick glass viewing screen, ventilation, and solid attachments for 3 wire stays. The housing was sealed with Silastic for blizzard proofing.

In the event the camera functioned when connected to a laptop, but was unable to affect a transfer of a picture either on the surplus satphone or our normal data satphone. It was decided to RTA the equipment to develop a more robust and reliable system for next trip. The meter box will have to be blizzard proofed or replaced for next year.

11.10 GROUND PENETRATING RADAR - THEORY AND GENERAL CONSIDERATIONS

This discussion applies to the three reports using Ground Penetrating Radar (GPR) – the Air Tractor search, the lakes bathymetry, and the hut floor ice survey. It is necessary to understand something of the way GPR works in order to understand the results and the limitations of the technique:

Ground penetrating radar theory:

Ground Penetrating Radar images are not like visual images, since the transmitted wave does not travel in a single direction like a pencil torch beam, rather it spreads out at an angle to the transmitting antenna – the angle depends on the frequency of the antenna.

The receiving antenna 'sees' reflections from objects both ahead and below. Thus if a radar unit passes over a buried object, the resultant image will be of a parabola 'draped' over the object; the focal point of the parabola being where the object actually is.

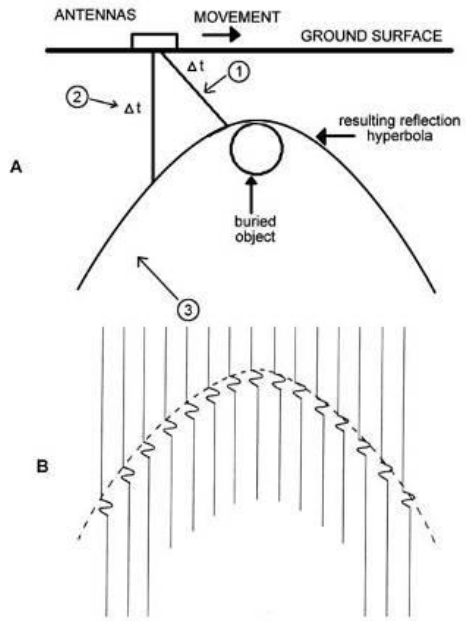


Figure 64: (A): Diagram of the way a radar beam is reflected back to the receiver as the antenna passes over it. The radar beam spreads out forwards (1) as well as below (2). The result is a parabola of reflections (3).

The trace seen by the operator looks like (B).

Radar pulses are transmitted into the ground, and the received signal is recorded. This signal varies between positive and negative rather like waves bouncing off a wall (Figure 2).

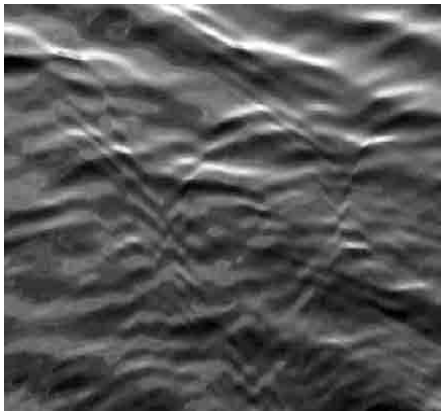


Figure 65: Compare this picture with Figure 3. This is a picture of ripples from the bow of a boat in calm water, and helps the reader understand how the radar trace is produced. Radar images are pictures of the 'ripples' of reflected radar waves down through the ground.

The amplitude of the radar waves is displayed as positive (white) and negative (black). The longer the return time the deeper the record. Pulses are transmitted every few centimetres, and are whole data stream is collected into a longitudinal record.

This is well shown in the next image[33] (Figure 2), where the parabola at A was from a plastic pipe on the left and a metal pipe on the right, while at B a piece of metal shows characteristic reflections spreading down through the trace.

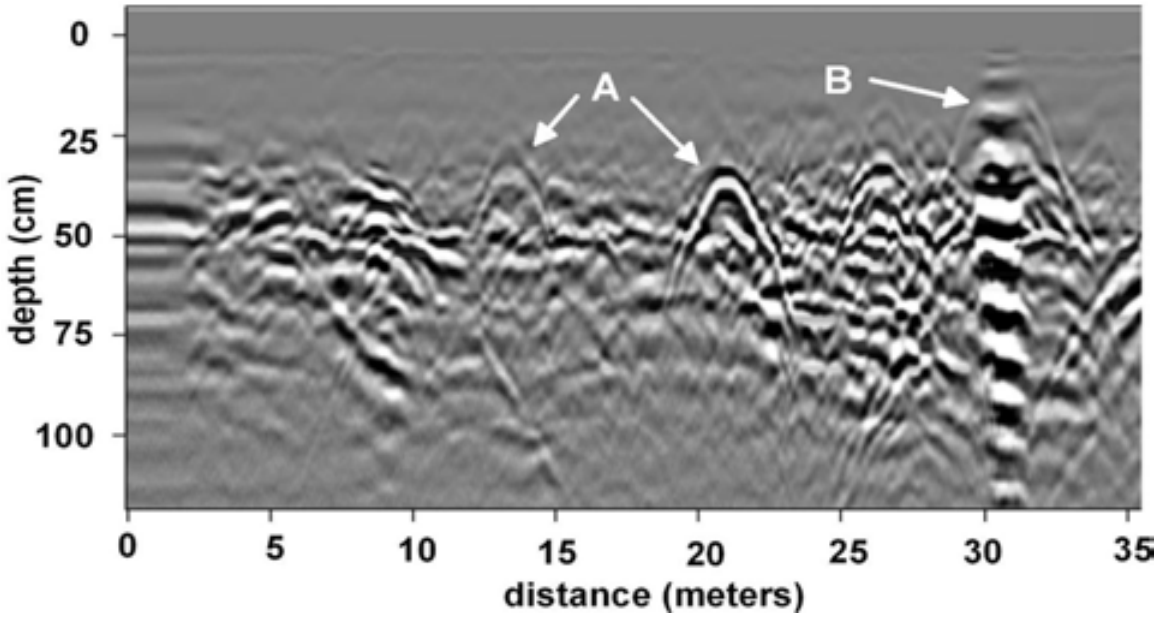


Figure 66: Typical GPR trace where the antenna passes over buried materials. The characteristics of different materials is demonstrated: A shows both a plastic and a metal pipe, while B is a metal plate on the surface. Note the parabolas which 'cover' the objects, and the overall wave-like structure of the reflected radar pulses. However radar is not like echo-sounding in water where only the bottom is seen, instead radar gives a signal at every depth so the whole picture is filled with signals.

[33] Images take from **http://www.du.edu/~lconyer/**

Factors affecting the GPR signal

The signal produced by the radar transmitter cannot penetrate all materials equally. Some materials, such as water, slow the beam down, whereas others, such as ice, allow it to pass easily (similarly we wade through water and skid on ice). So radar can 'see' to a much greater depth in ice.

Radar is very sensitive to changes in the velocity of the beam, and the radar scan shows the interface between substances clearly, like seeing the interface between oil and water in a glass.

Radar also is affected by the conductivity of a substance. For example seawater - which conducts electricity easily - spreads the radar wave rapidly. So in a few centimetres the radar beam has gone. Seawater is nearly impossible to scan. On the other hand, freshwater conducts electricity poorly and is easy to scan.

Resolution

The higher the frequency the sharper the image. Low frequency radar penetrates further but the trade off is loss of resolution. A high frequency aerial such as the 800 MHz one used on the ice in Mawsons Hut would barely reach 1 meter, but the 250 MHz aerial used to search for the plane reaches 5m into the ice.

However the resolution of the 800 MHz aerial is much greater, so much more detail is seen compared to the 250 MHz aerial.

Theoretically resolution is one quarter of the wavelength of a scanning wave, but in practice the 'rule of thumb' for GPR is that it is about ¾ of the wavelength of the wave. The velocity of a radar wave in freshwater ice is half that in a vacuum (ie it is 1.5x10^10 cm/sec).

The effective resolution of the aerials used in ice at Cape Denison is:

Frequency (Mhz)	Wavelength (cm)	Resolution in ice (cm)
250	60	45
500	30	22
800	11	7

What this means is that there is a limit to what the radar scans will show. For example the individual tubes making up the air tractor would probably not be visible, but the whole frame has enough area to be seen. And there is a limit to what can be expected from the radar in the hut – small objects in the ice just won't show up.

The Ground Penetrating Radar (GPR) equipment

The GPR was loaned by the University of Tasmania and AAD for the purpose of locating the Air Tractor at Cape Denison. The equipment as supplied clearly was unsuitable for operation in the ice, so a cart was made from recycled materials to protect the electronics, and to hold the materials, including batteries, together.

Cart construction:
The cart needed to be strong and light, and the aircraft-grade aluminium in a Zimmer frame and crutches provided this capacity, as did bicycle wheels and ice-hockey sticks.

Figure 67: the basic frame.

Figure 68: the cart in operation at the first search site. Pete Boyer towed it, and Chris Henderson pushed it. Here Chris looks at the radar trace, while Pete and the penguins wonder what is going on. (Photo: David London).

Search pattern:
GPR needs a close search pattern to work. Classically this is done by laying out a grid of closely spaced markers and recording individual computer files of each 'run'. This turned out to be so cumbersome that a better way was developed. The cart was tied to a central pole by a rope, and pushed around in a spiral, being wound closer each revolution by exactly the right 'grid' distance for an effective search density.

Figure 69: The search technique provided exactly the right spacing between scans while letting the operators concentrate on moving the cart. (Photo: David London).

The radar unit was triggered by a trailing wheel, which sent out regular pulses (Figure 5, the smaller side wheel). A position was recorded from a GPS unit (Trimble 5700) every time a radar wave was transmitted. The rope traced out a circle 17 metres in diameter, with a total of about 1400 positions being surveyed within that area.

***GPS accuracy**:*
Despite using a high quality GPS unit, the positions are not necessarily accurate on land, although the satellites readings are accurate. However, the search technique does not rely on absolute accuracy of a GPS position, but relative accuracy. In other words it did not matter where the GPS positions were, as long as they were accurate with respect to each other so that a reliable search pattern was generated. The positional accuracy depended on the position of the central pole, not the GPS readings. Essentially GPS readings were simply being used as an XY grid.

***Data processing**:*
The data was processed in several stages:

1) The GPS positions were converted into metres relative to an origin at the furthest north and west corner of a square centred on the pole. The conversion factors were determined locally since meridians converge rapidly at high latitudes. They were derived from the difference in the latitude and longitude readings respectively tangent to the circle of known 17m diameter, and proved accurate insofar as they described a proper circle. See figure 7.

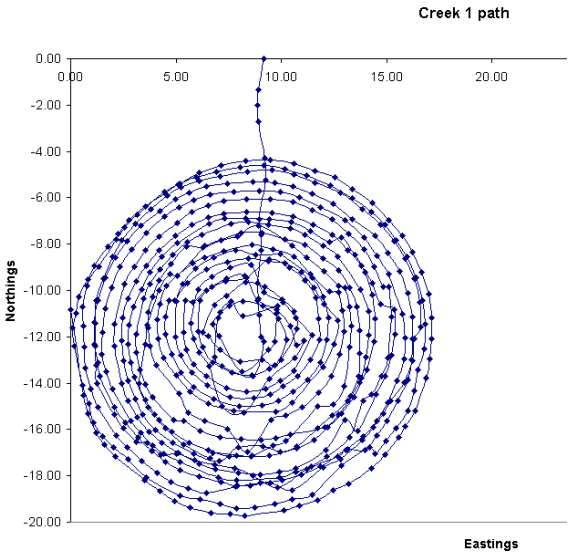


Figure 70: shows the data recorded by the GPS unit as the cart traced out a spiral around the central pole. The positions have been converted to metres south and east of an arbitrary origin. The diameter of the search area is 17 metres.

Variations from a perfect spiral are due either to 'drift' in the GPS signal, or, more likely, to difficulty in navigating the uneven surface of the sastrugi.

2) Raw GPR data was inspected for significant anomalies, and then spatially filtered by averaging to remove confounding horizontal features such as the ground wave; and enhanced using time varying gain to overcome depth attenuation. (see figure 8).

At this stage a number of different ways of processing the data can be used, and the decision determines the output. The data can be averaged – which was used in the air tractor studies – where a layer, say 2-2.5m is chosen, and all the data between those depths are averaged. Or a section of the data are plotted (see figure 12 below) to give a set of contours. The data can also be further temporarily or spatially filtered.

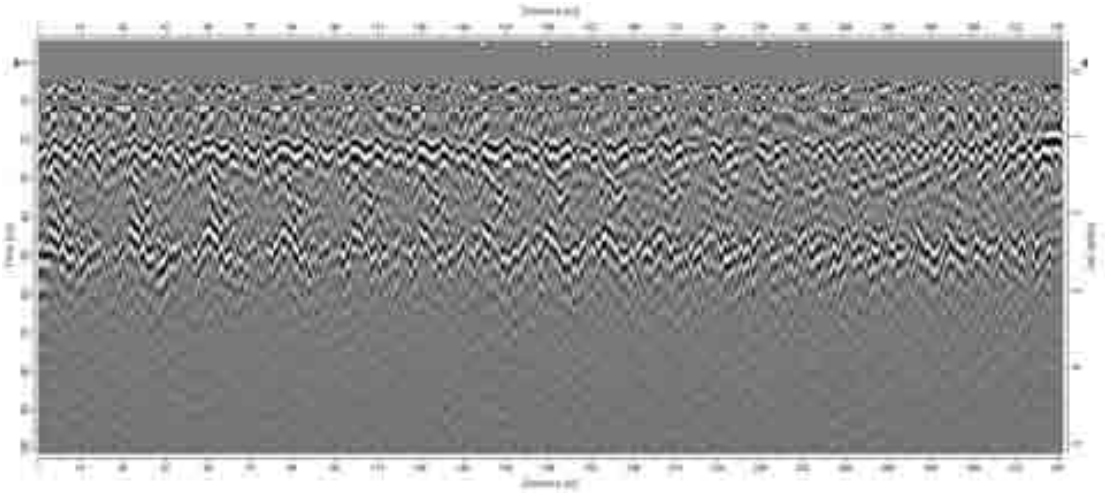


Figure 71: enhanced radar data showing two layers of anomaly at about 1.25m and about 2.5m (arrows). (250Mhz aerial)

3) This data was combined with the position data and processed using Surfer and Voxler (Golden Graphics Inc, Colorado sponsored this software), to produce 2D and 3D maps.

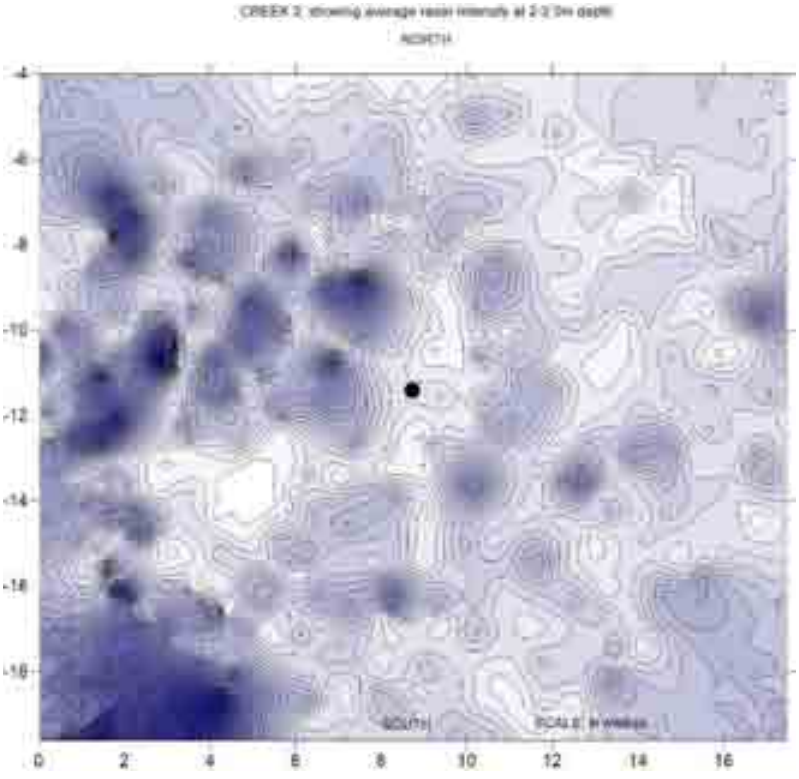


Figure 72: Contour map of ice at 2-2.5m depth, corresponding to the scan in figure 8. The central pole is the black dot in the middle. The darker areas are stronger reflection.

Other data processing methods produce different pictures:

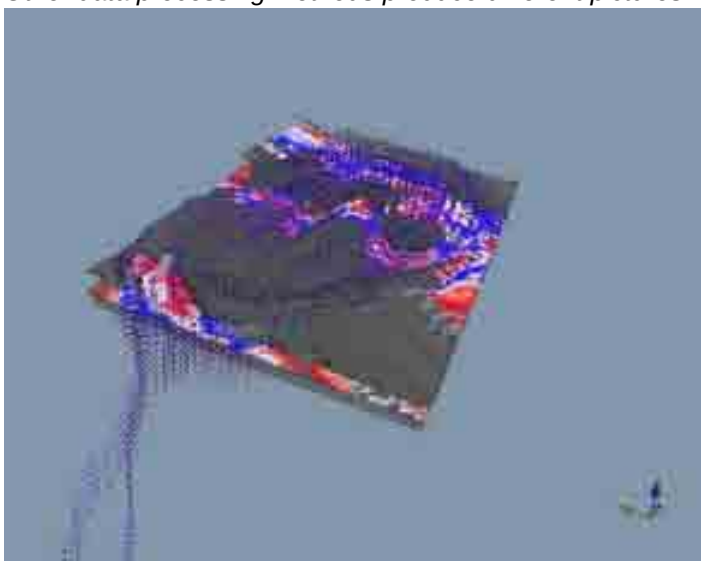


Figure 73: 3D picture of track of cart on Low Lake, with contour map of the radar reflections and a 'surface'. This is produced using Voxler (Golder Software). The long 'tail' is the track of the cart moving onto the lake ice. The track on the lake is a spiral, but without the central pole.

This is an example of the complex images that can be produced by Voxler software.

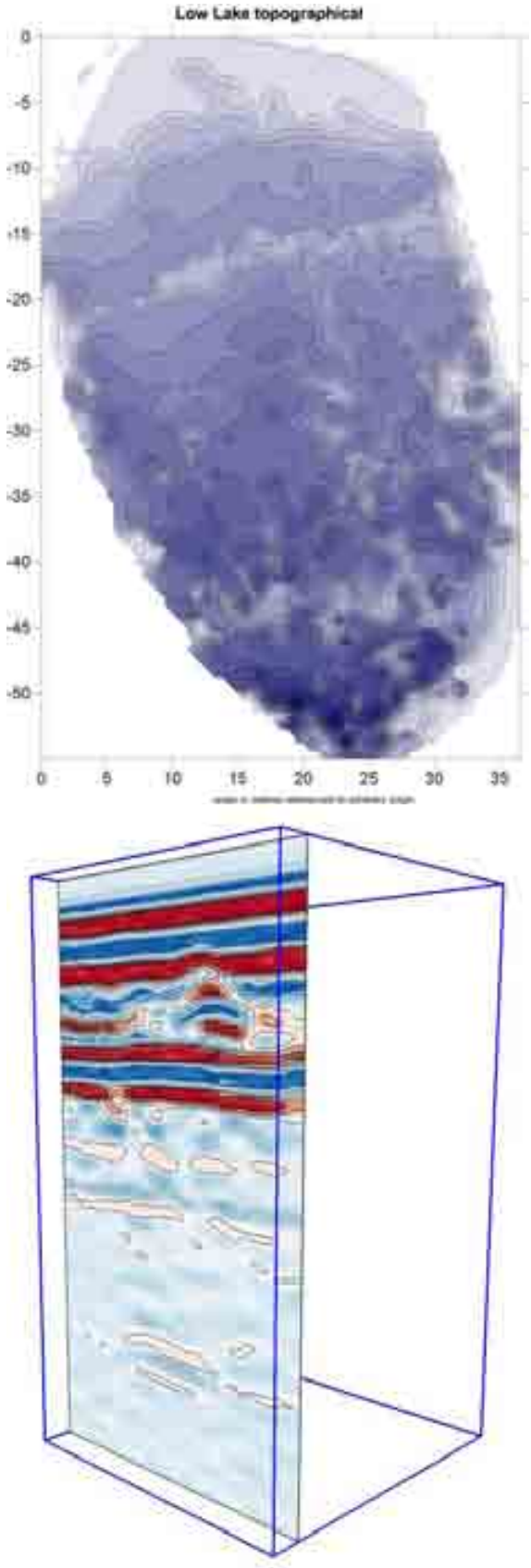


Figure 74: Contour map of the bottom of Low Lake using Surfer (left) and 3D image of objects within the ice on the floor of Mawsons Huts using Voxler (right)

12. APPENDICES

APPENDIX 1: OBJECTS EXPOSED/EXCAVATED DURING ICE REMOVAL:

1. Murphy's Bunk:

Large cylindrical tin

Milk powder tin (French origin?)

Dutch cocoa tin - rectangular

Bovril tin

Candle – remnant end

Paper – oil heater instructions, in 3 pieces

Small, round lid

Tar paper - scrap

Wires (attached to bunk), electrical clamp (?)

Tin

2. Above Mawson's Cubicle:

Wooden box stencilled c/o Dr Mawson

Small glass bottles and copper alloy cylinder

Pair of boots

Heavily corroded iron trough

Copper alloy can and iron box

3. JHC 1912 Bunk:

Books and papers

APPENDIX 2: MOISTURE MONITORING:

Unless otherwise specified, moisture contents were measured using a Protimeter Mini C applied to the central, longitudinal surfaces by direct contact until a stable reading was obtained. Care was taken to leave only pin-prick size holes in the surface.

Because most of the walls were covered by snow it was not possible to measure the moisture contents of external walls of the main hut.

For comparison, 2006 readings are giving in brackets following the 2008/09 data.

1. Western Wall – Hurley's Bunk:

A series of readings were taken of the wall timbers, from the bottom of Hurley's bunk to the board immediately below the upper bunk. Board numbers (1 - 6) refer to boards from the lowest to the uppermost. Readings were taken in areas substantially free of frost, with most taken in a vertical line.

Board Number	*Moisture content (%)*
1	25-26 - latter reading on the hoar frost border (22)
2	25-26 (21)
3	23-25 (21)
4	26-30 (22)
5	36 (22)
6	30 (18)
7	60 – in the only hoar frost-free zone (21)
8	Plank was completely covered in hoar frost

Structural bunk timbers (Oregon)	*Moisture content (%)*
Upright – south post, outer surface	22-25 (22)
Beams	19-20 (18/19)
Bookshelf	26 on edge (2006 covered in hoar frost)
Pine plank with name on	20-22 (19/20)

2. Bunk immediately above Hurley's

Side rail board (A McL 1913, PEC 1912)	20-22 (20)

3. Dark room door

Measurements were taken over the length of each panel (top, middle x2, bottom) with the range of values indicated below. In all cases the higher readings were obtained from higher positions on the door (possibly indicating more melt in these areas).

1 (nearest handle)	19-22 (18-19)%
2	19-25 (18-20)%
3	19-25 (19-22)%

4 19-23 (19-21)%

4. Outer wall of Mawson's cubicle – NW corner, bookshelf wall

Boards on this corner were the most exposed. Moisture contents were recorded from the lowest exposed plank to the top. Triplicate readings were taken approximately 10 cm from the NW corner.

.

1. 26 (22)% 2. 25-26 (22)% 3. 20-22 (19)%
4. 22-23 (21)% 5. 22-23 (19)% 6. 25 (21)%
7. 25 (22)% 8. 25-26 (22)% 9. 22-25 (22)%
10. 23-26 (22)% 11. 25-26 (23)% 12. 40 below the shelf, 23 above the shelf (23)%
13. 19-23 (19)%

Note that the lower readings for boards, 12 (above the shelf) and 13 may be due to sunlight exposure via the skylight.

5. Outer wall of Mawson's cubicle – NE corner, below chemical storage

Moisture contents were recorded from the lowest exposed plank to the top.

2. 28-32 (24)% 3. 23-25 (21)% 4. 32-36 (26)%
5. 48 (27)% 6. 32 (23)% 7. 32 (22)%
8. 32 (22)% 9. 28-32 (22)% 10. 28-32 (22)%
11. 32 (22)%

6. Platform

NW post ice level 20-22 (19)%, midway 23 (21)%, immediately below 1st rafter 32-36 (22)%
NE post ice level 20-22 (19)%, midway 23 (20)%, immediately below 1st rafter 23 (20)%

For the lower platform rafters, the readings were taken on the 'inside' of the timbers i.e. on the 'eastern' face of the western-most rafter and on the 'western' face of the eastern-most rafter.

Lower W rafter (original) average (of 7 readings) = 30 (22)%
Lower E rafter (original) average (of 5 readings) = 30.5 (21)%

Higher rafters (from W to E) average values of 4-5 readings for each

1. replacement timber = 17 (16.5)%
2 replacement timber = 17.5 (17)%
3. original timber = 19.5 (18.5)%
4. original timber = 22 (19)%
5. replacement timber = 17 (16)%
6 replacement timber = 17 (15.5)%

7. Southern wall

AJH bunk (lower) Name board, ave = 21 (19)%
ENW (upper) Name board, ave = 25 (20)%

8. Eastern wall

Measurements were taken in ice-free areas. Numbering is from level with the top of the bunk itself with numbers ascending as the planks get higher above the bunk base.

FHB bunk

1.	25-26 (20)%	2.	28-32 (22)%	3.	26-28 (23)%
4.	26-28 (22)%	5.	25-26 (22)%	6.	frost (frost)
7.	32-36 (frost)	8.	26-28 (21)	9.	36 (22)%
10.	40-50 (22)%	11.	40-50 (frost)		

CL 1912 bunk (upper)

Planks are numbered from the floor up, with the lowest plank on Laseron's bunk being No 9.

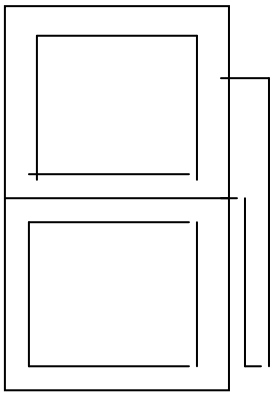
9.	25-26 (frost)	10.	26-28 (21)%	11.	23-25 (22)%
12.	23-26 (20)%	13.	23-26 (20)%	14.	25-28 (20)%
15.	23-28 (20)%	16.	22-28 (18)%		

9. Ceiling profile from plate height to skylight

A range of lower ceiling boards were tested, with values averaging 28%. In 2006, all of the ceiling boards were completely covered by fine hoar frost crystals, preventing any measurements from being taken.

APPENDIX 3: TIMBER THICKNESS MONITORING

1. Absolute Magnetic Hut



Position from lowest point of timber	2000/01 thickness (mm)	2008/09 thickness (mm)
5	17.72	17.37
10	18.22	18.19
15	17.25	17.67
20	18.16	18.11
25	18.22	18.21
30	17.51	17.36
35	18.15	18.37
40	18.78	18.76
45	18.49	18.58
50	17.92	17.94
55	34.38	34.13
60	34.93	3.71
65	34.63	34.69
70	35.04	34.51
75	35.47	34.96
80	35.16	34.74
85	35.12	34.84
90	35.08	34.73

2. Magnetograph House:

Timber thicknesses were measured on the end grain of a small facia board on the NE corner of the building (northern face), with measurements taken from the bottom of the board to the top at 1 cm intervals. Note that from the 5 to the 10 cm mark, the timber was shielded from the prevailing wind by other wood and wool. Measurements taken during the 2008/09 fieldtrip are compared with those taken from the same position in 2000/01.

Position from lowest point of timber	2000/01 thickness (mm)	2008/09 thickness (mm)
1	13.99	14.21
2	14.61	14.54
3	14.69	14.94
4	15.33	15.41
5	15.79	15.54
6	15.52	15.81
7	15.87	15.70
8	15.88	15.89
9	15.50	15.99
10	15.68	16.07
11		15.66
12		15.78

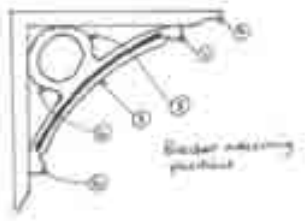
Timber thicknesses were also measured on a small piece of timber (approximately 30 cm long) on the southwest corner (western face). The lower portions of this piece were protected by the rock wall. Readings were taken, where possible at 3 cm intervals. Readings should also have been taken of another small piece of timber on the SW corner (southern face) as this piece had been measured previously in 2000/01 (see image below).

Position from lowest point of timber	2008/09 thickness (mm)
3	12.11
6	11.89
9	10.89
12	11.05
15	10.30
18	9.56
21	9.63
24	8.49
27	9.20
30	7.98

SW corner of the magnetograph house

3. Transit Hut:

No comparative timber measurements were possible for the transit hut as the timber that had been documented in 2000/01 has been lost from the building in the intervening years. Measurements were taken however, of one of the shelving brackets to see if corrosion and wind abrasion losses of corrosion products could be determined via measurements of the metal thicknesses. Measurements were taken in triplicate and averaged. Sampling positions are shown below, as is comparative data for the NE bracket (2000/01 and 2008/09 seasons).



Transit hut brackets, classified as NW (foreground) and NE (background)

Position	2000/01 average thickness (mm)	2008/09 average thickness (mm)
1	3.86	3.83
2	5.68	5.72
3	3.83	3.65
4	3.53	3.58
5	3.78	3.65
6	3.83	3.68

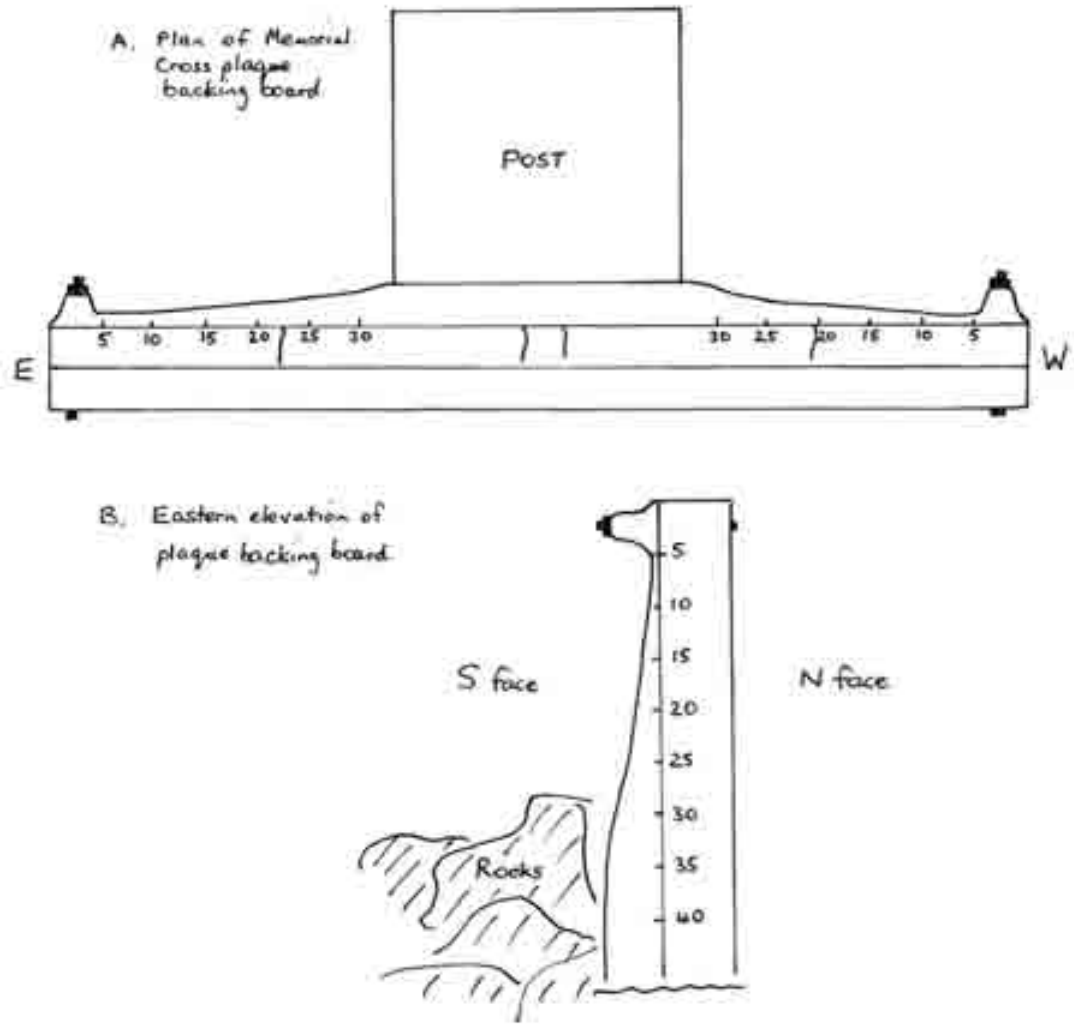
Note that data for sampling positions 2 and 3 are not as reliable as the others because of the presence of a double layer of metal.

4. Memorial Cross and Plaque:

(a) Replica plaque – backing board:

Timber thicknesses (mm) were measured using a set of digital vernier callipers (DigiMax) at regular intervals along the most southerly facing side of the backing board attached to the replica memorial plaque. Points at which timber thicknesses were measured are shown in the sketch below.

Schematic of timber thickness monitoring points (2000/01, 2006 and 2008/09)



Data for the 2000/01, 2006 and 2008/09 expeditions are provided in the accompanying table. The data clearly indicates the severe abrasion that occurs above the level of the rocks placed around the pole and plaque. Designations A and B refer to the above sketch. The thickness at the very base of the plaque backing board was 21.80 mm.

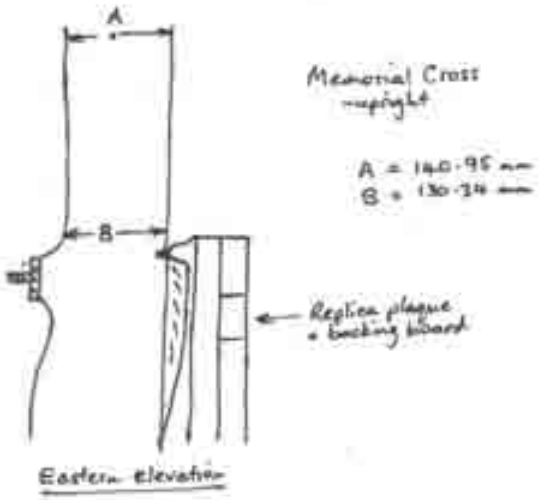
Table: Timber thickness of the memorial plaque backing board as measured in 2000/01 and 2006

A - plan	**0**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**45**
East end									
2000/01		6.22	5.80	4.97	7.08	14.95	20.81		
2006	1.1	0.4	0.6	0.5	0.6	11.6	20.7		
2008/09	-	-	-	-	-	11.42	20.83		
Wood loss	1.1	6.22	5.80	4.97	7.08	3.53	+0.02		
West end									
2000/01		7.16	6.91	5.92	5.87	11.68	20.71		
2006	1.0	2.2	1.8	0.8	0.4	8.7	20.4		
2008/09	-	-	-	-	-	8.81	20.50		

Wood loss	1.0	7.16	6.91	5.92	5.87	2.87	0.21		
B - elevation									
East elevation									
2000/01	5.17	8.49	10.58	10.91	16.73	18.62	20.36	20.85	22.36
2006	0.6	4.1	5.8	5.5	15.4	16.7	19.3	20.2	22.2
2008/09	-	3.0	5.37	4.49	13.59	16.27	18.84	20.15	20.95
Wood loss (mm)	5.17	5.49	5.21	6.42	3.14	2.35	1.52	0.70	1.41

(b) Memorial cross - post:

Measurements were taken as shown in the diagram below. In addition to the readings taken of the post near the memorial plaque, a measurement taken just below the cross-arm, immediately adjacent to the metal support was 146.3 mm (measured on the eastern side of the post.



APPENDIX 4: INVENTORIES

1. Conservation Laboratory Inventory

Equipment	Amt/No.	Manufacturer/Model
pH Meter	1	Eutech
pH electrodes	2	Eutech
Hot Plate/magnetic stirrer	1	Industrial Equipment and Control (IEC)
magnetic stirrer bar	1	15mm x 4.5mm
magnetic stirrer bar	2	20mm x 6mm
magnetic stirrer bar	2	30mmx 6mm
magnetic stirrer bar	1	25mm x 6mm with pivot ring
weighing scales to 4 kgs	1	TE4101 Sartorius
Ozito Numatic Drill chisel/hammer drill	1	
Microscope, Olympus SZ61	1	
Microscope Stand, Olympus SZ61	1	
Microscope DP12 camera	1	
Photographic lights. Elichrom D-Lite 4	2	Returned to Australia, to be replaced
photographic tripod, missing the head		Manfrotto, 055XPROB
photographic back drop	1	Grey cloth
Glass jars	50 and lids	500ml
pyrex beaker	5	500ml
pyrex beaker	10	100ml
Glass funnel	3	80mm stem
Glass stirring rod	5	
Glass measuring cylinder	1 x 25ml	
Glass measuring cylinder	1 x 100ml	
Glass measuring cylinder	1 x 500ml	
Magi Lamp	1	
scalpel handle No.3	3	
scalpel handle No.4	4	
Scalpel blades No. 24	box of 100	
Scalpel blades No. 15	box of 100	
Scalpel blades No. 10	box of 100	
smoke sponge	10 blocks	
gaffer tape	3	
filmoplast P90 tape	2	
brushes, bristle	5	

brushes, sable	5	
Paints, small water colour set		
dental picks	12	
plastic containers x 4		clip tops
tool trolleys	2	Kinchrome
nitrile gloves	large, med, small	3 boxes
Bottle 2L HDPE square with wide mouth	4	
plastic buckets	2	
Dremel tool		Dremel
Dremel tool brushes, abrasive heads assorted		
Sharps Container	1 x 2L	
Methylated Spirits	4.5L	Diggers
White Spirit	500ml	Walkabout
Acetone	550ml	2 x winchesters
Tannic Acid	1kg	2 x Containers of 500g
PE Wax	500g	100g made up with white spirit
Paraloid Top B72 Coat for labelling 30%	60ml	
Paraloid B67 Top Coat for labelling 30%	60ml	
Silica Gel Self indicating orange 2-5mm	1700g	4 containers
Paraloid B67 Beads	500gms	
Paraloid B72 beads	500gms	
Buffer Solution pH4	500ml	Biolab
Buffer Solution pH7	500ml	Biolab
Portable Fume Cupboard	1	Walton Plastics Engineering W.A. Model RE 1000
Laboratory stools	3	
Vacuum Cleaner and accessories	1	Nilfisk GD930S2
Eyewash station, wall mounted	1	
safety glasses	6	
spatulas, metal	2 x 150mm x 8mm	
spatulas, metal	2 x 150mm x 3mm	
spatulas, metal	1 x 200mm x 11	
Stainless steel tray	2 x 265 x 162 x 63mm	
Drager Tube for Acetylene Gas 100 - 2500ppm	1 x pack 10	
Fire Extinguisher Dry Powder. AB(E)	1 x 4.5kg	
Fire Blanket	1	
Photographic developing tray	6 x 20 x 25cm	
A-P Magnifying Loupe 8 X magnifying	2	
SanDisk Extreme IV Compact Flash 2 GB	4	
EVA Adhesive	500ml	returned to Australia for Storage, cannot freeze

Plextol B500	500ml	returned to Australia for Storage, cannot freeze
Museum Wax	2	Incorrectly supplied, should have been Renaissance Wax
Hot Glue gun	1	Hotweld
Glue sticks	10	
Cutting Matt	1 x 450 x 600mm	
Hotjet S Hot Air Blower		Technspan Australia
Plastic disposable eye droppers	5	
Permanent markers	assorted	
Merck Index 14th Edition		
Hole punch	1	
pencils assortd grades	24	
white ink pens	5	
bubble wrap, from packing equipment		
rope and twine	assorted	
black plastic sheeting	10m	
Stanley knives	3	
cotton rags	1 bag	
paper towels	10	
bamboo skewers	1 pkts	
clothes pegs	100	
tea towels	10	
Archival Cardboard, single thickness	5 sheets	
Acid Free Blotting Paper	20 sheets	
Gortex	3 metres	
Japanese Tissue	assorted grades	
Mylar	10metre	
Chloride test strips 30 - 60mg	pkt of 40	
cotton wool	5 x 375gm	
tongue depressors	1 box	
jewellers pliers	1	
side cutters	1	
quick grip clamps small	2	
glass vials	10	
plastic vials	20	
zip lock bags assorted sizes	100's	
Tyvek Labels 40x 20mm	40x20mm x 2pks	
Tyvek Labels 60x 120mm	2pk	
Self adhesive linen tape 30mmx25m roll, white	1	
Cotton tape	1 roll	
Pigma Pens	15 assorted widths	
Reemay	5 m	
Felts	2 x A3	
Tacking Iron		

Archival Papers	A4 260gsm x 1 pkt	
Archival Papers	A3 260gsm x 1 pkt	
Bone folders	2	
Leather weights	4	
weighing boats large	150	
weighing boats small	150	

2. Conservation Equipment/Materials Needed For 2009/10

Phosphoric Acid		
alternate ferrous treatments for colour		
tweezers	a selection	
Killrust		
more cheap brushes range of sizes		
scrubbing brushes		
light source for microscope		
tripod head for manfrotto tripod		
more dremel tool brushes		
linen thread		
quick grip clamps	assorted sizes	
garyflex blocks		
heat set tissue		
acrylic paints		
fumed silica		
plastic funnels		
lab coats/aprons		
black water colour paint		
citric acid		
acetic acid		
ferroguard		
wet and dry sand paper		
more heat resistant brushes		
jars with lids that fit		
Small bottles with lids		
chemical scoops or spoons		
hyxtal epoxy resin		
white pens fine pressure flow		

starch paste		
steel ruler		
surface ph electrodes		
solvent waste container		
extra large nitrile gloves		
solvent respirator		
measured squeeze bottles 250 mls		casablanca
spare magi lamps globes		
solvent cabinet	small	size of tool cabinet

3. Food and related items list for 2008-09 expedition

NOTE: Items in red were recorded as being at Cape Denison at the end of last season.
Items in blue available in sufficient quantity as left-overs from previous seasons.
Items in green to be obtained separately (not via Purdon & Featherstone)
Items in orange supplied by private donation

Product & package size	*Amount/ quantity*	*Left at Sorensen in January 2008*
GENERAL STAPLES		
Breadmix - multigrain	30 kg	10kg (2x5kg)
Breadmix - white	-	10kg (2x5kg)
Butter	20kg	10.5kg (23x454g tins)
Castor sugar (500 grams)	4	1kg (2x500g)
Condensed milk (c 400g tin)	-	11 x 395g tins
Egg powder 1kg	2	
Flour - white, plain	6 kg	2kg (2x1kg)
Flour - white, self-raising	10 kg	
Icing sugar (500g)	3	500g (1 pkt)
Milk powder (full cream) - pkt 750g	8	7.6 kg (8x750g pkts, 4x400g tins)
Olive oil	4 litres	Half-empty 4-litre tin
Sugar, raw	12 kg	10kg (5x1kg)
Vegetable oil (sunflower)	3 litres	1x750ml bottle
Vinegar - white wine	1 litre	Malt v. 1x750ml bottle
Yeast - Mauripan dry yeast 500g vac. pack	4	12x1oz sachet packs
VEGETABLES, FRESH & CANNED FRUIT		
Apples (good keeping)	1 box	
Asparagus, canned (c400g)	8	2x425g cans
Baked beans c 400g can	10	
Beetroot, canned	10	1x425g can
Canned fruit c 825g: apricots	5	Apricots 3x825g
Canned fruit c 825g: fruit salad	5	Fruit salad 3x825g
Canned fruit c 825g: peaches	5	Peaches 3x825g
Canned fruit c 825g: pears	5	
Canned fruit c 825g: pears	5	
Canned fruit c 825g: pineapple rings	5	
Carrots (fresh)	4 kg	
Chickpeas (canned) c 350g	12	3x300g cans
Frozen stir-fry vegetables 500g pkts: Thai, Vietnamese, Cantonese	24	

Frozen veges, 500g pkts: beans-7, peas-7, broccoli-7, cauliflower-7, spinach-3, carrots-7, corn kernels-8	46	Dried peas (13x100g), dried peas/carrots (2x 100g), dried peas/corn (18x100g)
Mushrooms, canned in gravy (not champignons) - small cans	10	
Mushrooms, dried	250g	
Onions: frozen sliced	6kg	
Oranges (good keeping)	1 box	
Potatoes, fresh	10 kg	Deb instant (11x115g)
Pumpkins (whole)	2	
Red kidney beans (canned) c 400g	12	1x420g, 6x300g
Sauerkraut (c350g pkts)	4	
Tomatoes, canned (c400g; whole (15), diced (15)	30	

DRINKS (NON-ALCOHOLIC)

Cocoa, c375g pkt	1	1x375g pkt
Berri Lemon squeeze 500ml	5	
Berri Lime squeeze 500ml	5	
Coffee, ground, Vittoria Espresso 200g	4	5x200g Vit. Esp.
Coffee: Nescafe Mild Roast 150g	2	3x150g Nescafe
Cordial, blackcurrant 750ml	5	4x750ml
Drinking chocolate, 400g cans	2	2x400g cans
Fruit juice, 1 litre: pineapple-8, orange-8, orange+mango-6, apple-8	30	2x1litre orange juice
Gatorade powder (1 pkt each of Fruit Punch, Glacier Freeze)	2	
Milo, 750g can	-	1x750g can
Tea, green - bags	1	2x50-bag boxes
Tea, standard black - bags	1	3x50-bag boxes
Tea, standard (black), loose-leaf, Madura or Dilmah, 200g pkts	3	

SOUPS

Cup-of-soups (4-serve pkts): variety-tomato, mushroom, pumpkin, laksa, vegetable	20	19 x tomato, 11 x spring onion, 6 x cream of mushroom
Miso paste: assorted light, dark, 500g pkt	3	
Miso sachets (individual serves)	50	12 sachets
Stock cubes - non-veg.	-	1x25cubes beef, 2x12 cubes beef, 1x25 cubes chicken - all opened
Stock cubes - vegetable	2	2x10 pkts

CEREALS

Kelloggs Sustain 375g pkt	4	4x375g pkts
Muesli - Eumarrah mix from E. Wholefoods	10kg	1x375g pkt walnut
Rolled oats (U. Tobys) 500g	3	2x500g pkt
Weetbix 375g	10	1x375g pkt

SPREADS, PICKLES

Cream cheese spread, 250g jar	2	5x150g jars
Honey 250g jar	2	8x250g jars
Jams: blackberry, strawberry	2	4x250g jars
Marmalade (5 jars to be supplied separately)	-	
Nutella 750g jar	-	1x750g jar

Peanut butter, 500g	-	6x500g jars
Vegemite 400g jar	2	4x400g jars
Sweet mustard pickle	-	1x400g jar
Spread - eggplant and garlic	-	1x230g jar
Spread - Tomato and basil	-	1x230g jar

LUNCHES, SNACKS

Anchovies in safflower oil	5	13x80g jars
Biscuits Arnotts Granita 250g packs	4	
Biscuits assortd creams	-	6x500g pkts
Biscuits butternut snaps	2	4x250g pkts
Biscuits ginger nuts	-	8x250g pkts
Cheese: cheddar, 1kg blocks	15	
Chocolate dark 275g block	7	
Chocolate milk 275g block	13	
Crackers Arnotts Sesame wheat 250g	5	
Crackers Arnotts Jatz (OR Savoy) c 250g	20	
Crackers Arnotts Vita-wheat 250g assorted	20	
Dried fruit (1.5kg each) - apricots, peaches, pears, prunes, apples	7.5 kg	1x1kg apricots; 1x0.5kg pears; 1x1kg prunes; 1x1kg, 4x200g apples
Dried tomatoes (sun-dried)	4kg	
Ham: cans, c 350g	5	1x450g can
Mars bars 85g	-	84x85g
Muesli bars U. Tobys, 185g packs (various flavours)	15	
Nuts (1kg each) - peanuts salted, cashews, almonds, walnuts, mixed nuts	5kg	2x1kg beer nuts; 1-1kg almonds; 1x1kg walnuts; 1x1kg mixed nuts
Olives: Greek Kalamata black, pitted	3kg	
Oysters smoked, 85g tins	5	3x85g tins
Pickled cucumbers (jars)	2kg	
Popcorn 375g bags	2	5x375g bags
Potato crisps - Red Rock Deli various flavours x 100g	30	
Pumpernickel 500g	15	
Salami Danish c 300g	2kg	
Salami Hungarian c 300g	2kg	
Salmon canned 415g cans	5	3x415g cans, 31x95g can
Sardines canned	-	12x106g (in water), 11x105g (in tom. sauce)
Sesame bars 85g	-	84x85g
Snickers bars 85g	-	84x85g
Sultanas, dried	4kg	2x1kg sultanas
Summer rolls 85g	-	84x85g
Tuna canned 95g cans	20	
Tuna canned 415g cans	4	

DINNERS

Bacon - vacuum packed	8kg	
Fish fillets - Australian - frozen c 500g pkts	8	Australian
Leg lamb x 2.2 kg	2	
Lentils - brown	2kg	
Lentils - red	4kg	

Minced meat - vacuum packed	8kg	
Pasta lasagne sheets 500g	-	8x250g
Pasta macaroni 500g	-	8x500g - fettucine/macaroni
Pasta spaghetti 500g	-	8x500g - fettucine/macaroni
Pork - diced - vacuum packed	3kg	
Prawns - frozen c 500g pkts	8	
Puff pastry sheets x 500g	6	
Rice (jasmine) 1kg pkts	10	
Ricestick/Soba noodles 250g	6	
Sausages - vacuum packed	8kg	
Steak - vacuum packed	12kg	
Tempe - soybean	4kg	

CONDIMENTS, SPICES, FLAVOURINGS, BAKING ITEMS		
Allspice ground c 60g	1	
Baking powder - c 100g container	1	
Bicarbonate of soda - c 100g container	1	
Black bean sauce	-	Opened c 200 ml left
Black pepper - ground c 150 bottle	2	
Cardamom ground c 60g	1	
Chili flakes 120g bottle	3	
Cinnamon ground c 60g	1	
Cloves c 60g	1	
Coconut (desiccated) 250g bag	1	1x250g bag
Coconut cream (cans)	12	4x400g cans
Coriander ground c 120g	2	
Cornflour	-	2x300g
Cummin 120g bottle	3	
Curry mix - Chana dahl 100g pkts	2	2x100g pkt
Curry mix - Thai green 140g can	1	2x140g can
Curry mix - Vindaloo 100g pkts	1	1x200g jar
Dashi, instant, 10g pkts	-	8x10g pkts
Fish sauce	-	Opened c 500ml left
Garam Masala c 60g	1	
Garlic - crushed c 150g bottle	10	
Ginger - crushed c 150g bottle	5	
Gravox	-	1x425g container
Herbs (dried) 60g bottle - Basil	1	
Herbs (dried) 60g bottle - Mint	1	
Herbs (dried) 60g bottle - Mixed herbs	1	
Herbs (dried) 60g bottle - Oregano	2	c 50g
Herbs (dried) 60g bottle - Parsley flakes	1	
Herbs (dried) 60g bottle - Rosemary	1	
Lemon pepper seasoning	-	c 170g, open on shelf
Lemon squeeze (Berri lemon juice) 500ml bottles	2	
Melrose maple syrup 250ml bottle	1	
Melrose Organic Worcestershire sauce 250ml bottle	1	
Mirin	-	c100m left in bottle
Mustard whole grain	-	1x175g jar
Nutmeg ground c 60 g	1	
Parmesan cheese (grated) - 250g jars	10	3x250g
Peanut sauce	-	1x200g pkt
Pesto (basil)	-	2x190g jars

Salt 750g	3	
Sesame oil	-	1x375ml - c 250ml left
Soy sauce 750ml	1	Opened bottle c 500ml left
Tabasco sauce, 60ml bottle	4	c 50 ml left in bottle
Tamarind (souring agent)	-	1x200g jar
Tomato paste (twin 140g tubs)	8	7x140g tubs
Tomato sauce 560g bottles	2	
Turmeric c 120g	1	
Yoghurt mix Easi-yo 140g sachets (1sachet = 1 litre) - berry fruit	3	2 x 140g sachets
Yoghurt mix Easi-yo 140g sachets (1sachet = 1 litre) - plain	3	3 x 140g sachets

DESSERTS, OTHER SWEETS

Cake mix (3 each - date loaf, banana bread, muffins)	9	3x choc; 3x sultana butteercake; 1 blueberry muffins
Cream, long-life 1 litre pkt	8	
Custard powder	-	4x350g pkts
Jelly crystals (pkts, various flavours)	10	6x85g pkts
Pancake shake mix	-	3x375g bottles

SPECIAL (FESTIVE SEASON)

Christmas cakes (CWA shop)	2	
Christmas pudding (Legacy)	2	
Roast pork (2.5 kg)	1	

CLEANING, OTHER SUPPLIES

Aluminium foil	-	2x20m; used–widex1,cateringx1
Chux superwipes	-	1x10 giant, 1x3 thick, 1x15 std.
Cleaner (Jiff Cream)	-	2.5 x 750ml bottles
Clothes washing detergent	-	Cold Power 2.5 x 2lt bottles, Wool mix 1.5 x 750 ml bottles
Dettol	-	1 x 500ml bottle
Dishwashing detergent x 1 litre	1	1 x 1 litre
Gladwrap	-	3x30m rolls, 1 used catering roll
Methylated spirits	-	1 x 2 litre container
Paper towels (rolls)	20	Uncertain
Pegs	-	c 24
Plastic bags (various)		
Plastic sheets	-	2 sheets, 2.6m x 3.6 m
Rubber gloves	-	4x3 per pkt, 2x2/pkt, 1x2 h.duty
Rubbish bags	-	69 x Super size, s-strong 80 x 120cm; 11 x large bin liners 147cm x 113cm; 10 bin liners 80cm x 70cm; c 20 bin liners on roll
Scourer (Scotch Brite)	-	8 scourers
Scrubbing brushes (hand)	-	2 brushes
Soap	-	white washing x 8, yellow Velvet x 3, Palmolive Gold x 3
Steel wool	-	2 packets
Tea towels	-	4 towels
Toilet paper (Delsey)	72	Not specified
Wet Ones	-	>100 (part-used containers)
Wettex - pack of 3	2	2 pads

4. Food and kitchen supplies remaining at Sorensen Hut at departure of 2008-09 team

SORTED BY ITEM

Location key as per last column in following list.

NOTE The numbers below are just a key referring you to shelves or bins for each item (as per the last column of the list, headed "locn."). Many bins have numbers written on them, but these are confusing because they're from different years. I would have re-numbered the bins but ran out of time – PB.

1 **Open shelf**, top below ceiling, on wall, LHS as you enter
2 **Open shelf**, second from top, LHS
3 **Open shelf**, top below bench, LHS
4 **Plastic container**, open shelf, top below bench, LHS
5 **Open shelf**, bottom below bench, LHS - includes flour in blue bin)
6 **Open shelf**, shelf 1 (top bunk), RHS
7 **Open shelf**, shelf 2 (bottom bunk), RHS
8 **Open**, floor below bottom bunk
9 **Bin**: Blue, marked BL (pre-2008-09)
10 **Bin**: Box 100 (pre-2008-09)
11 **Bin**: 2007 F 24 (pre-2008-09)
12 **Bin**: 2007 F 19 (pre-2008-09)
13 **Bin**: 2007 F 26 (pre-2008-09)
14 **Bin**: Box 101 (pre-2008-09)
15 **Bin**: 2007 F 20 (pre-2008-09)
16 **Bin**: Box 102 (pre-2008-09)
17 **Bin**: Box 103 (pre-2008-09)
18 **Bin**: Box 104 (pre-2008-09)
19 **Bin**: 2007 F 17 (pre-2008-09)
20 **Bin**: 2007 F 18 (pre-2008-09)
21 **Bin**: MHF 1 (2008-09)
22 **Bin**: MHF 2 (2008-09)
23 **Bin**: MHF 4 (2008-09)
24 **Bin**: MHF 5 (2008-09)
25 **Bin**: MHF 7 (2008-09)
26 **Bin**: MHF 8 (2008-09)
27 **Bin**: MHF 11 (2008-09)
28 **Bin**: MHF 12 (2008-09)
29 **Bin**: MHF 18 (2008-09)

Item	*Comes in…*	*Amount*	***Locn.***
asparagus 425		2	**11**
asparagus 425gms		2	**13**
Asparagus spears 425g	can	2	**26**
Assorted cream biscuits		4	**12**
Baked beans 420 ml	can	1	**26**
Baked beans 420g	can	2	**7**
Baking powder 125 g	cardboard packet	1	**1**
bamboo skewers		400	**9**
Bars muesli bar		35	**16**
Beans red kidney	can	6	**27**
beer nuts 500gms		1	**18**
beetroot 425gm		2	**13**
Beetroot 825 g	can	1	**7**
Beetroot slices 825g	can	2	**21**
beetroot tins 825gms		3	**11**
besan flour 500gms		2	**14**
Bicarbonate of soda 250g	cardboard packet	1	**23**

Biscuits Ginger nuts 250g	plastic packet	1	**7**
Black bean sauce 210 ml	glass bottle	1	**2**
blackberry jam 250gms		2	**14**
Butter allowrie butter cans 450 gms		21	**14**
butternut snap biscuits		3	**12**
cadburys drinking chocolate 400gms		3	**29**
Cake mix - banana bread	cardboard packet	1	**27**
Cake mix - Madeira	cardboard packet	1	**24**
Cake mix madeira 310g	cardboard packet	1	**25**
Caster sugar c 300 g (1/2 gone)	plastic pkt	1	**1**
Cereal - Kelloggs Sustain	cardboard packet	2	**24**
Chai tea loose leaf	cardboard packet	1	**2**
Cheese parmasan 250gms		1	**14**
Cheese Parmesan grated 250 g	plastic jar	1	**3**
Cheese parmesan grated 250g	plastic bottle	3	**26**
Cheese parmesan grated 250g	plastic bottle	4	**25**
Cheese parmesan grated 250g	plastic jar	2	**27**
chick pea tins 410gms		5	**11**
Chick peas. 400g	can	5	**27**
chick peas 300gms		2	**13**
chickpeas 400gms		1	**29**
Chocolate bar 250g, dark	paper wrap	2	**26**
Chocolate bar 250g, dark	paper wrap	2	**27**
Chocolate bar 250g, milk	paper wrap	2	**26**
Chocolate Cadbury's dairy 50g	paper wrap	1	**7**
Christmas pack Eumarrah	plastic packet	2	**7**
Christmas pudding 700 g	plastic tub	1	**3**
chux wipes pkt		4	**9**
Cleaner bottles of jiff		3	**9**
clothes pegs		60	**9**
Cocoa 125 g	cardboard packet	1	**25**
Cocoa 250g	cardboard packet	1	**23**
Cocoa 250g	cardboard packet	1	**23**
Cocoa 375 g (1/2 gone)	cardboard packet	1	**2**
Cocoa 375g	paper packet	1	**7**
Coconut cream 400 ml	can	5	**26**
coconut cream 400gms		1	**11**
Coconut desiccated 250g	plastic bag	1	**23**
coconut dessicated 250gms		1	**14**
Coffee nescafe blend 43 150gm		2	**12**
Coffee Vittoria ground 200 g	foil vacuum pack	3	**1**
Coffee vittoria ground coffee 200gms		5	**12**
Cordial blackcurrant Cascade Ultra-C	glass bottle	2	**21**
cornflour 300gms		2	**17**
Cornflower 300 g (1/2 gone)	cardboard packet	1	**1**
Crackers Jatz	cardboard packet	6	**24**
Crackers Jatz		12	**20**
Crackers Salada 250gms		3	**19**
Crackers Vita Weat	cardboard packet	5	**28**
Crackers Vita Weat 250gms		14	**20**
Crackers Vita Weat pkts 250gms		28	**19**

Cup a soup boxes of 4 sachets		52	**15**
cup a soup pkt 4		2	**29**
Cup-a-soup	cardboard packet	2	**24**
Cup-a-soup various (4 per pkt)	cardboard packet	5	**1**
Deb mashed potato 115g	plastic packet	1	**7**
Detergent cold power detergent 1L		4	**9**
dettol liquid wash		1	**9**
disinfectant wipes		1	**9**
dried apples 200gms		2	**17**
Drink powder Gatorade berry flavour	plastic jar	1	**3**
Drink powder Gatorade lem/lime flavour	plastic jar	1	**3**
Easy Yo Yogurt sachets		2	**10**
Egg powder 400gms		4	**14**
Egg powder 4L (3/4 gone)	can	1	**3**
Fish sauce 750 ml (1/2 gone)	plastic bottle	1	**1**
Flour bread multigrain (1/2 gone) x 2.5 kg (enough for 4 loaves)		1	**5**
Flour bread multigrain 2.5 kg (8 loaves)	paper bag	2	**5**
Flour bread white (7/8 gone) 2.5 kg (enough for 1 loaf)		1	**5**
Flour plain 1 kg	paper bag	2	**5**
Flour plain 1 kg (1/2 gone)	paper bag	1	**5**
Flour plain 2 kg	paper bag	1	**23**
Flour plain 2kg	paper bag	1	**26**
Flour self-raising 1 kg	paper bag	1	**5**
Flour self-raising 2 kg	paper bag	1	**5**
Flour self-raising, 2 kg	paper bag	2	**22**
Flour, plain	paper bag	1	**27**
Foil x ditto	roll	x	**5**
Fruit apricot halves 825 g	can	1	**25**
Fruit apricot halves 825 g	can	1	**26**
Fruit dried apples 200gms		2	**18**
Fruit dried apples 400gms		1	**18**
Fruit dried apples 700gms		1	**18**
Fruit dried apricots 2 kgs		1	**18**
Fruit pear slices 825 g	can	1	**25**
Fruit pear slices 825 g	can	2	**26**
Fruit pear slices 825g	can	1	**21**
Fruit pineapple sliced 825 g	can	1	**25**
Fruit pineapple sliced 825g	can	2	**21**
Fruit salad 825g	can	2	**7**
Fruit sliced pineapple 825 g	can	1	**26**
Fruit: dried apple (large bag)	plastic bag	1	**27**
Fruit: dried peaches (large bag)	plastic bag	1	**28**
Fruit: dried pears (large bag)	plastic bag	1	**28**
Fruit: dried prunes (large bag)	plastic bag	1	**28**
garbage bags	rolls	3	**9**
garlic 160gm		2	**13**
garlic 170gm		4	**29**
Garlic crushed 170 g	glass jar	1	**2**
ginger 160gm		1	**13**
ginger 170gm		4	**29**
gingernuts		6	**12**

Glad wrap x several kilometres	roll	x	**5**
golden syrup 850gm		1	**14**
gravox 425gms		1	**17**
Gravox brown onion gravy powder	can	1	**2**
green scourer pad		12	**9**
ground black pepper 100gms		2	**29**
ground coffee 250gm		3	**17**
Ham leg 450 g	can	2	**7**
Ham plumrose ham		1	**11**
Herb/spice: Allspice - pimento	blue-cap plastic container	1	**4**
Herb/spice: Allspice 30 g	glass jar	2	**2**
Herb/spice: Basil 33g (1/2 gone)	glass bottle	1	**2**
Herb/spice: Basil 50g	glass jar	1	**2**
Herb/spice: basil leaves 33g	glass bottle	1	**22**
Herb/spice: black pepper 100 g	dispenser	1	**2**
Herb/spice: Cardamom 30g	blue-cap plastic container	1	**4**
Herb/spice: cardamom 45g	glass bottle	1	**23**
Herb/spice: cardamom 45g	glass bottle	1	**23**
Herb/spice: chili flakes	glass bottle	6	**25**
Herb/spice: Chili flakes (1/2 gone)	blue-cap plastic container	1	**4**
Herb/spice: chili flakes 16g	plastic jar	4	**2**
Herb/spice: chili flakes 18g	small jar	6	**27**
Herb/spice: Cinnamon (1/2 gone)	blue-cap plastic container	1	**4**
Herb/spice: Cinnamon ground 32g	glass bottle	1	**2**
Herb/spice: cloves (3/4 gone)	blue-cap plastic container	1	**4**
Herb/spice: cloves 20g	glass bottle	1	**23**
Herb/spice: cloves 20g	glass bottle	1	**25**
Herb/spice: Cloves whole 20g	glass jar	1	**2**
Herb/spice: coriander 20g	glass jar	1	**22**
Herb/spice: Coriander 395 g	plastic bottle	1	**1**
Herb/spice: coriander seeds	glass bottle	1	**25**
Herb/spice: Coriander seeds 25g	glass jar	1	**4**
Herb/spice: Cumin ground 350 g	plastic bottle	1	**3**
Herb/spice: Curry powder	can	1	**4**
Herb/spice: Garam masala c 300 g	glass jar	1	**1**
Herb/spice: garlic crushed 170g	glass jar	3	**22**
Herb/spice: Lemon pepper	glass bottle	1	**2**
Herb/spice: mint (full)	blue-cap plastic container	1	**4**
Herb/spice: mint 7g	glass bottle	2	**23**
Herb/spice: mint 7g	small jar	5	**27**
Herb/spice: Mixed herbs	blue-cap plastic container	1	**4**
Herb/spice: mixed herbs 10g	glass bottle	2	**25**
Herb/spice: mixed herbs 40g	glass bottle	1	**2**
Herb/spice: mixed spice 100 g	glass jar	1	**4**
Herb/spice: nutmeg (1/2 gone)	blue-cap plastic container	1	**4**
Herb/spice: nutmeg (1/2 gone)	blue-cap plastic container	1	**4**
Herb/spice: nutmeg 30g	glass bottle	1	**23**
Herb/spice: nutmeg 30g	small jar	1	**27**
Herb/spice: Oregano 150 g	plastic bottle	1	**1**
Herb/spice: Oregano c 30 g	glass jar	1	**4**
Herb/spice: Paprika (1/2 gone)	blue-cap plastic container	1	**4**

Herb/spice: Parsley flakes 75g	plastic jar	1	**1**
Herb/spice: pepper black ground 40g	glass jar	1	**2**
Herb/spice: pepper white ground 40g	glass jar	1	**2**
Herb/spice: Pesto basil	glass jar	1	**2**
Herb/spice: Rosemary (small amt)	blue-cap plastic container	1	**4**
Herb/spice: rosemary 16 g	small jar	2	**27**
Herb/spice: Rosemary 16g	plastic jar	2	**4**
Herb/spice: Tamarind concentrate 200g	plastic jar	1	**2**
Herb/spice: Turmeric (pnut butter jar, 9/10 gone)		1	**4**
Herb/spice: Turmeric 30g	glass jar	1	**2**
Herb/spice: turmeric 30g	glass jar	1	**22**
Herb/spice: turmeric 30g	small jar	1	**27**
Herb/spice: Vindaloo 320g (1/2 gone)	plastic bottle	1	**2**
Honey 250 g (small)	glass jar	1	**2**
honey 250g		6	**14**
honey 250gms		1	**29**
Jam blackberry	glass jar	2	**24**
Jam strawberry	glass jar	1	**7**
Jam strawberry	glass jar	1	**25**
Jam strawberry jam 250gms		2	**14**
jasmine rice 1kg		3	**14**
Jelly crystals	cardboard packet	4	**25**
Jelly crystals various flavours	packet	1	**7**
kitchen gloves pr		5	**9**
kitchen sponges		4	**9**
Lemon squeeze 250 ml	plastic bottle	2	**1**
Lemon squeeze 250 ml	plastic bottle	4	**7**
Lentils brown 2 kg	plastic bag	1	**26**
Lentils red 1 kg	plastic bag	2	**26**
Lime squeeze 250 ml	plastic bottle	4	**1**
Lime squeeze 250ml	plastic bottle	4	**21**
Maple syrup 330g (1/2 gone)	glass jar	1	**2**
marmalade 600gms		1	**14**
Matches Greenlite (waterproof)	matchbox	48	**1**
Matches Redhead (standard)	matchbox	17	**1**
Methylated spirits 2L (2/3 full)	plastic bottle	1	**3**
methylated spirits 500 ml		1	**9**
Milk condensed 395 g	can	1	**1**
Milk condensed milk 395 gms		7	**14**
Milk powder 400gms		3	**10**
Milk powder 750 g	plastic bag	1	**7**
Milk powder 750 gms		10	**10**
Milk powder 750gms		1	**12**
milk powder 750gms		2	**29**
Milo 750g	can	1	**7**
Mirim cooking sake 300 ml (2/3 gone)	plastic bottle	1	**1**
mushrooms in butter sauce 250gms		3	**11**
Mushrooms in sauce 220g	can	2	**26**
Mustard oil 250 ml	glass bottle	1	**2**
Nescafe blend 43 150gms		2	**29**
noodles 1kg		1	**17**

Noodles soba noodles 270gms		1	**14**
Noodles soba noodles 300gms		4	**17**
Noodles udon noodles 270gms		1	**17**
Nutella 750 g	plastic jar	1	**1**
Nutella 750 g (1/2 gone)	plastic jar	1	**1**
Nuts almonds 1kg	plastic bag	1	**23**
Nuts mixed 1 kg	plastic bag	1	**23**
Nuts peanuts (large bag)	plastic bag	1	**27**
Nuts walnuts (large bag)	plastic bag	1	**27**
Nuts walnuts 700gms		1	**18**
Oats 500gms		2	**12**
oats 500gms		2	**17**
Oil olive 2L	metal can	1	**21**
Oil sunflower	plastic bottle	2	**21**
Oysters smoked in oil 85g	can	3	**7**
pancake shake		1	**17**
Pancake shake 375g (1/2 gone)	plastic bottle	1	**1**
Paper towel, 80m	rolls	8	**8**
Paper towels rolls		4	**13**
Pasta fettucini c 150g	plastic packet	1	**7**
Pasta Lasagna sheets 250 g	packet	1	**7**
Pasta lasagne sheets 250gm pkt		4	**18**
Pasta macaroni shells 500g	plastic packet	1	**7**
Pasta macaroni tubes 500 g	plastic packet	2	**7**
Peach halves 825 g	can	1	**7**
peach slices 825gms		1	**13**
peanut butter 500gms		2	**13**
peanut butter 500gms		4	**11**
Peas dehydrated peas		29	**17**
Plastic bags, truckloads	packets, all known varieties	x	**5**
popcorn 375 gms		6	**16**
Popping corn	plastic bag	1	**26**
Pumpernickel 500g	plastic packet	2	**7**
Pumpernickel roll 250g	plastic packet	1	**7**
Pumpernickel 500g	plastic wrap	10	**25**
red kidney beans 410gms		3	**11**
red salmon tin 410gm		2	**11**
Rice Jasmine 1kg	plastic packet	1	**7**
Rice jasmine rice 1kg		2	**16**
Rice long grain rice 1kg		2	**16**
Rice long grain rice 1kg		3	**17**
Rice sticks (flat noodles) 400g	plastic packet	1.5	**7**
Salt Saxa table	plastic bottle	3	**21**
sardines in springwater 106gm		11	**11**
sardines in tomato sauce		11	**11**
sauerkraut 425gms		2	**13**
sauerkraut tin 410gms		2	**11**
scourer pads		12	**9**
scrubbing brush		1	**9**
self raising flour 2kgs		2	**29**
sesame bars		45	**16**

Sesame oil 375 ml (1/2 gone)	glass bottle	1	**2**
Sesame oil 375ml	glass bottle	1	**1**
sesame wheat crackers 250gms		4	**29**
small bottles of anchovies		14	**11**
soap cakes		16	**9**
Soy sauce	glass bottle	2	**21**
Soy sauce 1L (1/2 gone)	plastic bottle	1	**1**
Soy sauce 250ml (1/3 gone)	glass jar	1	**2**
Soybean paste 1 kg	plastic bag	1	**3**
steel wool pkt		10	**9**
Stock cubes beef x 2	plastic jar	1	**2**
Stock cubes chicken x 20	plastic jar	1	**2**
Stock cubes chicken x 25	plastic jar	1	**2**
Stock cubes Oxo beef (12) 71g	cardboard packet	2	**2**
Stock cubes vegetarian 105g (1/2 gone)	cardboard packet	2	**2**
Sugar brown 100g	plastic packet	1	**2**
Sugar caster 500g	plastic bag	4	**23**
Sugar caster sugar 500 gms		2	**10**
Sugar icing 500g	plastic bag	2	**23**
Sugar icing sugar 500 gms		1	**10**
Sugar raw	plastic bag	2	**21**
Sugar raw 1kg		5	**10**
Sugar raw 2kg	plastic bag	2	**23**
Sugar raw 2kg	plastic bag	2	**28**
Sugar soft icing 250g	plastic packet	1	**7**
Sugar soft icing 500 g (1/2 gone)	plastic bag	1	**3**
Sultanas	cardboard packet	2	**27**
sultanas 3kg		1	**18**
Sultanas 500 g	cardboard packet	2	**25**
Sultanas 500g	cardboard packet	1	**22**
Sultanas 500g	cardboard packet	2	**26**
summer roll		60	**16**
Sustain 575gms		2	**12**
sustain cereal 575 gms		2	**13**
sweet gherkins, 2 kg		1	**18**
Tabasco sauce	bottle in cardboard box	1	**25**
Tabasco sauce	plastic bottle	1	**24**
Tabasco sauce 60ml	bottle	3	**1**
Table salt 750 g	plastic tub	2	**7**
Tang instant drink powder	plastic jar	1	**7**
Tea loose leaf 250 g	packet	3	**7**
Tea towels		14	**6**
tinned fruit apricot halves 825gm		2	**13**
tinned fruit salad 825gms		1	**13**
tinned tomoates 425 gms		3	**13**
Toilet paper	rolls	42	**8**
Toilet paper	rolls	113	**6**
Tomato paste 140g	plastic tub	13	**7**
Tomatoes 410g	can	1	**22**
Tomatoes sundried (not in oil) 4kg		1	**18**
Tonic water	plastic bottle	2	**24**

Tonic water 1.25 L	plastic bottleqq	2	**25**
Tuna 425 g	can	2	**26**
Tuna lemon pepper 95g	can	1	**7**
Tuna sweet chili 95g	can	1	**7**
tuna tins 95gms		24	**11**
Vanilla essence 200 ml (1/8 gone)	plastic bottle	1	**2**
Vegemite 400 g (1/2 gone)	glass jar	1	**1**
vegemite 400gms		2	**13**
vegetmite 400gms		3	**11**
Vinegar malt 750 ml (2/3 full)	plastic bottle	1	**3**
Vinegar white wine 500 ml	glass bottle	1	**1**
Vinegar white wine 500 ml	glass bottle	1	**26**
Weetbix	cardboard packet	3	**24**
Weetbix 375g	cardboard packet	6	**25**
white wings cake mix		1	**16**
white wings cake mix		6	**29**
white wings cake mix pkt 520gms		6	**15**
wool wash bottles		2	**9**
Worcestershire sauce 250 ml	glass bottle	1	**1**
Yeast dried 500g	plastic wrap (vacuum packed)	1	**7**

5. Non-food items identified by 2008-09 team as needed for 2009-10 summer:

CATEGORY OR USE	ITEM	# needed
Apple Hut	Door handle	1
Apple Hut	Interior sealer to inhibit insulation breakdown - Ben suggests low-viscosity acrylic paint e.g. acrylic waterproofing membrane - 4L CAN	1
Books	Standard reference books on AAE/Huts, wildlife including Antarctic and Subantarctic Animals by Hadorni Shirihai	5
Electrical	Power supply line filter	1
Kitchen/dining	Spray'n'Wipe cleaner	1
Kitchen/dining	Sponges	6
Kitchen/dining	quality plastic wine glasses	8
Kitchen/dining	Cup hooks	10
Kitchen/dining	Flint lighter for gas fittings	2
Kitchen/dining	Tea strainer	1
Kitchen/dining	Teapot	1
Parts	Gas line for Rinnai heater	1
Parts	Metal louvred vents for Sorensen H. internal doors x 6 (2 for each of 3 doors)	6
Supplies: generator	Generator oil - 5W/40	
Supplies: maintenance	Varnish for bunk beds - 4L can	1
Supplies: printer	Ink cartridge for Canon - PG40-CL41	2

Tents	Ice screws	16
Toilet	Pine-O-Clean spray	1
Tools/fasteners	Offset tin snips (1 ea. left-hand, right-hand)	2
Tools/fasteners	Plastic spades (for moving snow from Main Hut entrance	2

6. Granholm Inventory – Tools & Equipment:

Item	Size	Quantity	Per	Category	Sub Category	Building	Bin
countersunk slotted head 8g	25mm	160	Only	Fixings	Brass Screws	Granholm	Wooden Box 1
metal thread countersunk head with nuts and washers	50mm	8	Only	Fixings	Brass Screws	Granholm	Wooden Box 1
metal thread countersunk head with nuts and washers	25mm	3	Only	Fixings	Brass Screws	Granholm	Wooden Box 1
assortment 4g	Various	100	Only	Fixings	Zinc Screws	Granholm	Wooden Box 1
wood thread countersunk phillips head 8g	50ml	100	Only	Fixings	Galvanised Screws	Granholm	Wooden Box 1
wood thread countersunk slotted head 12g	40mm	50	Only	Fixings	Zinc Screws	Granholm	Wooden Box 1
wood thread countersunk slotted head 12g	50mm	50	Only	Fixings	Zinc Screws	Granholm	Wooden Box 1
Hex nuts whitworth	3/8"	90	Only	Fixings	Brass nuts	Granholm	Wooden Box 1
Hex head screws self tapping metal tip 12g	35mm	40	Only	Fixings	Galvanised Screws	Granholm	Wooden Box 1
Rivets aluminium 6.4mm grip	1/8"	900	Only	Fixings	Aluminium rivets	Granholm	Wooden Box 1
Coat Hooks	small	4	Only	Domestic	coat hooks	Granholm	Wooden Box 1
Washers	3/16"	50	Only	Fixings	Steel Washers	Granholm	Wooden Box 1
304 stainless steel washers	1/4 x 5/8	100	Only	Fixings	Stainless	Granholm	Wooden Box 1
304 stainless steel washers	3/16 x 7/16	200	Only	Fixings	Stainless	Granholm	Wooden Box 1
copper square boat nails	25mm x 2mm	3.7	kg	Fixings	Nails	Granholm	Wooden Box 1
copper square boat nails	40mm x 3.2mm x	4	kg	Fixings	Nails	Granholm	Wooden Box 1
copper square boat nails	50mm x 3.2 x	4	kg	Fixings	Nails	Granholm	Wooden Box 1
copper square boat nails	76mm x 3.6mm x	4	kg	Fixings	Nails	Granholm	Wooden Box 1
countersunk square head	30mm	47	Only	Fixings	Bronze screws	Granholm	Wooden Box 1
Robertson drive screws pan head 8g	19mm	450	Only	Fixings	Stainless screws	Granholm	Wooden Box 1
Robertson drive pan head 8g	25mm	350	Only	Fixings	Stainless screws	Granholm	Wooden Box 1
Robertson drive countersunk 8g	31mm	350	Only	Fixings	Stainless screws	Granholm	Wooden Box 1
Robertson drive countersunk 10g	31mm	150	Only	Fixings	Stainless screws	Granholm	Wooden Box 1
Robertson drive countersunk self tapping 10g	37mm	250	Only	Fixings	Stainless screws	Granholm	Wooden Box 1
Robertson drive pan head 8g	50mm	650	Only	Fixings	Stainless screws	Granholm	Wooden Box 1
Robertson drive countersunk 8g	50mm	1100	Only	Fixings	Stainless screws	Granholm	Wooden Box 1
Robertson drive countersunk 10g	50mm	300	Only	Fixings	Stainless screws	Granholm	Wooden Box 1
Robertson drive countersunk 10g	62mm	200	Only	Fixings	Stainless screws	Granholm	Wooden Box 1
Robertson drive countersunk 10g	75mm	200	Only	Fixings	Stainless screws	Granholm	Wooden Box 1
Robertson drive countersunk 14g	75mm	200	Only	Fixings	Stainless screws	Granholm	Wooden Box 1
Robertson drive countersunk 12g	75mm	10	Only	Fixings	Stainless screws	Granholm	Wooden Box 1
Robertson drive countersunk 12g	50mm	200	Only	Fixings	Stainless screws	Granholm	Wooden Box 1

Robertson drive pan head 8g	37mm	100	Only	Fixings	Stainless screws	Granholm	Wooden Box 1
Robertson drive countersunk 8g	37mm	100	Only	Fixings	Stainless screws	Granholm	Wooden Box 1
Robertson drive countersunk 6g	31mm	100	Only	Fixings	Stainless screws	Granholm	Wooden Box 1
countersunk phillips head 10g	50mm	200	Only	Fixings	Stainless screws	Granholm	Wooden Box 1
trimhead robertson drive 7g	56mm	100	Only	Fixings	Stainless screws	Granholm	Wooden Box 1
Stainless Steel Nuts	M12	15	Only	Fixings	Stainless Steel Nuts	Granholm	Wooden Box 2
Brass Washers and Nuts	M6	50	Only	Fixings	Brass Washers and Nuts	Granholm	Wooden Box 2
Brass Washers and Nuts	M8	25	Only	Fixings	Brass Washers and Nuts	Granholm	Wooden Box 2
Brass Washers and Nuts	M10	225	Only	Fixings	Brass Washers and Nuts	Granholm	Wooden Box 2
Stainless Steel Washers and Nuts	M12	23	Only	Fixings	Stainless Steel	Granholm	Wooden Box 2
Stainless Steel Washers and Nuts	M10	40	Only	Fixings	Stainless Steel	Granholm	Wooden Box 2
75mm x 10mm galvanised with washers and nuts	75mm	60	Only	Fixings	Cup Head Bolts	Granholm	Wooden Box 2
100mm x 10mm galvanised with washers and nuts	100mm	130	Only	Fixings	Cup Head Bolts	Granholm	Wooden Box 2
120mm x 10mm galvanised with washers and nuts	120mm	27	Only	Fixings	Cup Head Bolts	Granholm	Wooden Box 2
150mm x 10mm galvanised with washers and nuts	150mm	24	Only	Fixings	Cup Head Bolts	Granholm	Wooden Box 2
170mm x 12mm galvanised with washers and nuts	170mm	15	Only	Fixings	Cup Head Bolts	Granholm	Wooden Box 2
100mm x12mm galvanised with washers and nuts	100mm	8	Only	Fixings	Cup Head Bolts	Granholm	Wooden Box 2
Coach screws	50mm	50	Only	Fixings	Coach screws	Granholm	Wooden Box 2
Coach screws	10mm x 100mm	5	Only	Fixings	Coach screws	Granholm	Wooden Box 2
Coach screws	10mm x 120mm	8	Only	Fixings	Coach screws	Granholm	Wooden Box 2
Coach screws	10mm x 150mm	8	Only	Fixings	Coach screws	Granholm	Wooden Box 2
Coach screws	12mm x 75 mm	6	Only	Fixings	Coach screws	Granholm	Wooden Box 2
Coach screws	12mm x 100mm	8	Only	Fixings	Coach screws	Granholm	Wooden Box 2
Coach screws	12mm x 120mm	8	Only	Fixings	Coach screws	Granholm	Wooden Box 2
Coach screws	12mm x 150mm	8	Only	Fixings	Coach screws	Granholm	Wooden Box 2
Steel washers	16mm	36	Only	Fixings	Steel washers	Granholm	Wooden Box 2
Nyloc nuts	M16	9	Only	Fixings	Nyloc nuts	Granholm	Wooden Box 2
Threaded rod joiner nuts	M12	6	Only	Fixings	Threaded rod joiner nuts	Granholm	Wooden Box 2
Galvanised nuts	M12	24	Only	Fixings	Galvanised nuts	Granholm	Wooden Box 2
Joist Hangers	45mm x 100mm	11	Only	Fixings	Joist Hangers	Granholm	Wooden Box 2
Galvanised angle brackets		6	Only	Fixings	Galvanised angle brackets	Granholm	Wooden Box 2
Bullet head galvanised	25mm x 1.6mm x 2.5kg	25	kg	Fixings	Nails	Granholm	Wooden Box 3
Bullet head galvanised	50mm x 2.15mm x 25kg	25	kg	Fixings	Nails	Granholm	Wooden Box 3

Bullet head galvanised	75mm x 3.75mm x 25kg	25	kg	Fixings	Nails	Granholm	Wooden Box 3
Clouts	25mm	300	Only	Fixings	clouts	Granholm	Wooden Box 3
5 piece chisel set		1	Only	Tools	Hand	Granholm	Box 1 (metal)
handsaws		3	Only	Tools	Hand	Granholm	Box 1 (metal)
nail bags		2	Only	Tools	Hand	Granholm	Box 1 (metal)
8m tape measures		2	Only	Tools	Hand	Granholm	Box 1 (metal)
small ball pein hammer		1	Only	Tools	Hand	Granholm	Box 1 (metal)
claw hammers		2	Only	Tools	Hand	Granholm	Box 1 (metal)
small jemmy bar		1	Only	Tools	Hand	Granholm	Box 1 (metal)
lump hammer		1	Only	Tools	Hand	Granholm	Box 1 (metal)
bolster		1	Only	Tools	Hand	Granholm	Box 1 (metal)
wire brush		1	Only	Tools	Hand	Granholm	Box 1 (metal)
mastic gun		4	Only	Tools	Hand	Granholm	Box 1 (metal)
straight tin snips		2	Only	Tools	Hand	Granholm	Box 1 (metal)
carpenters pencils		3	Only	Tools	Hand	Granholm	Box 1 (metal)
putty knife		1	Only	Tools	Hand	Granholm	Box 1 (metal)
large vice grips		2	Only	Tools	Hand	Granholm	Box 1 (metal)
paint scraper		2	Only	Tools	Hand	Granholm	Box 1 (metal)
garden trowels		2	Only	Tools	Hand	Granholm	Box 1 (metal)
Allen Key set metric and imperial (inside staple box)		1	Only	Tools	Hand	Granholm	Box 1 (metal)
stapler		1	Only	Tools	Hand	Granholm	Box 1 (metal)
rat tail files		4	Only	Tools	Hand	Granholm	Box 1 (metal)
pointing trowel		1	Only	Tools	Hand	Granholm	Box 1 (metal)
30m tape		1	Only	Tools	Hand	Granholm	Box 1 (metal)
12mm staples		1	box	Tools	Hand	Granholm	Box 1 (metal)
10mm staples		1	box	Tools	Hand	Granholm	Box 1 (metal)
multisaw		1	Only	Tools	Hand	Granholm	Box 1 (metal)
multisaw blades		2	Only	Tools	Hand	Granholm	Box 1 (metal)
small pinch bar		1	Only	Tools	Hand	Granholm	Box 1 (metal)
hack saws		2	Only	Tools	Hand	Granholm	Box 1 (metal)
hacksaw blades		40	Only	Tools	Hand	Granholm	Box 1 (metal)
pop rivet gun		1	Only	Tools	Hand	Granholm	Box 1 (metal)
lazy tong rivet gun		1	Only	Tools	Hand	Granholm	Box 1 (metal)
calipers		1	Only	Tools	Hand	Granholm	Box 1 (metal)

robertson hand drivers small and medium		2	Only	Tools	Hand	Granholm	Box 1 (metal)
cutter knife		1	Only	Tools	Hand	Granholm	Box 1 (metal)
nail punch		1	Only	Tools	Hand	Granholm	Box 1 (metal)
spring clamp		1	Only	Tools	Hand	Granholm	Box 1 (metal)
work bench dogs		2	Only	Tools	Hand	Granholm	Box 1 (metal)
drift rods		1	set	Tools	Hand	Granholm	Box 1 (metal)
steel fixers pliers		1	Only	Tools	Hand	Granholm	Box 1 (metal)
handsaws		2	Only	Tools	Hand	Granholm	Box 2 (metal)
chisel	6mm	2	Only	Tools	Hand	Granholm	Box 2 (metal)
chisel	12mm	1	Only	Tools	Hand	Granholm	Box 2 (metal)
chisel	32mm	1	Only	Tools	Hand	Granholm	Box 2 (metal)
small ball pein hammer		1	Only	Tools	Hand	Granholm	Box 2 (metal)
claw hammer		1	Only	Tools	Hand	Granholm	Box 2 (metal)
small jemmy bars		2	Only	Tools	Hand	Granholm	Box 2 (metal)
large jemmy bar		1	Only	Tools	Hand	Granholm	Box 2 (metal)
combination square		1	Only	Tools	Hand	Granholm	Box 2 (metal)
bevel gauges		2	Only	Tools	Hand	Granholm	Box 2 (metal)
lump hammer		1	Only	Tools	Hand	Granholm	Box 2 (metal)
bolster		1	Only	Tools	Hand	Granholm	Box 2 (metal)
wirebrush		1	Only	Tools	Hand	Granholm	Box 2 (metal)
mastic gun		2	Only	Tools	Hand	Granholm	Box 2 (metal)
left hand tin snips		2	Only	Tools	Hand	Granholm	Box 2 (metal)
15" multigrips		1	Only	Tools	Hand	Granholm	Box 2 (metal)
12 " shifter		1	Only	Tools	Hand	Granholm	Box 2 (metal)
8" shifter		1	Only	Tools	Hand	Granholm	Box 2 (metal)
10" shifter		1	Only	Tools	Hand	Granholm	Box 2 (metal)
side cutters		1	Only	Tools	Hand	Granholm	Box 2 (metal)
long nosed pliers		2	Only	Tools	Hand	Granholm	Box 2 (metal)
panasonic cordless drill with spare battery,		1	Only	Tools	Battery	Granholm	Box 2 (metal)
pincers		1	Only	Tools	Hand	Granholm	Box 2 (metal)
panasonic cordless drill and spare battery with battery charger		1	Only	Tools	Battery	Granholm	Box 2 (metal)
200mm brace		1	Only	Tools	Hand	Granholm	Box 2 (metal)
screwdriver bit for brace		1	Only	Tools	Hand	Granholm	Box 2 (metal)
stanley number 4 plane		1	Only	Tools	Hand	Granholm	Box 2 (metal)
oil can		1	Only	Tools	Hand	Granholm	Box 2 (metal)

mallet		1	Only	Tools	Hand	Granholm	Box 2 (metal)
triangle scraper		3	Only	Tools	Hand	Granholm	Box 2 (metal)
small cold chisels		2	Only	Tools	Hand	Granholm	Box 2 (metal)
medium cold chisels		2	Only	Tools	Hand	Granholm	Box 2 (metal)
large cold chisels		2	Only	Tools	Hand	Granholm	Box 2 (metal)
robertson handdrivers small and medium		2	Only	Tools	Hand	Granholm	Box 2 (metal)
cutter knife		1	Only	Tools	Hand	Granholm	Box 2 (metal)
centre punch		1	Only	Tools	Hand	Granholm	Box 2 (metal)
plastic spring clamp		2	Only	Tools	Hand	Granholm	Box 2 (metal)
flat file		1	Only	Tools	Hand	Granholm	Box 2 (metal)
large slotted screw driver		1	Only	Tools	Hand	Granholm	Box 2 (metal)
large ball pein hammer		1	Only	Tools	Hand	Granholm	Box 2 (metal)
off set left hand tin snips		1	Only	Tools	Hand	Granholm	Box 2 (metal)
hose clamps	200mm	2	Only	Tools	Hand	Granholm	Box 3 (metal)
hose clamps	100mm	2	Only	Tools	Hand	Granholm	Box 3 (metal)
hose clamps	50mm	2	Only	Tools	Hand	Granholm	Box 3 (metal)
gas heating torch		1	Only	Tools	Hand	Granholm	Box 3 (metal)
250mm sliding bar clamps		4	Only	Tools	Hand	Granholm	Box 3 (metal)
600mm sliding bar clamps		4	Only	Tools	Hand	Granholm	Box 3 (metal)
14 piece screwdriver set		1	Only	Tools	Hand	Granholm	Box 3 (metal)
10 piece holesaw set		1	Only	Tools	Hand	Granholm	Box 3 (metal)
9" angle grinder		1	Only	Tools	Electric	Granholm	Box 3 (metal)
spare gas regulator and fittings		1	Only	gas	spares	Granholm	Box 3 (metal)
extension cords	15m	1	Only	Tools	Electric	Granholm	Box 4 (metal)
extension cords	20m	1	Only	Tools	Electric	Granholm	Box 4 (metal)
extension cords	10m	2	Only	Tools	Electric	Granholm	Box 4 (metal)
extension cords	25m	1	Only	Tools	Electric	Granholm	Box 4 (metal)
RCD four plug power box with weather proof plugs		1	Only	Tools	Electric	Granholm	Box 4 (metal)
double adapters		2	Only	Tools	Electric	Granholm	Box 4 (metal)
7 1/4" circular saw + blades		2	Only	Tools	Electric	Granholm	Box 10 (metal)
9" grinder		1	Only	Tools	Electric	Granholm	Box 10 (metal)
belt sander		1	Only	Tools	Electric	Granholm	Box 10 (metal)
electric planer		1	Only	Tools	Electric	Granholm	Box 10 (metal)
planer guide		1	Only	Tools	Electric	Granholm	Box 10 (metal)
router and set of bits		1	Only	Tools	Electric	Granholm	Box 10 (metal)

right angle drill		1	Only	Tools	Electric	Granholm	Box 10 (metal)
jigsaw		1	Only	Tools	Electric	Granholm	Box 10 (metal)
electric drill 10mm chuck		1	Only	Tools	Electric	Granholm	Box 10 (metal)
electric screwgun		1	Only	Tools	Electric	Granholm	Box 10 (metal)
metabo heat gun		2	Only	Tools	Electric	Granholm	Box 10 (metal)
720 watt percussion drill		1	Only	Tools	Electric	Granholm	Box 10 (metal)
115mm grinder		1	Only	Tools	Electric	Granholm	Box 10 (metal)
abortech grinder		1	Only	Tools	Electric	Granholm	Box 10 (metal)
electric reciprocating saw		1	Only	Tools	Electric	Granholm	Box 10 (metal)
7 1/4 circular saw guide		1	Only	Tools	Electric	Granholm	Box 10 (metal)
electric drill 10mm keyless chuck		1	Only	Tools	Electric	Granholm	Box 10 (metal)
rain jackets		2	Only	Clothing	safety	Granholm	Box 8 (metal)
waterproof bib and brace		3	Only	Clothing	safety	Granholm	Box 8 (metal)
chainsaw chaps		2	Only	Clothing	safety	Granholm	Box 8 (metal)
box of ear plugs		80	pair	Clothing	safety	Granholm	Box 8 (metal)
welding mask		1	Only	Clothing	safety	Granholm	Box 8 (metal)
welding mask lenses		2	Only	Clothing	safety	Granholm	Box 8 (metal)
welding gloves		1	pair	Clothing	safety	Granholm	Box 8 (metal)
ear muffs		6	Only	Clothing	safety	Granholm	Box 8 (metal)
safety glasses		1	Only	Clothing	safety	Granholm	Box 8 (metal)
antivibration gloves		1	pair	Clothing	safety	Granholm	Box 8 (metal)
knee pads		8	Only	Clothing	safety	Granholm	Box 8 (metal)
rubber gloves		1	pair	Clothing	safety	Granholm	Box 8 (metal)
wollen gloves		3	pair	Clothing	safety	Granholm	Box 8 (metal)
cotton gloves		12	pair	Clothing	safety	Granholm	Box 8 (metal)
disposable rubber gloves		100	pair	Clothing	safety	Granholm	Box 8 (metal)
barrier man overalls		1	Only	Clothing	safety	Granholm	Box 8 (metal)
9" metal cutting disks		21	Only	Tools	Consumable	Granholm	Box 12 (metal)
115mm metal cutting disks		5	Only	Tools	Consumable	Granholm	Box 12 (metal)
115mm metal grinding disks		14	Only	Tools	Consumable	Granholm	Box 12 (metal)
115mm sanding disks	80 grit	6	Only	Tools	Consumable	Granholm	Box 12 (metal)
115mm sanding disks	60 grit	6	Only	Tools	Consumable	Granholm	Box 12 (metal)
belts for belt sander	80 grit	4	Only	Tools	Consumable	Granholm	Box 12 (metal)
belts for belt sander	60 grit	3	Only	Tools	Consumable	Granholm	Box 12 (metal)
electric planer blades + fitting kit		1	Only	Tools	Consumable	Granholm	Box 12 (metal)

reciprocating saw blades metal		29	Only	Tools	Consumable	Granholm	Box 12 (metal)
reciprocating saw blades wood		1	Only	Tools	Consumable	Granholm	Box 12 (metal)
sandpaper sheets 80grit	80 grit	3	Only	Tools	Consumable	Granholm	Box 12 (metal)
sandpaper sheets100grit	100 grit	6	Only	Tools	Consumable	Granholm	Box 12 (metal)
sandpaper sheets 60grit	60 grit	3	Only	Tools	Consumable	Granholm	Box 12 (metal)
sandpaper sheets 220grit	220 grit	3	Only	Tools	Consumable	Granholm	Box 12 (metal)
sandpaper sheets 240grit	240 grit	3	Only	Tools	Consumable	Granholm	Box 12 (metal)
spade bit extension driver		2	Only	Tools	drilling	Granholm	Box 12 (metal)
spade bit set full range 6-35mm		1	Only	Tools	drilling	Granholm	Box 12 (metal)
25mmx400mm auger bit		1	Only	Tools	drilling	Granholm	Box 12 (metal)
long series drill bits	3/8"	1	Only	Tools	drilling	Granholm	Box 12 (metal)
long series drill bits	1/8"	2	Only	Tools	drilling	Granholm	Box 12 (metal)
long series drill bits	1/4"	2	Only	Tools	drilling	Granholm	Box 12 (metal)
long series drill bits	1/2"	1	Only	Tools	drilling	Granholm	Box 12 (metal)
metal drill set (missing 13mm)		1	Only	Tools	drilling	Granholm	Box 12 (metal)
metal drill set (missing 1/4,1/8)		1	Only	Tools	drilling	Granholm	Box 12 (metal)
metal drill set (missing 1/2, 3/16,11/64, 5/32, 9/64)		1	Only	Tools	drilling	Granholm	Box 12 (metal)
drill bits double ended	1/8"	8	Only	Tools	drilling	Granholm	Box 12 (metal)
assorted driver bits, robertson, phillips, hexhead, bugle head, slotted		heaps	Only	Tools	drilling	Granholm	Box 12 (metal)
Sharpening Stone		1	Only	Tools	Hand	Granholm	Box 12 (metal)
Letter and Number punch set		1	Only	Tools	Hand	Granholm	Box 12 (metal)
7 1/4 circular saw blade		1	Only	Tools	Electric	Granholm	Box 12 (metal)
arbortech kit		1	Only	Tools	Electric	Granholm	Box 12 (metal)
string lines		4	Only	Tools	Hand	Granholm	Box 12 (metal)
jigsaw blades		50	Only	Tools	Consumable	Granholm	Box 12 (metal)
hilti masonary bits SDS max chuck to suit large makita hammer drill	25mm	2	Only	Tools	drilling	Granholm	Box 12 (metal)
hilti masonary bits SDS max chuck to suit large makita hammer drill	32mm	2	Only	Tools	drilling	Granholm	Box 12 (metal)
hilti masonary bits SDS max chuck to suit large makita hammer drill	12mm	2	Only	Tools	drilling	Granholm	Box 12 (metal)
bulldog clamps, gal for 10mm wire rope		2	Only	Hardware	cable	Granholm	Fish bin 2
bulldog clamps, gal for 12mm wire rope		29	Only	Hardware	cable	Granholm	Fish bin 2
bulldog clamps, gal for 6.5mm wire rope		30	Only	Hardware	cable	Granholm	Fish bin 2
D shackles galvanised	10mm	8	Only	Hardware	cable	Granholm	Fish bin 2
D shackles galvanised	12mm	1	Only	Hardware	cable	Granholm	Fish bin 2
D shackles galvanised	6mm	2	Only	Hardware	cable	Granholm	Fish bin 2

D shackles galvanised	20mm	11	Only	Hardware	cable	Granholm	Fish bin 2
thimbles	10mm	8	Only	Hardware	cable	Granholm	Fish bin 2
thimbles	12mm	15	Only	Hardware	cable	Granholm	Fish bin 2
thimbles	6mm	2	Only	Hardware	cable	Granholm	Fish bin 2
wire rope 10mm galvanised		20	metres	Hardware	cable	Granholm	Fish bin 2
wire rope 6.5mm galvanised		20	metres	Hardware	cable	Granholm	Fish bin 2
bow shackles	10mm	3	Only	Hardware	cable	Granholm	Fish bin 2
turnbuckles	20mm	4	Only	Hardware	cable	Granholm	Fish bin 2
turnbuckles	12mm	1	Only	Hardware	cable	Granholm	Fish bin 2
rock eyelets and wedges		4	Only	Hardware	cable	Granholm	Fish bin 2
stainless steel eyelets 6mm		8	Only	Hardware	cable	Granholm	Fish bin 2
aluminium brackets (left over stair tread supports)		10	Only	Hardware	cable	Granholm	Fish bin 2
ratchet straps		8	sets	Hardware	tie down	Granholm	Fish bin 3
PVA Glue Exterior		500	ml	Liquid	Adhesive	Granholm	Fish bin 7
PVC plumbing glue		50	ml	Liquid	Adhesive	Granholm	Fish bin 7
purbond glue		1	litre	Liquid	Adhesive	Granholm	Fish bin 7
locktite		100	ml	Liquid	Adhesive	Granholm	Fish bin 7
linseed oil		500	ml	Liquid	oils	Granholm	Fish bin 7
mineral turps		500	ml	Liquid	cleaning	Granholm	Fish bin 7
RP7 can		1	Only	Liquid	lube	Granholm	Fish bin 7
machine oil		120	ml	Liquid	lube	Granholm	Fish bin 7
fuel funnels		4	Only	Tools	sundry	Granholm	Fish bin 7
spare jerry can spout		1	Only	Tools	sundry	Granholm	Fish bin 7
safety goggles		3	Only	Tools	safety	Granholm	Fish bin 7
multi purpose grease		500	gram	Liquid	lube	Granholm	Fish bin 7
contact glue		250	ml	Liquid	Adhesive	Granholm	Fish bin 7
duct tape rolls		2	Only	Hardware	tape	Granholm	Fish bin 7
masking tape		2	Only	Hardware	tape	Granholm	Fish bin 7
wire brush		1	Only	Tools	Hand	Granholm	Fish bin 7
note pad		1	Only	Tools	Hand	Granholm	Fish bin 7
feeler gauge metric		1	Only	Tools	Hand	Granholm	Fish bin 7
feeler gauge imperial		1	Only	Tools	Hand	Granholm	Fish bin 7
spare sled bolts		2	Only	Fixings	bolts	Granholm	Fish bin 7
sikaflex sausages		12	Only	Liquid	Adhesive	Granholm	Fish bin 11

sikaflex sausage gun		1	Only	Tools	Adhesive	Granholm	Fish bin 11
nozzles for sausagegun		2	Only	Tools	Adhesive	Granholm	Fish bin 11
sika surface cleaner 1-205		30	ml	Liquid	Cleaner	Granholm	Fish bin 11
sikaflex PVC primer 209N		100	ml	Liquid	Primer	Granholm	Fish bin 11
sausagegun with seized nozzle		1	Only	Tools	Adhesive	Granholm	Fish bin 11
plastic mushroom bolt m16		17	Only	Fixings	nylon	Granholm	Fish bin 11
new quad battery dry with acid		2	Only	Quad	Parts	Granholm	Fish bin 12
2 litre measuring jug for oil		1	Only	Quad	tools	Granholm	Fish bin 12
RP7		1	Only	Liquid	lube	Granholm	Fish bin 12
spark plugs		9	Only	Quad	Parts	Granholm	Fish bin 12
plug spanners		2	Only	Quad	tools	Granholm	Fish bin 12
air filters		4	Only	Quad	Parts	Granholm	Fish bin 12
choke replacement kits		5	Only	Quad	Parts	Granholm	Fish bin 12
throttle cable		1	Only	Quad	Parts	Granholm	Fish bin 12
o rings		5	Only	Quad	Parts	Granholm	Fish bin 12
sump plug washers		5	Only	Quad	Parts	Granholm	Fish bin 12
spark plugs		3	Only	Dunlite Generator	Parts	Granholm	Fish bin 12
airfilter		1	Only	Dunlite Generator	Parts	Granholm	Fish bin 12
CRC 5-56		1	Only	Liquid	lube	Granholm	Fish bin 13
CRC softseal		2	Only	Sealant	Consumable	Granholm	Fish bin 13
white spraypaint		1	Only	Liquid	paint	Granholm	Fish bin 13
zinc rich primer spray		1	Only	Liquid	paint	Granholm	Fish bin 13
killrust white enamel spray		1	Only	Liquid	paint	Granholm	Fish bin 13
white fast dry oilbased paint		2	4 litre can	Liquid	paint	Granholm	Fish bin 13
grey fast oilbased paint		2	litre	Liquid	paint	Granholm	Fish bin 13
mineral turps		500	ml	Liquid	cleaning	Granholm	Fish bin 13
butane cartridges for cookers		2	Only	Gas	Consumable	Granholm	Fish bin 13
neatsfoot oil		300	ml	Liquid	oils	Granholm	Fish bin 13
paint rollers		2	Only	Tools	Paint	Granholm	Fish bin 13
roller tray		1	Only	Tools	Paint	Granholm	Fish bin 13
4 inch brush		1	Only	Tools	Paint	Granholm	Fish bin 13
contact glue		100	ml	Liquid	Adhesive	Granholm	Fish bin 13
rapidset grout		30	kg	Fixings	cement	Granholm	Fish bin 10

batten(buglehead) screws galv	150 mm	60	Only	Fixings	screws	Granholm	Fish bin 14
batten(buglehead) screws galv	100 mm	950	Only	Fixings	screws	Granholm	Fish bin 14
batten(buglehead) screws galv	75 mm	950	Only	Fixings	screws	Granholm	Fish bin 14
batten(buglehead) screws galv	50 mm	100	Only	Fixings	screws	Granholm	Fish bin 14
buglehead squaredrive black powdercoat	150 mm	30	Only	Fixings	screws	Granholm	Fish bin 14
batten(buglehead) screws galv	200 mm	30	Only	Fixings	screws	Granholm	Fish bin 14
adhesive foam strip 9x6mmx20m		1	roll	Hardware	sealer	Granholm	Loose in Granholme
foam joint strips(75x25x 7m)		1	pack	Hardware	sealer	Granholm	High shelf loose items
foam sleeping mats		2	Only	field	sleeping	Granholm	High shelf loose items
sleeping bag		1	Only	field	sleeping	Granholm	High shelf loose items
glass panel 500x400x 4mm		1	Only	Hardware	building	Granholm	High shelf loose items
climbing helmets		3	Only	Clothing	safety	Granholm	High shelf loose items
rags		2	large bag	Hardware	sundry	Granholm	High shelf loose items
ext weather sensor housings		2	Only	Hardware	sundry	Granholm	High shelf loose items
Malthoid dampcourse		2	20m	Hardware	sealer	Granholm	Lower shelf items
hoop iron strap		1	45m	Hardware	building	Granholm	Lower shelf items
tie wire		2	roll	Hardware	building	Granholm	Lower shelf items
Tent pegs		10	Only	field	equipment	Granholm	Lower shelf items
dolphin torches (no batteries)		2	Only	Tools	Battery	Granholm	Lower shelf items
height staff		1	Only	Tools	hand	Granholm	Lower shelf items
flood lights		2	Only	Tools	Electric	Granholm	Lower shelf items
4mm cord		300	ml	field	cord	Granholm	Lower shelf items
putty		2	kg	Hardware	sealer	Granholm	Lower shelf items
builders square		1	Only	Tools	hand	Granholm	Lower shelf items
screwdriver set 10 piece		1	Only	Tools	hand	Granholm	Lower shelf items
large plastic garbage bags		15	Only	Hardware	sundry	Granholm	Lower shelf items
polyester 8mm sinking line		280	metres	Hardware	rope	Granholm	Lower shelf items
metric spanner set		1	Only	Tools	hand	Granholm	Green canvas bag:
imperial spanner set		1	Only	Tools	hand	Granholm	Green canvas bag:
1/2" drive 40 piece socket set metric and imperial		1	Only	Tools	hand	Granholm	Green canvas bag:
1/4" drive 23 piece socket set metric and imperial		1	Only	Tools	hand	Granholm	Green canvas bag:

fluorescent tubes		3	Only	electrical	spares	Granholm	Top shelf items
dewalt radial arm dropsaw		1	Only	Tools	Electric	Granholm	Top shelf items
Dewalt saw bench		1	Only	Tools	Electric	Granholm	Top shelf items
spare 60 tooth dropsaw blade		1	Only	Tools	Electric	Granholm	Top shelf items
8mm galvanised guy wire		3	roll	Hardware	building	Granholm	Top shelf items
weather shield sarking		20	metres	Hardware	sealer	Granholm	Top shelf items
bag of tent pegs and snow stakes		1	bag	field	equipment	Granholm	Top shelf items
Green bag with assortment of cable ties		1	lot	electrical	ties	Granholm	Top shelf items
Rear quad bike wheels with tyres fitted and inflated		2	Only	Mechanical	spares	Granholm	Other loose items
Front quad bike wheels with tyres fitted and inflated		4	Only	Mechanical	spares	Granholm	Other loose items
Makita Electric Chainsaw		1	Only	Tools	Electric	Granholm	Other loose items
Black plastic 2.4m wide		30	metres	Archeological	spares	Granholm	Other loose items
copper earth rods		2	Only	electrical	earthing	Granholm	Other loose items
fire blanket		1	Only	fire	safety	Granholm	Other loose items
1m2 photographic grids		2	Only	Archeological	tools	Granholm	Other loose items
guy rope cutters		1	Only	Tools	hand	Granholm	Other loose items
gas regulator kit		1	Only	gas	parts	Granholm	Other loose items
900mm spirit level		1	Only	Tools	hand	Granholm	Other loose items
Makita Rotary Hammer drill (SDS max chuck)		1	Only	Tools	Electric	Granholm	Other loose items
Dewalt cordless drills		2	Only	Tools	Battery	Granholm	Other loose items
batteries to suit dewalt cordless drill		9	Only	Tools	Battery	Granholm	Other loose items
battery chargers for dewalt cordles drill		2	Only	Tools	Battery	Granholm	Other loose items
baileys 900mm step ladder		1	Only	Tools	Ladder	Granholm	Other loose items
baileys 1800mm step ladder		1	Only	Tools	Ladder	Granholm	Other loose items
baileys extension ladder		1	Only	Tools	Ladder	Granholm	Other loose items
saw benches		2	Only	Tools	benches	Granholm	Other loose items
saw horses		2	Only	Tools	benches	Granholm	Other loose items
PVC wall vent		1	Only	building	ventilation	Granholm	Front room
Spare PVC 'H' Cowls		1	Only	building	ventilation	Granholm	Front room
Candles		8	Only	field	equipment	Granholm	Front room
Redhead matches		20	box	field	equipment	Granholm	Front room
Tilley lamp		1	Only	field	equipment	Granholm	Front room
crevasse travel kit		1	Only	field	equipment	Granholm	Front room
3 person survival kit		1	Only	field	equipment	Granholm	Front room
shellite fuel		13	litre	Liquid	Fuel	Granholm	Front room

petrol		15	litre	Liquid	Fuel	Granholm	Front room
gas burner		1	Only	field	equipment	Granholm	Front room
8.5 kg gas bottle (1/2 full)		1	Only	Gas	gas	Granholm	Front room
square mouth shovels		2	Only	Tools	hand	Granholm	Front room
snow shovel		1	Only	Tools	hand	Granholm	Front room
spades		2	Only	Tools	hand	Granholm	Front room
sledge hammer		1	Only	Tools	hand	Granholm	Front room
stainless steel flat bar	50mm x 3mm x 2m	4	Only	Hardware	building	Granholm	Under
galvanised flat bar	50mm x 4mm x 1.2m	1	Only	Hardware	building	Granholm	Under
galvanised flat bar	100mm x 4mm x 1.8m	1	Only	Hardware	building	Granholm	Under
galvanised flat bar	100mm x 4mm x 1.7m	1	Only	Hardware	building	Granholm	Under
galvanised flat bar	130mm x 4mm x 1.8	1	Only	Hardware	building	Granholm	Under
galvanised flat bar	150mm x 4mm x 1.8m	2	Only	Hardware	building	Granholm	Under
galvanised flat bar	220mm x 4mm x1.8m	3	Only	Hardware	building	Granholm	Under
galvanised plate	2mm x 1.8m x 0.9m	1	Only	Hardware	building	Granholm	Under
ridge flashing	2.4	3	Only	Hardware	building	Granholm	Under
300mm lead flashing	300mm	5	roll	Hardware	building	Granholm	Under
saw horses		2	Only	Tools	benches	Granholm	Under
Front wheel and tyre (new)		2	Only	Quad	spares	Granholm	Lower shelf items
Battery, Li Ion for Vernier Caliper	xxV	1	only	Battery	Non Rechargeable	Granholm	Electrical Box
Battery Terminals	Large	2	only	Battery	Terminator	Granholm	Electrical Box
Holesaw	20mm	2	only	Tools	Drillbit	Granholm	Electrical Box
Holesaw	25mm	2	only	Tools	Drillbit	Granholm	Electrical Box
Alligator Clips	Large	1	only	Electrical	Accessory	Granholm	Electrical Box
Alligator Clips	Small	1	only	Electrical	Accessory	Granholm	Electrical Box
Alligator Clips	Small	2	Pairs	Electrical	Accessory	Granholm	Electrical Box
Alligator Clips	Large	2	Pairs	Electrical	Accessory	Granholm	Electrical Box
Gland, PVC	20mm	1	only	Electrical	Accessory	Granholm	Electrical Box
Gland, PVC	25mm	1	only	Electrical	Accessory	Granholm	Electrical Box
Gland, PVC	32mm	2	only	Electrical	Accessory	Granholm	Electrical Box
Heat Shrink, Black	5mm	1	metres	Electrical	Accessory	Granholm	Electrical Box
Heat Shrink, Black	10mm	1	metres	Electrical	Accessory	Granholm	Electrical Box
Heat Shrink, Red	5mm	1	metres	Electrical	Accessory	Granholm	Electrical Box
Heat Shrink, Red	10mm	1	metres	Electrical	Accessory	Granholm	Electrical Box
Jumper Leads	Large	1	only	Electrical	Cable	Granholm	Cable Box

Active Link	Medium	1	only	Electrical	Connector	Granholm	Electrical Box
Cigarette Lighter Fitting, Female	Standard	1	only	Electrical	Connector	Granholm	Electrical Box
Cigarette Lighter Fitting, Male	Standard	2	only	Electrical	Connector	Granholm	Electrical Box
Connectors	1 screw	80	only	Electrical	Connector	Granholm	Electrical Box
Connectors	2 screw	40	only	Electrical	Connector	Granholm	Electrical Box
Neutral Link	Medium	1	only	Electrical	Connector	Granholm	Electrical Box
Terminal Strip	Medium	3	only	Electrical	Connector	Granholm	Electrical Box
Terminal Strip	Large	2	only	Electrical	Connector	Granholm	Electrical Box
Bolt Lugs	16mm x M8	3	Pairs	Electrical	Crimp	Granholm	Electrical Box
Bolt Lugs	2.5mm x 5M	80	only	Electrical	Crimp	Granholm	Electrical Box
Bolt Lugs	4mm x 5M	5	only	Electrical	Crimp	Granholm	Electrical Box
Bolt Lugs	4mm x M5	4	only	Electrical	Crimp	Granholm	Electrical Box
Bolt Lugs	2.5mm x M5	8	only	Electrical	Crimp	Granholm	Electrical Box
Links	2.5mm	8	only	Electrical	Crimp	Granholm	Electrical Box
Links	4mm	8	only	Electrical	Crimp	Granholm	Electrical Box
Spade Lugs, Female	4mm	3	only	Electrical	Crimp	Granholm	Electrical Box
Spade Lugs, Female	2.5mm	45	only	Electrical	Crimp	Granholm	Electrical Box
Spade Lugs, Male	4mm	3	only	Electrical	Crimp	Granholm	Electrical Box
Spade Lugs, Male	2.5mm	6	only	Electrical	Crimp	Granholm	Electrical Box
Building Wire Black	0.75mm	20	metres	Electrical	Cable	Granholm	Cable Box
Building Wire Red	0.75mm	20	metres	Electrical	Cable	Granholm	Cable Box
High amp, Low Volt	2.5mm	20	metres	Electrical	Cable	Granholm	Cable Box
Speaker Cable	0.75mm	100	metres	Electrical	Cable	Granholm	Cable Box
Speaker Cable	2.5mm	6	metres	Electrical	Cable	Granholm	Cable Box
Speaker Cable	2.5mm	20	metres	Electrical	Cable	Granholm	Cable Box
Building Wire Red	2.5mm	120	metres	Electrical	Cable	Granholm	Cable Box
Building Wire, Earth	2.5mm	30	metres	Electrical	Cable	Granholm	Cable Box
Building Wire, Earth	4mm	20	metres	Electrical	Cable	Granholm	Cable Box
Building Wire, White	2.5mm	70	metres	Electrical	Cable	Granholm	Cable Box
Orange Circular (Low Temp)	2.5mm	6	metres	Electrical	Cable	Granholm	Cable Box
Orange Circular (Low Temp)	1.5mm	50	metres	Electrical	Cable	Granholm	Cable Box
TPS 3core + earth	1.5mm	3	metres	Electrical	Cable	Granholm	Cable Box
TPS 3core + earth	1.5mm	20	metres	Electrical	Cable	Sorensen	Underneath
Cord Extension Socket (WP)	10A	2	only	Electrical	Cable	Granholm	Electrical Box
Plug Top (WP)	10A	2	only	Electrical	Terminator	Granholm	Electrical Box

Conduit, PVC	20mm	16	metres	Electrical	Conduit	Granholm	Underneath
Saddles	20mm	15	only	Electrical	Fixing	Granholm	Electrical Box
Elbow	20mm	3	only	Electrical	PVC fitting	Granholm	Electrical Box
Junction, 2 way (Elbow)	20mm	2	only	Electrical	PVC fitting	Granholm	Electrical Box
Junction, 3 way	20mm	7	only	Electrical	PVC fitting	Granholm	Electrical Box
Earth Clips	Standard	2	only	Electrical	earthing	Granholm	Electrical Box
Blank Plate	Standard	1	only	Electrical	Accessory	Granholm	Electrical Box
Light Switch	1 Gang	1	only	Electrical	Accessory	Granholm	Electrical Box
Insulation Tape 5 colours	Standard	6	only	Electrical	Consumable	Granholm	Electrical Box
Cable Ties	200mm	60	only	Electrical	Consumable	Granholm	Electrical Box
Cable Ties	100mm	60	only	Electrical	Consumable	Granholm	Electrical Box
Automotive Fuse, Blade	30 amp	5	only	Electrical	Safety	Granholm	Electrical Box
Automotive Fuse, Glass	3 amp, 5mm x 20mm	10	only	Electrical	Safety	Granholm	Electrical Box
Automotive Fuse, Glass	3 amp, 6mm x 30mm	20	only	Electrical	Safety	Granholm	Electrical Box
Automotive Fuse, Glass	15 amp, 6mm x 30mm	10	only	Electrical	Safety	Granholm	Electrical Box
Automotive Fuse, Glass	10 amp, 6mm x 30mm	15	only	Electrical	Safety	Granholm	Electrical Box
Automotive Fuse, Glass	7.5 amp, 6mm x 30mm	10	only	Electrical	Safety	Granholm	Electrical Box
Automotive Fuse, Glass	2A, M205	6	only	Electrical	Safety	Granholm	Electrical Box
Automotive Fuse, Glass	1A, M205	6	only	Electrical	Safety	Granholm	Electrical Box
Insulation Tester	500v	1	only	Electrical	Testing	Granholm	Electrical Box
Clamp Meter	Current	1	only	Electrical	Testing	Granholm	Electrical Box
Multi Meter	Multi	1	only	Electrical	Testing	Granholm	Electrical Box
RCD Tester	RCD	1	only	Electrical	Testing	Granholm	Electrical Box
Wire Stripper	Various	1	only	Electrical	Tool	Granholm	Electrical Box
Wire Crimper	Various	1	only	Electrical	Tool	Granholm	Electrical Box
Philips	30mm	100	only	Fixing	Screw	Granholm	Electrical Box
Stainless Steel nut and bolt set	25mm x M5	10	sets	Fixing	Screw	Granholm	Electrical Box
Washer head	12mm	100	only	Fixing	Screw	Granholm	Electrical Box
Foam Filter	3mm thick	1 sq	metres	Dunlite Generator	Spare	Granholm	Electrical Box
Black foam weather seal	25mm	2.5	metres	Dunlite Generator	Spare	Granholm	Electrical Box
Capacitors (from Fluoros)	4mF	5	only	Electrical	Parts	Granholm	Electrical Box
Torch Globes	10w	5	only	Electrical	Parts	Granholm	Electrical Box
Tubes, 500w Halogen	500w	2	only	Electrical	Parts	Granholm	Electrical Box

Thread Tape, white	Standard	3	only	Plumbing	Water	Granholm	Electrical Box
Crimp Kit Assorted	1.5mm to 4mm	1	only	Electrical	Crimp	Granholm	Electrical Box
Plug Top (WP)	32A, 4 pin	3	only	Electrical	Terminator	Granholm	Blue Battery Box
High Tension Cable	16mm2	10	metres	Electrical	Cable	Granholm	Blue Battery Box
Battery plugs	Large	2	only	Electrical	Terminator	Granholm	Blue Battery Box

13. REFERENCES:

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