Beyond Direct Impacts of Multi-Year Maintained Ice Routes
Case Study: McMurdo-South Pole Surface Re-Supply Traverse
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Information Paper Submitted by ASOC to the XXIX ATCM

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I. Introduction

A surface re-supply traverse between McMuro and South Pole stations is expected to become operational in two to three years, following a successful ‘proof of concept’ exercise during 2004-05 and 2005-06. It is likely to become one of the longest, most frequently used multi-year ice traverses in Antarctica, along with the routes between Cap Prudhomme and Dome C, and between Mirny and Vostok stations. The environmental impact of the route has been considered as minor in an earlier Comprehensive Environmental Evaluation (CEE) (NSF, 2004), due to the localized nature of impacts and the remote location of the route.

The purpose of this paper is to highlight issues beyond the direct environmental impacts of multi-year maintained ice routes. In ASOC’s view, these issues have received insufficient attention thus far in the environmental impact assessment process. While this paper focuses on the McMuro–South Pole ice route, the issues discussed are relevant to other multi-year maintained ice routes. First, we discuss briefly the wilderness protection requirements under the Protocol of Environmental Protection to the Antarctic Treaty (the Protocol). Subsequently we discuss three key issues beyond the consideration of direct environmental impacts:

- **Opening up of the Antarctic wilderness:** Increased access provided by a multi-year maintained ice route may have far-reaching consequences on the fragmentation and diminution of the Antarctic wilderness already encroached upon by a range of other activities. This includes the possibility of commercial tourism operations utilizing the traverse to further penetrate the interior of the continent.
- **Actual environmental balance:** The question of whether surface re-supply traverses will truly result in resource (fuel) savings and consequent environmental benefits, given the high degree of interest in expanding scientific operations using the ice route and the air resources displaced by the route that will be used elsewhere in the Antarctic.
- **Actual cost of supporting remote stations:** The need to balance increasing cumulative impacts on the Antarctic wilderness with the continued development such as the expansion of existing remote stations or the construction of new ones.

II. Summary of the South Pole Road Proposal

In 2005, the U.S. Antarctic Program successfully completed a proof of concept exercise for an ice supply route between McMuro and South Pole stations. It is now expected that the route will be established as an annual surface traverse re-supply route between the two stations. If the future operations follow the description set out by the NSF (2004), the McMuro – South Pole ice route is likely to become one of the longest and most frequently used multi-year ice traverses in Antarctica (Table 1, Appendix 1). Its operation is expected to result in the transportation of the largest amounts of cargo and the highest fuel consumption among surface re-supply routes in Antarctica.

According to a review conducted by the U.S. National Science Foundation (NSF, 2004), there have been over 60 scientific and 13 re-supply surface traverses in Antarctica since the 1950’s. Among the multi-year re-supply traverses, the routes between Cap Prudhomme and Dome C, and between Mirny and Vostok hold the record of covering the greatest distances while having been used for the longest duration (Table 1, Appendix 1).

A detailed assessment of direct environmental impacts of the surface traverse capabilities of the U.S. Antarctic Program, including the McMuro – South Pole route, has been presented in the form of a Comprehensive Environmental Evaluation (CEE) in 2004 (NSF, 2004). It concluded that most of the direct
environmental impacts arising from the ice route and its operation are low. Appendix 2 contains a list of direct impacts and a brief discussion of those impacts in the light of recent publications.

III. Protecting Wilderness Values

The protection of wilderness values is one of the basic mandates of the Protocol on Environmental Protection to the Antarctic Treaty (the Protocol) – notably Art. (3)(1). Different operators have described the concept of wilderness at different times and places, and while there is no agreed definition of “wilderness” or ‘wilderness values’ in the Antarctic context, there appears to be a broad understanding of what it is meant.¹

For instance, Appendix I of the Guidelines for Implementation of the Framework for Protected Areas Set Forth in Article 3, Annex V of the Environmental Protocol contains the following description that is adapted from Porteous (1996) with reference to the philosopher Kant:

\[
\text{does the area contain characteristics e.g., remoteness, few or no people, an absence of human-made objects, traces, sounds and smells, untravelled or infrequently visited terrain that are particularly unique or representative components of the Antarctic environment?}
\]

Wilderness values have also been referred to as:

- “…derived from the isolation and relative low level of human impact” (ATCPs 2002);
- “…attributes, which are generally associated with land areas that are unmodified, wild, uninhabited, remote from human settlement” (NSF, 2004),
- associated with “…pristine environment[s] largely undisturbed and uncontaminated by humans” (ATCPs, 2004) or which
- “…show little sign of past or current human presence” (Australia, Russia and China, 2005).

Overall, that remoteness and a relative absence of both people and indications of past and present human presence or activity are key attributes of wilderness. There is also a broad understanding – notably in Art. 3 of the Protocol, and also in various management plans – that the Antarctic wilderness deserves protection, and actions that compromise or jeopardize wilderness values are not desirable.

IV. Beyond Direct Impacts

Beyond direct impacts there are consequences resulting from opening up of the Antarctic wilderness, uncertainty about resource savings, and the cost of supporting remote stations. These issues will be discussed briefly below.

A. Opening up of the Antarctic wilderness

Antarctica is the largest contiguous piece of wilderness on earth. Human activities, such as research stations and traverse routes, occupy a negligible percentage of the area of Antarctica. However, part of the value and uniqueness of the Antarctic wilderness lies in its immensity, integrity and abundance. If the Antarctic wilderness is fragmented or reduced, its wilderness values will be greatly diminished.

One serious concern for the impact of multi-year maintained ice routes on the Antarctic wilderness is the increased access that they provide into pristine areas. Throughout the world, road access into wilderness areas has often been a precursor to development, frequently accompanied by cumulative environmental degradation and resulting loss of wilderness values. Examples can be found in the Amazonian forest (Laurence et al., 2005) as well as in the Alaskan Arctic (National Resource Council, 2003).

It may be argued that the situation would be different in Antarctica, given the special mandate for scientific research and the provisions set out under the Antarctic Treaty and its Environmental Protocol. Thus, any development will primarily take place for scientific reasons. However, the scientific purpose of development

¹ Antarctic Treaty instruments refer mostly to wilderness “value/s”, although there are also references to wilderness “quality/ies” and “significance” and – in a more physical sense – wilderness “area” or “features” of which there may be an “outstanding example”.

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is no guarantee against the degradation of wilderness values. Current development proposals are
categorized by the near simultaneous expansion of a range of activities – including scientific activities,
support logistics, and tourism – over hitherto near-pristine or pristine areas (ASOC, 2005a,b). Direct air links
between Antarctica and the rest of the world are likely to increase access to the continent (ASOC, 2005a).
The possibilities of using the McMurdo – South Pole route to support new scientific traverses and field
camps in hitherto unexplored regions of the Antarctic have frequently been considered (NSF, 2004;
McMurdo Area Users Committee, 2001).

In addition, Antarctica is also facing increasing commercial pressures both on land and at sea. The number
of tourists visiting Antarctica has been increasing steadily for over a decade. While most tourists currently
arrive to Antarctica by ship, there is also an ongoing transition towards a greater component of land-based
support for tourism operations through fly-sail operations, and visitor accommodation ashore.

Development and commercial pressures on Antarctica may lead to a range of consequences including:

- Increased access to more remote areas of the Antarctic wilderness;
- Establishment of infrastructure deeper into the Antarctic continent;
- Transit of more people in previously inaccessible wilderness areas; and
- Impacts associated with waste disposal, accidental spills and air emissions arising from increased
  human presence in hitherto pristine or near-pristine areas.

These activities and the resulting direct, indirect and cumulative impacts may result in the encroachment of
wilderness and a deterioration of wilderness values. In the case of the McMurdo – South Pole route CEE,
wilderness values were considered to be ‘affected’ only as a result of the use of markers and the physical
disturbance of the snow surface, while use of explosives to fill in crevasses, accidental fuel spills, wastewater
disposal along the route, etc., were not considered to have any impacts on ‘wilderness values’. These
activities along the 1,600 km route are also signs of human presence and modification, and their impacts on
the Antarctic wilderness should also be addressed.

In order to avoid unintended cumulative impacts, it may be necessary to define limits on the usage of the
route per season, \textit{a priori}, based on projected activities for a certain period, e.g., 5 years. An example of such
a limit is set out in Table 2 (Appendix 1). In addition, discouraging or prohibiting the use of government-
maintained infrastructure by commercial entities and private operators will also minimize unintended
cumulative impacts.

\textit{It would be prudent to consider the cumulative impacts of all possible activities arising from the presence of
a maintained multi-year ice route before the inauguration of such a route, and to establish forward looking
mitigation measures as needed, including controlling access to the traverse. If not addressed proactively,
these may be difficult to manage at a later stage.}

\textbf{B. The actual fuel balance between road and air transport}

Undoubtedly, replacing some air re-supply operations by surface traverses is likely to lead to significant
savings in fuel usage and other operational costs. It also has the environmental advantages of reducing
impacts on air quality in Antarctica as well as decreasing the contribution of Antarctic operations to global
climate change.

However, are net resource savings real when the entire picture is examined? As mentioned earlier, in the
case of the McMurdo – South Pole route, there appears to be widespread interest within NSF and among
scientists to expand scientific operations using the ice route, as well as the air resources that will be freed up
will be zero – or negative – if is the fossil fuel savings resulting from the McMurdo-South Pole maintained
ice route are used elsewhere in the Antarctic.

\textit{True resource savings will be realized only if the displaced resources are not used to expand logistics
elsewhere.}
C. Support of remote stations at what cost?

At this point, it might be helpful to recast the question of the purpose of surface re-supply routes. If the aim of a surface re-supply route is to reduce the economic and environmental costs of science and support at a remote station, through reduction of fuel consumption, then perhaps, the question is not how resources can be saved, but what are the true resource needs of the station.

In the case of South Pole station its capacity has been increasing, with an additional boost from the modernization project. It is legitimate to ask at which point the cumulative impacts and the increased pressure put on the Antarctic wilderness arising from the support and operations of the station exceed the benefits obtained from increasing the capacity of the station. Table III (Appendix 1) compares fuel usage as a result of different combinations of logistical support and levels of operation at South Pole station.

*Do the savings and benefits justify the economic and environmental costs incurred in the establishment of such a route?*

V. Conclusions

The CEE on the “Development and Implementation of Surface Traverse Capabilities in Antarctica” produced by NSF in 2004 provides a wealth of information on the operations and likely direct impacts of the McMurdo – South Pole ice route. However, at the time of its preparation, the proof of concept exercise was still underway and it was unknown whether the route would be used for routine re-supply operations. As a result, the CEE discussed the environmental impacts of traverse capabilities, without committing to what the full use of the ice route will be when operational. Hence, cumulative impacts of all possible activities on the route (direct and indirect, including commercial tourism use) could not be assessed with any reasonable level of certainty, nor were indirect impacts resulting from air transport capacity freed from supporting South Pole Station analyzed.

Now that the proof of concept for the South Pole traverse has been completed and plans are being made to establish a multi-year re-supply route, a *supplementary environmental impact assessment* on the schedule of the operations, policy on road usage and cumulative impacts from all projected activities arising from the route is necessary.

The aims of a supplementary environmental evaluation could be three-fold. It can:

1. **Provide information on the logistics of the operations.** This would include but not be limited to the:
   - Expected lifetime of the ice route;
   - Number of caches along the route;
   - Number of air drops to be used and fuel consumption used for air drops;
   - Projected activities along the route for a certain planning period, e.g., during 5 years, including how many scientific and re-supply traverses are likely to take place simultaneously?

2. **Improve the assessment of cumulative impacts.** Consider:
   - The cumulative impacts of all possible activities arising from the presence of the ice route;
   - Alternatives for setting limits to use of and access to the ice route.

3. **Discuss usage policy of the route by commercial, private and non-governmental operators.**

ASOC submits that under the circumstances, this type of analysis is required by the Protocol and by US implementing legislation. A supplementary environmental impact assessment would increase the transparency of the operations and will also contribute greatly to avoiding unintended environmental impacts.

VI. References


Australia, China and Russia, 2005. Draft Antarctic Specially Managed Area (ASMA) management plan of Larsemann Hills, East Antarctica. WP 27. ATCM XVIII, Stockholm, 2005.


ATCPs (2002): Management plan for Antarctic Specially Protected Area No. 123, Barwick and Balham Valleys, South Victoria Land. Annex to Measure XXV-1. ATCM XXV.


National Science Foundation. 2004. Development and implementation of surface traverse capabilities. Final CEE.


### Appendix 1 – Tables

#### Table 1 - Multi-year re-supply traverses in Antarctica

<table>
<thead>
<tr>
<th>Traverse</th>
<th>Period</th>
<th>Duration</th>
<th>No. of tractor trains</th>
<th>Distance (one way)</th>
<th>No. of swings / year</th>
<th>Cargo load / year</th>
<th>Fuel consumption / swing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neumayer - EPICA</td>
<td>Since 2000</td>
<td>Ongoing</td>
<td>Up to 8</td>
<td>750 km</td>
<td>Up to 2</td>
<td>325 tonnes</td>
<td>n/a</td>
</tr>
<tr>
<td>EBase / SANAE III – SANAE IV</td>
<td>1993 – 1998</td>
<td>4 years</td>
<td>Up to 5</td>
<td>160 km</td>
<td>1-2</td>
<td>800 tonnes</td>
<td>n/a</td>
</tr>
<tr>
<td>Prudhomme – Dome C (Concordia)</td>
<td>Since 1996</td>
<td>Ongoing</td>
<td>6-7</td>
<td>1,100 km</td>
<td>Up to 3</td>
<td>Up to 360 tonnes</td>
<td>80,000 litres</td>
</tr>
<tr>
<td>Mirny – Vostok</td>
<td>Began in 1958</td>
<td></td>
<td>n/a</td>
<td>1,429 km</td>
<td>2 before 1994 ; 1 after 1994</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>McMurdo – South Pole</td>
<td>From 2008?</td>
<td></td>
<td>n/a</td>
<td>1,600 km</td>
<td>6</td>
<td>800 tonnes</td>
<td>125,000 litres</td>
</tr>
</tbody>
</table>

Data sources: (NSF, 2004; Russia, 2001)

n/a = data not available

#### Table 2 - An example of a priori limits on ice route usage based on projected activities.

The number of caches and vehicle days per season are specified as a function of the projected activities.

<table>
<thead>
<tr>
<th>Operations scenario</th>
<th>Tractor-trailer days per year</th>
<th>Number of caches</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resupply only</td>
<td>1,080&lt;sup&gt;a&lt;/sup&gt;</td>
<td>N&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Possible seasonal limit (Resupply + 1 simultaneous</td>
<td>~1,200&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1.1N</td>
</tr>
<tr>
<td>scientific traverse)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup> Calculated from 6 tractor-trailers x 6 swings x 30 days per swing assumed for a season of 180 days.

<sup>b</sup> Information to be provided by US Antarctic Program

<sup>c</sup> Resupply scenario same as in a. Scientific traverse calculated from 2 tractor-trailers x 1 swing x 60 days.

#### Table 3 - Comparison of fuel usage from different logistical combinations to South Pole station.

Note that fuel savings are only true savings if they are not used to expand logistics elsewhere.

<table>
<thead>
<tr>
<th>Logistical support</th>
<th>Operation of South Pole station</th>
<th>Number of flights / Number of traverses</th>
<th>Fuel consumption</th>
<th>Fuel savings from present 100% air operations</th>
</tr>
</thead>
<tbody>
<tr>
<td>100% air</td>
<td>100%</td>
<td>169 / 0</td>
<td>2,915,000 L</td>
<td>-</td>
</tr>
<tr>
<td>80% air + 20% land</td>
<td>100%</td>
<td>136 / 18</td>
<td>2,692,000 L + air drops</td>
<td>&lt;8%</td>
</tr>
<tr>
<td>60% air + 40% land&lt;sup&gt;d&lt;/sup&gt;</td>
<td>100%</td>
<td>100 + air drops / 36</td>
<td>2,456,000 L + air drops</td>
<td>&lt;16%</td>
</tr>
<tr>
<td>80% air</td>
<td>80%</td>
<td>136 / 0</td>
<td>2,332,000 L</td>
<td>20%</td>
</tr>
</tbody>
</table>

Data source: NSF, 2004

<sup>d</sup> Proposed operation level by NSF.
Appendix 2 – Direct environmental impacts of multi-year maintained ice routes

Visual and noise impacts

During the operation of the McMurdo – South Pole traverse, two traverse trains are expected to operate simultaneously, every day of the 180 days of the austral summer, for 12 hours a day, approximately at a distance of more than 700 km apart\(^2\). Each train consists of six tractor-trailer combinations, of a total length of approximately 300 m\(^3\). A traverse train would pass any specific point once every three weeks, and may be visible from a fixed vantage point for two hours or less. Noise and vibration will be generated by the traverse vehicles, generators, and ancillary equipment. According to CEE, these disturbances are not expected to result in a significant impact because they would occur in extremely remote inland areas, with no receptors, and no ecologically sensitive wildlife habitats (NSF, 2004).

Physical disturbances, waste discharges and accidental spills

The compacted route surface is likely to extend approximately 10 m across (NSF, 2004). If snow needs to be harvested to fill in crevasses, surfaces of up to 5,120 m\(^2\) (or approximately 70 m x 70 m) near the route will be exploited. This near zone will likely be impacted by a) wastewater discharge, b) deposition of particulate matter from exhaust gas emissions and c) accidental spills of fuel, etc (Figure A.). These impacts would be highly localized to the traverse route and the effects would be persistent and more than transitory. However, according to the CEE the cumulative impacts would remain relatively isolated and would not be expected to adversely impact human health or the Antarctic environment (NSF, 2004).

Wilderness values were considered to be affected only as a result of the use of markers and the physical disturbance of the snow surface, while use of explosives to fill in crevasses, accidental fuel spills, wastewater disposal along the route, etc., were not considered to have any impacts on wilderness values. These activities along the 1,600 km route are also signs of human presence and modification, and their impacts on the Antarctic wilderness should also be addressed.

Air quality

It is estimated that emissions from vehicle use on the ice route would be far below those at McMurdo station. At McMurdo, fuel consumption is ten times higher than that estimated on the ice route and at the same time air quality standards are satisfactorily met more than sufficiently. Therefore air quality along the ice route is not expected to be adversely impacted. However, in the draft Management Plan proposed for the Amundsen-Scott South Pole station Antarctic Specially Managed Area (ASMA) (United States, 2005), overland transit is prohibited in a zone within a 150,000 m radius of the Atmospheric Research Observatory building, in order to preserve the “cleanest air on Earth” for scientific research. By extension, one could infer that air quality within a 150 km radius from the 1,600 km road will be disturbed and may not be sufficiently clean for all research purposes.

\(^2\) Assuming that the two traverse trains begin 5 days apart and they both travel at a speed of 8 km/h, operating 12 h/day (NSF, 2004, Appendix A).

\(^3\) Assuming the swing configuration presented in NSF (2004) of 6 tractors and approximately 11 long sleds and 11 short sleds; each tractor is assumed to be 6 m in length, each long sled assumed to be 15 m, and each short sled assumed to be 6 m.
Figure A: Aerial schematic of disturbance zones around ice route.

Physical disturbance zone
- 70 m width, in case of snow mining for filling in crevasses

Zone of compaction (the route”)
wastewater discharges and possible accidental spills

150,000 m radius;
Non clean air zone

Ice route
1,600,000 m length

Trailer-tractor train
~300 m length