Summary of strategic environmental assessment report

(SEA 2007 report – US)

Sent to public hearing
from December 10, 2007
until January 15, 2008

Prepared
in connection with the aluminum project
by the Greenland Home Rule
SEA working group

Version: December 12, 2007

Greenland Home Rule
Nuuk, December 12, 2007

Foreword

In the spring of 2006 The Greenland Home Rule received a démarche from the aluminum company Alcoa who would like to investigate the possibilities of establishing an aluminum smelter facility here in this country. Through 2006 the opening negotiations were accomplished.

The Home Rule was from the beginning very much aware of the fact that among other things it will have natural and environmental consequences if an aluminum smelter facility was established, and from December 2006 the initiative was taken to start the first preliminary investigations in the natural and environmental field.

This led to the appointment of a working group concerning infrastructural, environmental and natural conditions relative to the establishment of an aluminum smelter facility. The working group delivered a report in March of 2007, which entered as background material for the preparation of “Review of energy intensive industry in Greenland” that was presented at the spring parliament meeting 2007. The review was well received by all parties in the parliament.

One of the recommendations of the review was that prior to a final dicision of an implementation of the project as well as a siting of the aluminum smelter facility, a strategic environmental assessment (SEA) should be carried out in the whole area which as a starting point is included in the preliminary investigations. This area extends from north of Sisimiut to the south of Nuuk.

Immediately after the positive reception of the review at the spring parliament meeting the first steps were taken in April to implement the work with the strategic environmental assessment. This work has temporarily culminated in the strategic environmental assessment report now being sent to public hearing on up till Tuesday January 15th, 2008.

The strategic environmental assessment report may be requisitioned from Direktoratet for Miljø og Natur (Department for Environment and Nature) or downloaded from the internet address www.aluminium.gl/smv.

It is my hope that all interested will take active part in the hearing process. It has been planned in week 2 of 2008 to carry through a number of civic meetings in the involved communities. However, nobody has to wait quite till the civic meetings to come forward with comments to the present SEA report.

Arkalo Abelsen
Secretary for Health and Environment

December 2008

Table of contents

0.0 Introduction

This strategic environmental assessment report (SEA) is only a piece in the overall preparations for the decision about siting an aluminum smelter at either Nuuk, Maniitsoq or Sisimiut. The present time content of this report is not the completed text. The report has now been sent to public hearing and anyone has the opportunity to comment on what is in the report.

It must thus be stressed that this is a temporary report. It is expected to undergo excessive trimming as a result of the public hearing before the report can enter into the entire basis for decision which to begin with will be presented to the Home Rule Government at the end of February 2008 and then is to be discussed in the Parliament at the spring meeting in April.

The Home Rule Government has from the beginning given very high priority to this task of elucidation and has allocated means to the carrying out of a number of environmental investigations which found the basis of the SEA report.

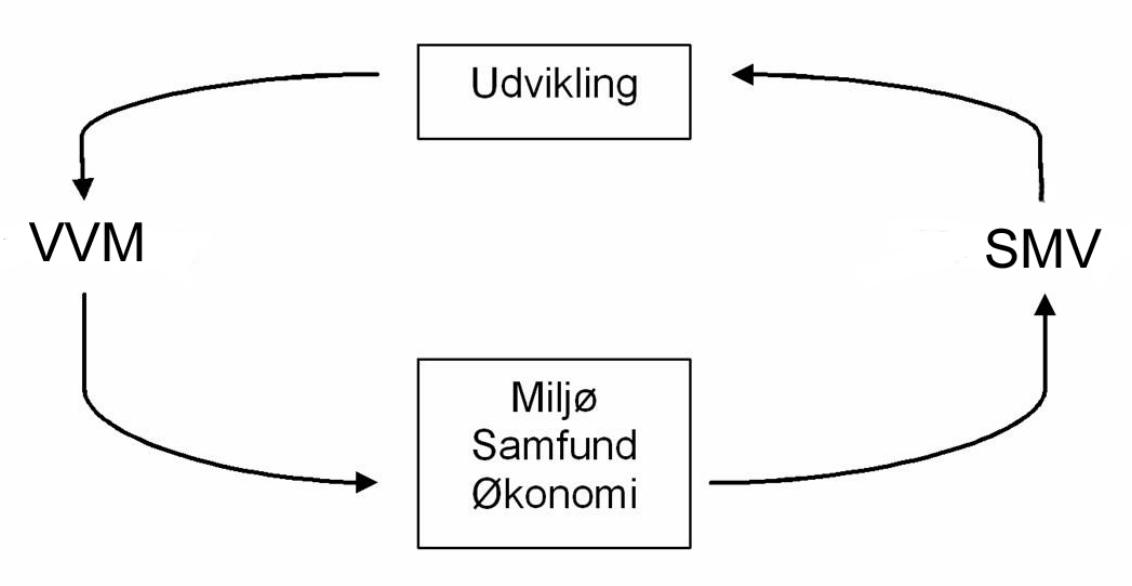
It is the first time that a strategic environmental assessment (SEA) of this sort is prepared in Greenland. In the legislation there were no directions prior to the preparation of the SEA report about the preparation of the SEA. The legislation for SEA in Denmark has therefore been used as a foundation for this SEA report.

0.1 SEA and EIA

When big construction projects were decided upon there was previously only a socalled effects on environment assessment (EIA) that was worked out but this is a strategic environmental assessment (SEA).

The difference beteween these two elucidations is that a SEA is prepared before a final decision is made about whether to carry through a project. Thus SEA is a tool to examine the advantages and disadvantages of a project before a political decision is made. An EIA on the contrary is an examination which is not undertaken until a political decision to start a construction project has been made. EIA’s have been done for years, so we know it. The object of an EIA is slightly different from the object of a SEA. An EIA is to show, on the condition that a project has been decided, how the project can be carried through with least possible effect on the environment.

The difference between EEA and SEA may be illustrated thus:



Udvikling = Development
Miljø = Environment
Samfund = Society
Økonomi = Economy

The figure is to be understood this way, we have a society (bottom in the middle) that wants to examine the prospects of a certain development. To examine these prospects before a political decision is made, a strategic environmental assessment (SEA) can be carried out. This is what we are at with this report.

At a certain time a political decision is made about a certain development – for example about the construction of an aluminum smelter. One of the tools to make this decision is a SEA but many other tools are used, too.

After deciding on a concrete developmental project, the project mus be carried into effect. To be able to carry through the project the best way and with the least possible effect on the surrounding society, an effects on environment assessment (EIA) can be worked out.

The EIA examinations which will be carried out at a later time will deal with many of the same issues mentioned in this report. The only difference is what the examinations are for. The EIA examinations are to concretely assess the environmental effects of an already adopted construction of for example hydroelectric power plants whereas almost the same examinations in the present SEA context – from an assessment of the overall conditions at the

carrying through of a project of these dimensions and nature – are to be used to decide whether we want to construct for example hydroelectric power plants.

0.2 Mandate

Below follows a compilated and updated version of "Mandate for the working group concerning SEA (Strategic Environmental Assessment) of Central West Greenland":

0.2.1 Background

Secretary of Industry, Labor Market and Occupational Education and Secretary of Health and Environment will in May of 2008 (this was later changed to February 1st, 2008) present a strategic environmental assessment (SEA 2008) of Central West Greenland for political discussion. A revised SEA (SEA 2009) is expected to be presented in May of 2009.
The preparation of this SEA forms part of the aluminum smelter project in progress but is in its aim and assessment not limited to the aluminum industry.
The working group, having the responsibility for the preparation of this SEA, was appointed by the administrative following group (The Control group) on May 18th, 2007.
The working group also has responsibility for arranging general demands for the VVM and – in cooperation with the builder – to start and monitor overtly necessary VVM field investigations if possible beginning already in 2007 and in 2008.
As a starting point expenses related to SEA are paid by The Greenland Home Rule, whereas expenses for VVM are paid by the relevant builder(s). At present the aluminum producer is considered to be the builder, as other builder's-design has not been arranged at present.

0.2.2 Overall goal

The overall goal for the preparation of a SEA is to gather knowledge and views which make it possible to assess the single partial goals that the working group shall arrange. These partial goals are to be formulated within the frames of a broad concept of environment.
The broad concept of environment embraces in this context primarily: Physical environment (flora, fauna, soil, geology, water, air, climate, cultural heritage, energy, ressources), health (sickness, mishaps, a.s.o.), population (planning, settling, education, employment, crime, a.s.o.) and economy (regional economy, national economy a.s.o.).

These assessments are to form part of the overall political considerations whether and where one or more large-scale industrial facilities with hydroelectric power plants belonging to it may stand, and also in the overall national and regional planning which in part aims at avoiding or alleviating negative environmental consequences.
The overall goal with getting VVM field investigations started before the preparation of a SEA is to secure as much time as possible for these field investigations.

0.2.3 Assignment

The working group's job is to ...

1.: … within the given timeframe, within the given geographical boundary and within the given financial framework to prepare a SEA as adequate as possible. The prepared SEA is to meet relevant international quality standards on the area. As there is no legislation on the area at present, the working group is expected as a minimum to have as a basis the Danish legislation on the area ("Law on environmental assessment of plans and programs" including "Guide on the environmental assessment of plans and programs").
In partial areas where for example North American guidelines are assessed to be more relevant, these are taken as a basis. It may among others be in the area of health.
As an integrated part of the SEA the working group shall present economic analyses; including analyses of what consequences concrete sitings of an aluminum smelter may be expected to have for National Planning and regional development strategies to both the area in question and to Greenland at large.

2.: … in 2007 and in 2008 to arrange general demands to VVM and – in cooperation with the builder – to start and to monitor VVM field investigations in areas where the working group finds it necessary to start field investigations already at this time. The working group may with regard to the overall timeframe start VVM field investigations before a builder is dicisively identified. Expenses to these field investigations may if necessary at first be paid by the the working group but as soon as a builder has been identified these expenses must be accounted for by the builder.
Potential VVM field investigations starting as soon as possible include:
- Archaeological investigations at Tasersuaq and other water power lakes.
- Biological investigations within flora and fauna.
- Other environmental investigations from the broad concept of environment.

The working group shall separately through close dialogue with the other actors (The Control Group, Greenland Development, the active company(ies) and others) make sure that the field activities which the working group start or know about are coordinated as much as possible with other activities in the areas with a view to achieve as much cost efficiency as possible regarding logistics, especially helicopter transport, but not only that.

The working group must to the utmost extent possible make use of GIS and web-GIS through among other things widespread coordination with the started Nuna-GIS project under the auspices of DMN:

0.2.4 Geographical demarcation of Central West Greenland

The area that the working group is to be occupied with will alltogether here be designated "Central West Greenland" and the area is demarcated as follows:
To the south by Buksefjord and a straight line to the inland ice and following Kangaasarsuup Sermia's northern rim.
To the east by a line following the ice including glaciers.
To the north by Nordre Isortoq and its course to the inland ice at Isunnguata Sermia.
To the west by a line west of the coastal line including islands along the coast.
The area is about 40.000 km^2 in size.

However, to the north and south a main area is demarcated by Sondre Stromfjord (Kangerlussuaq) to the north and Godthaab (Nuuk) Fjord to the south.

The overall demarcation follows the marked out area by Alcoa in "A proposal …" (dated April 11th, 2007). The demarcation of the main area follows the marked out area by the IMN working group.

0.2.5 Organization

The working group is made up of an editorial group, a number of professionals having the main responsibility and others affiliated.

The editorial group is made up of:
Chairman of the working group Klaus Georg Hansen, DMN
Project associate Jakob Mathiassen, IP & project secretariat
Project associate Christel Lund Jæger-Hansen, IP & project secretariat

Professionals having the main responsibility and othes affiliated are:
For Nature:
Main responsibility professionally: Signe Gammeltoft, Natural department, DMN
For Environment:
Main responsibility professionally: Tina K. Petersen, Environmental department, DMN
For Culture:
Main responsibility professionally: Mikkel Myrup, NKA
For Health:
Main responsibility professionally: Ade Ojeniyi, SD
For Regional development:
Main responsibility professionally: Martin Bjærge Jensen, Spatial planning, DMN
For Cumulative investigation:
Main responsibility professionally: Klaus Georg Hansen, Spatial planning, DMN
Affiliated:
Miki Lynge, GD – attends primarily the united working group meetings.

The editorial group may according to requirement appoint additional people to being professionally main responsible.

The Control Group may carry out changes in the composition of the editorial group.

The working group is expected to make extensive use of professional counseling and of professional consultants (for example Denmark's Environmental Investigations, Institute for Societal Development and Planning and others).

0.2.6 Procedure

The working group establishes by itself the framework for communication, meetings, any reports and so on, obviously within the framework given by the administrative coordination group (ACG [in Danish: AKG]). The working group by its chairman refers to ACG by director Peter Hansen. The chairman of the working group is responsible that all relevant information is forwarded to ACG.

0.3 Time schedule for the strategic environmental assessment

The time schedule for working on the strategic environmental assessment (SEA) outlined here is the present time schedule. The process has up until now

been and will also in the future be a dynamic process where changes in the time schedule may occur.

After appointing the working group to the strategic environmental assessment in April of 2007 the work began by finding out how the SEA was to be elaborated. In the end the work was divided up into six topics, each having a responsible person for the topic. For each topic a chapter to the SEA report was to be prepared.

From spring and on up till October work was done on the various chapters and a number of background reports for the responsible persons were prepared. In October of 2007 the chapters were for the first time brought together and the material was sent to an internal hearing in the Homerule departments. In November the texts were brought together and translated and made ready for the public hearing in December and the first half part of January of 2008.

This is the SEA report now available but it is not the final SEA report. This SEA report, for sakes of ease being designated “SEA 2007 report”, is in public hearing from December 10th, 2007 until and including January 15th, 2008. Hereafter a new SEA report will be prepared on the basis of the received comments, which will be designated “SEA 2008 report”. The “SEA 2008 report” will in the spring of 2008 form part of the political assessments regarding placement of a aluminum smelter. The recommendations for further investigations in the SEA 2008 report will form the basis for the investigations to be carried out in 2008. In the light of these investigations a supplement to the SEA 2008 report will be prepared in the spring of 2009. This supplement will be designated “SEA 2009 report” and will form part of the final political considerations towards the end of 2009 where a final political decision is to be made whether the project on an aluminum facility is to be carried through.

0.4 The SEA report’s structure and objective

The six topics are – as previously mentioned – the following: Nature, environment, health, culture, regional development and cumulative investigation. The SEA report thus comprises six chapters having exactly those headings. In addition to that this introductory chapter has been prepared which partly contains a general explanation to the SEA and the SEA process, partly containing a summary of each of the six chapters.

The introductory chapter can thus be said to be a miniature edition of all of the SEA report's rather extensive six chapters. It has been the aim that each chapter should contain three general sections: The first section giving an overview of what is known at present on the area. The second section giving examples of the information we have today. The third section as far as possible giving recommendations as to how we may improve our knowledge on the area in question. Concretely, concrete investigations may be proposed recommended to be carried out during 2008.

As it will appear by reading it through, the structure and the angle of analysis is not quite the same from one chapter to the next. With the time that the SEA working group has had at its disposal on up to the public hearing, it has not been feasible to be in time for ensuring greater uniformity among the various chapters. An attempt to partly adjust this will be done up until the definitive delivery of the SEA 2008 report on January 28th, 2008.

It is not the SEA report's job to put forward recommendations as to where an aluminum smelter should be sited. On the contrary the SEA report is to give advantages and disadvantages for the different sites proposed by the municipalities, based on existing knowledge. The SEA report is furthermore to put forward recommendations as to which investigations can be carried out with benefit in 2008. Therefore it must be investigations that may give a better total foundation for decisionmaking for the politicians.

0.5 Internal hearing in the departments

At the internal hearing in October several important comments were returned. These comments have not to the full been worked into the present text, due to the tight time schedule for the SEA report. The comments will to a relevant extent be worked into the text up until the finishing of the SEA 2008 report.

Here, some of the comments that have appeared but which have not yet been worked into the text shall be given in a short form:
The CO_2 issue ought to be pinpointed.
Potential conflicts between interests in raw material on the one hand and on the other transmission lines and other facilities related to hydroelectric power stations ought to be elucidated.
The difference between SEA and VVM ought to be clarified.
Elaborated reflections over the effects on a national level ought to be included.

0.6 Forwarding of comments

The object of this public hearing is that anyone interested should be able to give comments of any kind to the present material. Comments may be formed in Greenlandic, Danish or English. Comments received up until January 15th, 2008 will be included in the proceeding work.

Comments can be forwarded this way:

Email:
The chairman of the SEA working group Klaus Georg Hansen at KGHa@gh.gl.

Letter to:
SEA hearing
Direktoratet for Miljø og Natur
P.O.Box 1614
DK-3900 Nuuk
Greenland

Personal appearance:
At the civic meetings in Nuuk, Maniitsoq and Sisimiut in the beginning of January of 2008.

1.0 Nature – summary of chapter 1

1.1 Introduction

This chapter is based on a draft status report that is currently being prepared by the Danish National Environmental Research Institute (NERI) and the Greenland Nature Institute (GN). The report is scheduled for completion by April 2008. This means that the final NERI/GN status report may differ from the draft version that forms the basis of this chapter.

The primary objective of the NERI/GN status report is to collate and assess existing data and knowledge about the natural environment and the use of natural resources within the area covered by the SEA. In addition, two specific studies (of harlequin ducks and geese) were conducted in the summer of 2007 in connection with the preparation of the report.

The status report describes the SEA region's plant and animal life as well at the use of natural resources through hunting, fishing and tourism. The report focuses on the following species:

- Species that are important to hunting and fishing
- Species that are endangered
- Species that are of international importance/interest

Maps showing the most important areas of distribution/resource utilisation have been made. It should be noted that the data available are often spread over time and space, for which reason other areas may also be important or, conversely, previously important areas may no longer be important.

For each species, the SEA region's importance in terms of the prevalence of the species in Greenland and the risk of the species being affected by the project are assessed. In addition, areas in which there is a shortage of data are identified and a number of recommendations for additional studies are given.

Some species are not described in detail, for example species that are common to the region such as Arctic fox and mountain hare and species that are unlikely to be affected by the project in terms of population levels. However, it cannot be excluded that there are unknown local or rare plants or animals that might be affected. This should be investigated as part of the project.

NERI and GN's status report will be available when it is finished.

1.2 Methodology

Based on the progress report, a number of factors are specified and assessed in relation to each species treated in this chapter. These assessments are summarised in two matrices: one for impacts in the construction phase, and one for impacts in the operation phase.

The following factors have been considered for each species:

- Data quality
- Impact and the types of impact that are considered to be relevant
- Causes of impact (such as the construction of a smelter or of hydropower stations)
- The seriousness of the individual impacts in terms of their effect on the species considered
- Red List categories
- Remedial measures
- Periods in which disturbance should be avoided
- Further studies and surveys

1.3 Conclusion

In all three municipalities, the location of a smelter in the area will have major impacts. However, most of these impacts can be reduced by means of remedial measures. Some of these measures will require prior studies or surveys, in particular in areas where activity should be avoided at certain times of the year, for example caribou calving areas and white-fronted geese moulting areas. Both recommended studies and surveys and possible remedial measures are listed in Annex 1 and Annex 2. The following sections set out the points that are considered to be most important in terms of protecting the natural environment in connection with the location of the smelter. The points are marked in grey in the table.

Sisimiut

Greenland white-fronted goose and Canada goose. West Greenland is the only place where the white-fronted goose breeds, and Greenland therefore has a special responsibility in relation to this species. The area to the north of Kangerlussuaq is generally important both for the Greenland white-fronted goose and the Canada goose. Consequently the area's specific significance for these two species and their use of the area should be mapped, so that activities can be avoided in staging and moulting areas in relevant periods.

Caribou. The area between Itilleq and Sisimiut is an important area for caribou. The installation of a transmission line to Sisimiut through this area could affect

migration between this area and inland areas. If roads are constructed in the area, it will cause increased disturbance and result in an increased hunting pressure because of easier access to the area.

Rare plants. The installation of transmission lines through an area at the bottom of Akugdleq, where the transmission line from Sisimiut to Tasersiaq (7e) is planned to be located, may cause irreversible damage of the habitats of a number of plant species in relation to which the SEA region is important in terms of their occurrence in Greenland. However, it would be relatively easy to remedy this effect by mapping the occurrence of rare plants in the area, so that the transmission line can be installed where it will not affect the plant habitats.

Maniitsoq

Thick-billed murre and black-legged kittiwake. If the transmission lines are drawn to Maniitsoq along the coast, they will pass breeding colonies of both thick-billed murre and black-legged kittiwake. Both these species are in decline in Greenland. It will in particular be in connection with the installation of the transmission lines that there will be a risk of disturbing the colonies. Disturbing activities such as passing helicopters and the use of heavy vessels close to colonies should therefore be avoided in the breeding season.

Nuuk

Caribou. The Nordland area (Akia) and Narssarssuaq north of Godthaab Fjord are core areas for caribou. The establishment of a transmission line to Nuuk will affect these important feeding areas by and large all along the transmission lines. Furthermore, the establishment of a smelter in the Nordland area will imply a location that is relatively close to a town, which will cause increased disturbance because of activities related to the smelter and increased hunting pressure resulting from increased recreational activities in the area.

There are no data indicating whether caribou in Greenland follow specific migration routes throughout the year. If a smelter is located at Nuuk or Sisimiut, it should be investigated whether such routes exist. Furthermore no systematic, direct studies of caribou reaction to structures such as transmission lines going through an area are available. If transmission lines are to be established through a core area for caribou, such studies should be made. The impact on migration routes may be reduced by avoiding blockage of narrow passages and by scheduling activities for periods in which only a few caribou are expected to be in the activity areas.

1.4 Additional studies and surveys

As the data available concerning the species considered are far from exhaustive, NERI and GN have listed a number of additional studies and surveys that should be made. Some of these studies would apply to all the areas potentially affected by the project, while others would only be relevant if certain structures are established. These structures are indicated in Table 5.

Table 5 Proposals for additional studies and surveys, depending on the structures to be established. ABC indicates smelter locations, T indicates transmission lines, and 7e1, 7e3, 7e4, 7d and 6g indicates hydropower potentials (see Figure 1)

		Sisimiut			Maniitsoq				Nuuk				Hydropower				
		A	B	T	A	B	C	T	A	B	C	T	7e1 and 7e4	7e 3	7 d	6 g	T
Vegetation	Mapping sensitive/rare/important types of vegetation	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Vegetation	Determining the occurrence of rare plants	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Caribou	Analysing herd sizes	x	x	x				x	x	x		x	x	x	x	x	x
Caribou	Mapping calving areas								x	x		x			x	x	x
Caribou	Investigating whether caribou follow specific migration routes	x	x	x					x	x		x			x	x	x
Caribou	Studying caribou reaction to transmission lines														x	x	x
Common seal	Studying haul-out areas												x	x			
Birds	Studying the occurrence of birds in freshwater areas												x	x	x	x	
Geese*	Mapping spring resting places	x	x	x								x	x	x	x	x	x
Geese*	Mapping moulting areas	x	x	x					x	x		x	x	x	x	x	x
Char	Determining the occurrence of Arctic charr														x	x	
Char	Determining the significance of the population												x	x	x	x	

* Greenland white-fronted goose and Canada goose

2.0 Environment – summary of chapter 2

2.1 Introduction

The chapter on the environment in the strategic environmental assessment describes seven central environmental themes: aquatic environment, water resources, waste, waste water, air emissions, noise and dust.

A number of the environmental impacts that will arise as a consequence of the aluminium project will basically be the same irrespective of where the aluminium smelter is located. For a number of the seven environmental themes it will therefore not be possible immediately to point to a single location that will be preferable rather than another, but combined with information on animal life and vegetation, natural areas protection or culture-historical values in an area, the review may contribute to identifying areas where the consequences vary.

In a review of the documents available no direct environmental impacts have been identified that would suggest that the project ought not to be implemented. However, a consequence of the establishment of an aluminium smelter is that Greenland's CO_2 emissions will be increased by 75 %. CO_2 emissions of this order conflict with applicable international obligations and with agreements concluded with Denmark, and it is as yet uncertain what the economic consequences of this will be.

Another purpose of this review is to throw light on topics that have not at present been illustrated sufficiently. Who will in the further course of events be responsible for being in charge of and financing the procurement of outstanding data is a matter to be decided in cooperation between Alcoa and the Greenland Home Rule.

The physical surroundings may be of decisive importance for the future effects of the facilities. An important purpose has therefore also been to create a basis for demonstrating how the establishment of the smelter, port facilities and roads, etc. will affect the natural surroundings before a decision is made concerning the final location.

A number of the environmental consequences of the project may be mitigated by demanding sound waste disposal, demanding limit values for the discharge of waste water and emissions and demanding that measures be taken that contribute to protecting animals and humans as much as possible during construction, establishment and operation. These demands are made in the

environmental approvals of the individual parts of the activities on the basis of the current practice, experience and demands made on similar projects in Greenland, Iceland, Norway, Canada and the EU as well as the material presented by the clients in the EIA report.

In the description of the seven environmental themes, an evaluation and a description of the biological and health effects of the various environmental impacts as a result of the project during both the construction phase and the establishment phase have been provided only to a limited extent.
A brief summary of the conclusions regarding the seven environmental themes is provided below. This summary includes the most important consequences, duration, mitigation measures and proposed further investigations.

2.2 Aquatic environment

The initial considerations show that the onshore and offshore aquatic environment will be affected both in connection with the establishment and during the operation of the various facilities.

In particular it is important to keep in mind that the establishment of hydroelectric power stations results in secondary effects in the inner parts of the fjords because the water chemistry and the content of suspended matter are changed. In addition, it may be anticipated that the structure of the rivers will change as a result of changes to the flow whereby changes will occur in sedimentation.

It is recommended that plans should be made on nature's own terms already at this early stage so that the construction of port facilities and discharges of waste water are tailor-made so that the use of, for instance, heavy technology that can result in extensive disturbance of the sea bed can be avoided. By making environmentally acceptable plans at this early stage the environmental impacts can be reduced.

In consequence of this it is recommended that the facilities should be tailor-made for the individual locations and that scenarios should be prepared in connection with the EIA process that describe precisely the environmental impact and the impact on nature for the individual locations.

2.3 Water resources

Drinking water is a limited resource in many areas of the country because most towns are situated close to the coast on islands or peninsulas. Nevertheless

water is an important parameter for the realisation of the project. The effect of implementation of the project may be negative for the area where the smelter is established and considerable inroads will be made into the existing water resource.

It is possible to remove salt from sea water, but that process is cost intensive and difficult. This will be detrimental to the profitability of the project. In reality the need for fresh water from lakes or rivers is therefore constant and great. The only measure that can be taken to remedy this is to incorporate lakes at more distant locations as water resources. This will involve large costs in construction and operation, for instance costs of frost proofing of the raw water pipes.

In connection with the environmental impact studies the raw water resources must be assessed in detail with regard to special vulnerability, quality and final capacity. When those studies have been completed there will be a need for preparation of abstraction permits, approvals of protection zones and water supply works; see part 6 of the Environmental Regulation.

2.4 Waste

As far as waste is concerned more information is needed concerning waste quantities, composition, etc. as well as information concerning waste management plans. When this information is available it will be necessary to examine the environmental consequences this will have. Detailed plans should be prepared for the management of the various types of waste during the construction phase, the establishment phase and the operating phase. Furthermore, the plans must describe the types, quantities and composition of waste that can be expected to be produced during the individual phases. Finally, a time schedule is required which shows where, when and from where the individual types, quantities and composition of waste may be expected to be produced. This time schedule should be prepared so that it can be rendered visible when a waste system will need to be ready to manage the various quantities and types of waste.

It is very likely that the increased activity will lead to a need for an extension of the municipal waste systems. Therefore, this need must be assessed in more detail.

Generally an illustration is needed of the types, quantities and composition of waste and what plans have been envisaged for the management of the

individual types and fractions of waste. In addition, an evaluation is needed of the environmental impacts that the management methods selected will bring about.

At present far too little is known about the quantities of waste from the individual activities, the composition of the waste and the choice of waste disposal methods, etc. Therefore it is not possible to indicate whether one location should be preferred to another.

On the basis of what is known it is not possible to assess the environmental consequences that will be brought about by the quantity of waste produced.

2.5 Waste water

In a possible later phase of the project it is quite clearly the discharge of waste water from the aluminium smelter to which the authorities should pay most attention since the largest impacts will come from that discharge.

In relation to waste water discharges there is generally a need for more information about the project as a whole, including the physical location of all facilities that are related to such discharges and the technical solutions and technologies intended to be employed before any specific statements can be made concerning the waste water problems in relation to a project of this order.

For instance, the same quantity of waste water will be discharged from the aluminium smelter irrespective of where it is located, but it may appear that some marine ecological environments will be more vulnerable to the addition of nutrients and xenobiotic substances than will others.

Therefore a thorough analysis of recipients ought to be performed before a final decision is reached on the location of the waste water outlets. Such an analysis can be made in connection with the EIA report and the base line surveys.

In addition it is found that an examination is needed concerning wastewater treatment technology in relation to the aluminium industry and its effect in Greenland and concerning limit values for this type of industry.

Finally, it must be borne in mind that in connection with the construction of, for instance, hydroelectric power stations and dams, tunnel excavations, etc. activities will be carried on at several locations. A characteristic of some of these locations will be that it will not immediately be possible to discharge waste

water to the sea or to a fjord. Therefore it will be necessary to find another practical and environmentally sound way in which to manage the waste water.

2.6 Air emissions during the operation of the smelter

It is anticipated that during normal operations the smelter will at worst have an annual impact on the surroundings of approximately:

- 4,600 tons of SO_2 (sulphur dioxide)
- 110 tons of fluorides
- 180 kg of PAHs
- 90 tons of particulate matter (under 10 µm)
- 450,000 tons of CO_2
- 7.1 tons of PFC gases corresponding to 46,000 tons of CO_2 equivalents

In addition, an unknown quantity of the following airborne substances will be emitted: Nitrogen oxides, carbon monoxide and cyanide that may be toxic even in small doses.
By introducing wet flue gas cleaning and carbon anodes with a high sulphur content a large part of the sulphur dioxide will be discharged with the waste water whereby the air emissions will be reduced annually to approximately:

- 300 tons of SO_2 (sulphur dioxide)
- 95 tons of fluorides
- 160 kg of PAHs
- 75 tons of particulate matter (under 10 µm)
- CO_2 and PFC unchanged emission

It must be assumed that there will also to a certain extent be a discharge of other environmentally damaging substances in the form of heavy metals, arsenic, vanadium, etc. as well as xenobiotic organic compounds, including chlorine compounds that may accumulate in the arctic ecosystems. However, there is no information concerning such emissions in the material available for which reason a closer examination should be made.

On the basis of the information available the emission of fluorides is regarded as the most important of the air pollution impacts on the surroundings. The reason for this is the relatively large quantity as compared with the low tolerance value of the ecosystems in respect of fluoride.

Furthermore, it is believed that emission of airborne substances as a result of operating accidents, etc. may constitute a not inconsiderable source of increased impact on the environment.

It should be emphasised that the above-mentioned quantities of emission relate to the corresponding Icelandic smelter and that therefore they are not necessarily to be regarded as applicable to a coming aluminium smelter in Greenland.

In connection with environmental approval of the aluminium smelter demands must be made with regard to cleaning with the use of the best available technology.

2.7 Noise

In connection with the construction of a smelter and dams the surroundings may be exposed locally to noise of a temporary nature. Transmission lines, transformer stations, ports and production plant may involve permanent noise exposure.

Noise is one of the factors that form part of the overall impact on the natural surroundings and a specific evaluation must be undertaken for each of the coming locations in which the anticipated generation of noise and the vulnerability of the area are weighed.

Noise load from enterprises is regulated by conditions in the environmental approvals of the enterprises and normally the point of departure is the indicative limit values issued by the Danish Environmental Protection Agency.

2.8 Dust

The anticipated dust impact from construction activities and operation of the smelter and hydroelectric power stations is partly dust fall where small particulate matter settles on the vegetation, partly from fine and ultra-fine particulate matter from the exhaust of vehicles, ships, etc. and from the discharge from production plants. It is expected that dust fall will be of a local nature, primarily related to construction activities, roads and extraction of sand and gravel to be used as construction materials. The actual harmful effect must be evaluated in relation to the vulnerability of the individual areas as far as plants and animal life are concerned. It is expected that dust-emitting materials such as cement and aluminium oxide will be stored in closed systems, containers, or the like, and therefore the dust impact from these is expected to be primarily related to accidents in the event of damage to silos or pipe systems.

Discharge of particulate matter from the production plant is considered in the section on emissions.

The discharge of fine and ultra-fine particulate matter from ships, planes and the exhaust of vehicles is injurious to health, but it must be expected that it will be considerably less than for instance the impact from a road with normal traffic. Locally the discharge of particulate matter will be a new impact, however, since in most areas there has been no activity previously.

3.0 Health – summary of chapter 3

3.1 Introduction

It will be endeavoured to split a contribution to a strategic environmental assessment (SEA) from Health into three sections. First of all, an account of our present knowledge about health conditions in Greenland in general, and in three specific areas–Nuuk, Maniitsoq and Sisimiut municipalities—in particular, as these three municipalities have been picked as potential sites for establishing an aluminium smelting plant. A good deal of data material is available from the period 1993–2007, which can be used to shed light on health conditions in Greenland for both children and young people as well as the adult population, exemplifying the kind of knowledge that can be extracted from these. The focus is particularly on the occurrence of chronic disorders, mental health and mortality in Greenland. Coupled to this is the empirical knowledge that is lacking in the area in order to draw a comprehensive picture of health conditions in Greenland, then an overview of the factors we need to be particularly aware of when setting up an aluminium smelting plant, while the third section will deal with some recommendations emerging on the basis of the preceding two sections.

3.2 SIF

This review of the data material that will be available to SIF for analysing health conditions in Greenland shows that data have been gathered from a broad section of the country's population. Data thus include information from both towns and settlements; pregnant women, infant neonates, children aged 0-12, schoolchildren aged 15-17 and adults 18 or above. All data material includes sociodemographic background information, health, living conditions and lifestyle, making it possible to shed light on the scope and distribution of illness and risk factors for chronic disorders. The bulk of the data material additionally contains information collected through clinical studies supplemented with blood and urine sample measurements, making it possible for adults aged 18 and above in particular to shed additional light on e.g. chronic disorders like asthma, cardiovascular disease and diabetes as well as the extent of pollution from environmental contaminants.

What all the data material has in common is that the information obtained in a study has generally also been sourced from other data material describing similar health conditions in Greenland, Denmark or other Inuit populations, so that it will be possible to make comparative analyses. In addition, most data material sets enable follow-up studies of the participants to be undertaken,

either by re-examining them or by merging the data with information from the Mortality Registry or the National Patient Registry. The latter, however, requires validation by the National Patient Registry.

Unfortunately, there is a lack of data elucidating health conditions in Sisimiut, as these are not included in SIF's population study 2005-2007, which should be made available before the construction of any aluminium smelting plant. Furthermore, it will be essential to follow up the possible derived effects of construction work and plant operations on health conditions. It may be expedient to obtain knowledge from other countries that have similar aluminium smelting work projects; among others, Norway and Iceland have had an aluminium smelting industry for some years.

3.3 Collecting new knowledge – SIF

The population studies done to date draw a picture of public health development since the beginning of the 1990s, and in connection with the Public Health Programme ongoing monitoring of the programme's goals and targets has been planned from 2009 to 2012. It is recommended coordinating any future monitoring programme relating to the creation of an aluminium smelting plant and other industries with general monitoring of the population's state of health. Future population studies should therefore adopt previous protocols' recommendation as a stepping stone to which data to collect as well as which health conditions it is particularly wished to monitor in the relevant study.

Prior to creating and operating an aluminium smelting plant in Greenland, it is expedient to have a comprehensive picture of health conditions available; this requires certain data to be collected.

The Greenland V population study includes both Nuuk and Maniitsoq with two settlements, but not Sisimiut. Thus there are no new, comparable health data for Sisimiut, which is unfortunate, were Sisimiut Municipality to be selected as the site for establishing an aluminium smelting plant. So no status report is available on the state of health prior to the construction of any aluminium smelting plant, which is essential in order to be able to evaluate whether there is any development in the state of health of Sisimiut over time. It is of some urgency, therefore, to conduct a population study in Sisimiut Municipality with a similar protocol to that for Nuuk and Maniitsoq. The study should include 350-500 adults from both the town and settlements, and should be conducted as soon as possible. The budget for a population study in Sisimiut Municipality,

including 300 participants from Sisimiut and 150 participants from the settlements, totals some DKK 1.8 million, cf. Appendix 2.

3.4 CAM

Under a joint programme, based on the work af AMAP (Arctic Monitoring and Assessment Programme), which is the international monitoring programme aimed at the Arctic region and approved by the Ethics Committee for Scientific Studies in Greenland (under the Commission for Scientific Research in Greenland (KVUG)), the Centre for Arctic Environmental Medicine has undertaken a series of population studies in Greenland to the following main ends:

1. To monitor blood levels of persistent organic pollutants (POPs)
2. To monitor blood levels of heavy metals
3. To evaluate the differences in levels found between different population groups in Greenland
4. To measure and evaluate any quantifiable health effects.

In order to obtain larger and more representative study groups, men and women in Greenland have been extracted for the studies in a systematic and randomizing fashion over the past nine years. Tests were done here for a series of heavy metals in blood and plasma, including Cd (cadmium), Hg (mercury), Pb (lead), Cu (copper) and Zn (zinc) as well as Se (selenium). In addition, analyses were done for fourteen different types of PCB (polychlorinated biphenyls), a number of organic pesticides: Aldrin, Chlordane, Dieldrin, DDT, Endrin, Heptachlor, Hexachlorbenzene, Mirex and Toxaphene. The study has since been extended with blood lipids, including fatty acid composition, triglycerides and cholesterol–both HDL and LDL cholesterol, which could act as dietary markers like health markers. While analysing the participants' blood for a variety of parameters, a standardized questionnaire study was also conducted at the same time, containing information about demographic, anthropometric and lifestyle factors including smoking, alcohol and dietary habits. In order to confirm or refute the smoking information given, subjects were also screened for Cotinine, a nicotine metabolite. In addition, examinations were done for contaminants as well as collecting nutrients in dietary samples.

3.5 Collecting new knowledge – CAM

To draw up an SMV study population: a "cohort" of 50 younger, healthy men aged 25-35 in each of the 3 towns of Nuuk, Sisimiut and Maniitsoq is suggested formed. These are chosen from a randomized draw from the national

registration office in each town. A preliminary condition for inclusion is that the individuals experimented with are willing to participate in follow-up investigations for instance every 3 or 5 years. The size of the population has been chosen from earlier statistical power calculation conducted in relation to CAM's AMAP projects in Greenland 1999-2006. To achieve this size of cohort it may be necessary to draw up to dubble as many via the national registration office, as others' experience shows that follow-up investigations have a low percentage of commitment of max 40-50 %, however, this is not our experience in Greenland. Plan and budget are based on district medical officer Ph.D. Henning Sloth Pedersen conducting the investigation under the auspices of CAM.

Questionnaire common: same wording as in CAM's AMAP questionnaire is used in case of comparison/co-ordination. The questionnaire contains demographic questions and lifestyle questions: questions concerning smoking and alcohol.

Total expected expenditure for drawing up the SMV study population: 1.1 million DKK.

4.0 Culture – summary of chapter 4

4.1 Introduction

The interior between Kangerlussuaq and Nuup kangerlua is the largest landlocked area in Greenland, and also the richest in resources. There is relatively easy access from the coast to the interior via valleys, rivers and lakes. Place names, ancient habitations, historical literature, old maps and so on all provide documentary evidence that the area has been exploited from the beginning of colonization in the 1700s up to the present day and that its history can be traced even further back in time, which is supported by the regional archaeology. Archaeological research can trace the use of the area back to the first people in the country; although the familiar traces become fainter and fewer, the further back we go.

Increasingly, understanding the way in which the area has been exploited over the ages seems to be central to our understanding of the local and regional past settlement patterns on the outer coast, but there is a dearth of data.

4.2 Conclusion

From the whole of the Palaeo-Eskimo part of West Greenland's prehistory (2400-100 AD), very little evidence has been recorded of the active use of the interior in the form of tent camps. Practically all knowledge of the Palaeo-Eskimos comes from the coastal settlements. This is scarcely a true or fair picture of the situation throughout the period.
It is essential to obtain a far more soundly founded picture of the prehistory of the great inland, because this is **also** instrumental in putting a more finessed perspective on the coastal settlements and thus on the individual periods of civilization.

The Norsemen (1000-1350 AD) must have had structures in the interior, but such finds would not involve any fundamental change to our understanding of the Norsemen's life and economy in the immediate term. There must also be structures along the west coast, stemming from their travels to the north and their exploration of the country, where encounters took place with the Thule culture. Throughout the Norse period we find bones from walruses (chiefly skulls and penises) on the farms. They must come from the north, and during the latter part of the period from areas where the Inuit have settled. These sites have not yet been found either.

The Thule culture established itself all across the area from c. 1300 onwards, over the next 400-500 years. Along the way, changes take place in structural

forms, organization of settlements, financial focus, climate, contact with Europeans, access to raw materials and resources etc.
The Thule culture builds up its use of the interior, which fluctuates in intensity over the centuries. These shifts are assumed to reflect variations in reindeer numbers. However, we lack a detailed chronological knowledge of the settlements on the outer coast and cannot, therefore, evaluate whether changes in social or economic structures in these areas may also have a bearing on the settlement and exploitation pattern seen in the interior.

The coastal area or coastal areas included in substantial plans of placing the smelting plant must be carefully examined and investigated. The focus will be on well-preserved and informative Thule structures, and particular attention will be paid to the presence of Norse or Palaeo-Eskimo relics.

New techniques such as aDNA must be applied in order to find the human element at the Palaeo-Eskimo sites (there are no skeletons or burials from this period) and data collected for a better understanding and appreciation of local and regional changes to landscape forms over time.

In overall terms, human settlement in the area and the use of land and sea extend over 3,000 years. From this period, but spread over a stretch of coast extending some 300 km as the crow flies and inland to a depth of some 100 km, we have approx. 1,000 Eskimo settlements, incl. a number of disused settlements and structures from the Colonial period and six Norse farms, cf. Table 1.
Of these 1,000 sites, the quantity in the Sarfartoq-Tasersiaq area alone makes up almost 44%. The quantity of known settlements (34) in the interior south of the Ice Cap is incredibly small in relation to the extent of structures along the coast and their ease of access. The figures are scarcely representative, therefore.

Nor do the dots provide adequate documentation. Each dot may mark one grave, one tent ring or a summer site with many tent rings, a settlement of 5,000 sq.m with ten homes and 15 graves, or a settlement of 40 sq.m or a plain old hearth etc.
The dots are not an expression of a number of structures, merely an expression of how man has made a great or small impression in the landscape.

The wealth of ancient monuments north of the Ice Cap is a scientific gold mine, which also imparts to the landscape a unique value in terms of the cultural landscape.
The poverty south of the Ice Cap makes it extremely imperative to have all potential settlement areas investigated carefully and to have all threatened structures examined in great detail, so that they can be placed in the right context.
In this area the known ancient monuments and potential settlement areas near lakes and rivers make up an unusual little pool of information-rich components, which can tell the tale of mankind and his presence in West Greenland over 3,000 years.

These days we take the appearance of the landscape for granted, and look for the past in a contemporary landscape, but have the rivers changed their course? Has the water level in delta areas and in the lakes been the same throughout the entire period? Has the vegetation changed its nature, and when? How has the correlation between sea and land evolved locally? The analysis is a scientific one, but such information is essential to understanding the landscapes that humans could exploit.
Throughout the whole of the period man has exploited both coast and inland. Nature removes and has removed many ancient monuments, but irrespective of how ancient monuments are vanishing, it will diminish our capability to understand how man and cultures through the millennia have acted in complex and different ecological areas and zones. The cultural dynamic and evolutionary phenomena functioned in a natural arena where mankind was a player without any of the modern-day capabilities for reshaping it. It is important, therefore, to view the ancient monuments in their own natural setting, not just within a contemporary framework.

All areas of the interior affected by hydroelectric plants and changes to lakes and rivers must be carefully examined. The interior is either unknown or virtually only ”populated” with structures from the Thule culture, which have not yet been attached to any chronological skeleton of any depth. The rich and varied source material on the Thule culture can be put to further use, providing we can expand our understanding of the structural forms in the interior and the causes of shifts in exploitation of the area. This can only be done by means of intensive reconnoitring and professional excavations of entire structures and settlements.

Central West Greenland is unique in Greenland, climatically, topographically and in terms of resources; and that has created altogether extraordinary

conditions and opportunities for its shifting cultures. If the man-made components and impressions on the landscape are ruined, the population of Greenland, tourists and research will for ever have lost their access to that part of history and hence to the opportunity to understand and convey the past in a far more subtly detailed way than we are currently able to do. That is why as much information as possible must be safeguarded.

5.0 Regional development and migration – summary of chapter 5

5.1 Introduction

This chapter of the strategic environmental assessment report addresses the regional economic and socioeconomic consequences of placing an aluminium smelter near Nuuk, Maniitsoq or Sisimiut. This section will therefore describe the impact on Greenland in terms of migration of labour to and from the town chosen for the aluminium smelter, and it will evaluate how the choice of location will affect regional development in Greenland in relation to patterns of settlement and regional development factors.

The chapter mainly describes the consequences for each of the three towns in which the aluminium smelter can be located – Nuuk, Maniitsoq and Sisimiut. Thus, no focus is placed on hydroelectric power stations. As the description focuses on the long-term regional economic and socioeconomic consequences, the focus of the assessment is on the operating phase of the aluminium smelting plant (and the hydroelectric power stations), i.e. from 2015. In the short term, the construction phase of hydroelectric power stations, the aluminium smelter and infrastructure will, of course, significantly enhance the regional economic and socioeconomic development trend that is expected to arise as a result of the location of the smelter.

National planning and regional development strategies are key to the future development – both economically and socio economically. The construction of a large-scale plant – for example, an aluminium smelter – therefore plays a role, too, and should be part of such a debate.

A number of investigations are in progress of economic conditions, investments etc. that will form part of the foundation for a decision for the Home Rule Government. These investigations will together with the strategic environmental assessment report form the entire foundation for a decision for the decision of the Home Rule Government and the Parliament on, among other things, the siting of the smelter at the spring Parliament meeting in 2008.

5.2 Data basis

The chapter is based partly on a report commissioned by Greenland Development A/S and prepared by Niras Greenland A/S with the title "Økonomiske konsekvenser af etablering af aluminiumsindustri i Grønland" (Niras 2007). The subject of this chapter is only to some extent dealt with by the

report. This chapter is therefore also based on interviews with Icelandic researchers from the University of Akureyri, who conducted the socioeconomic analyses in connection with the construction of Alcoa's aluminium smelter in Iceland. Because of the division of work between Greenland Development and the SEA working group in connection with the collection of background data, the SEA working group did not have sufficient time to incorporate additional background data. For that reason alone it is necessary to obtain additional information before a political decision is taken on the location of a smelter.

It is very difficult to predict people's behaviour in relation to migration because the number of factors that affect human behaviour is extremely large. However, researchers have, of course, an idea of what is significant, and in the present strategic process it is important to point out the significant parameters of which we do not have adequate knowledge:

- We do not know how much the coming migration will affect the social networks and what impact it will have on the economy.
- We know that social and family ties are very important in small communities like those in Greenland, but we do not know fully the extent to which it will affect the coming patterns of migration.
- We assume that community size is inversely proportional to the level of vulnerability to changes in social and family ties. But we do not know for sure whether this applies to Greenland.
- We do not know the towns that will experience migration. Thus we do not know whether it is the small or large towns that will see people move.
- We do not know what factors affect the ability to adapt in the Greenlandic society generally and among individuals specifically.
- We do not know the extent to which the inadequate infrastructure and the long distances between towns in Greenland will affect labour mobility/willingness, including inertia in relation to migration to new jobs.

It will not be possible before the decision at the spring Parliament meeting to get a full general view of all these conditions and as for some of the points it will not be possible to get a clear picture at all, because not everything can be – and should not be able to be – predicted in an open and democratic society.

However, the questions mentioned are under all circumstances important to include in the considerations in progress. At present several reviews are in progress and they are expected to be ready prior to the decision at the spring Parliament meeting, just as through 2008 closer investigations on the mobility issue will be carried out so that they can take part in shedding new light on

some of the mentioned areas and moreover in relation to industrial growth in other sectors.

As mentioned, there are many more factors that may affect the migration behaviour of the Greenlandic population and the list above is therefore far from exhaustive. Experience from Iceland shows that inertia is created in the migration because ”people await the situation”. Housing conditions including price and waiting lists etc. may also have a decisive effect on migration behaviour.

Migration is here used as an example of an area we do not know much about at present. However, there are other areas of which we do not have the knowledge required to take such a far-reaching decision on a well-informed basis.

The assessment of available regional growth models in a Greenlandic context is one of these other areas in which the data basis is inadequate. In this connection there are especially two scenarios that are interesting and should be clarified in both the medium and the long term:

1. What are the economic consequences for Greenland of focusing on several growth centres, for example, the four so called growth towns (Qaqortoq, Nuuk, Sisimiut and Ilulissat), which can compete with each other and hence sharpen regional competitiveness and create economic dynamics?
2. What are the economic consequences for Greenland of focusing on one strong regional growth centre in Nuuk in Greenland, which can enhance Greenland’s importance in the North West Atlantic region where Greenland will be competing with, for example, Nunavut, Labrador, Iceland, the Faroe Islands and Scotland?

Strategies for regional development assume many forms in Europe. Finland, for example, has a clear goal of spreading economic growth over many growth centres[1]. At the EU level, the aim of the ESDP (European Spatial Development Perspective) is to develop a deliberate polycentric growth strategy in European cities to ensure that economic growth is developed in more cities than just London and Paris[2], for example.

[1] The Ministry of the Interior in Finland describes the regional development strategies here: http://www.intermin.fi/intermin/home.nsf/pages/521E4C0E6BB6D91CC2256FB9006F420C?OpenDocument

[2] The report: ESDP - European Spatial Development Perspective - Towards Balanced and Sustainable Development of the Territory of the European Union, can be found here: http://ec.Europe.eu/regional_policy/sources/docoffic/official/reports/pdf/sum_en.pdf

In a Greenlandic context, however, there are large gaps in the detailed knowledge of, for example, the level of vulnerability of small communities to the 'brain drain', i.e. the migration of skilled persons and persons with a further or higher education.

This lack of knowledge outlined by this section illustrates firstly that there are many potential environmental targets that need to be set in an environmental assessment of an aluminium smelter in terms of migration and regional economic development. This strategic environmental assessment is mainly confined to areas addressed in the Niras report and is therefore far from adequate in an overall impact assessment of the location of an aluminium smelter in Greenland. In this chapter, therefore, only very simple, hypothetical environmental targets are set.

5.3 Conclusion

At the present moment the strategic environmental assessment cannot provide any very detailed assessments of the regional economic and socioeconomic consequences of constructing an aluminium smelter in one of the three towns. However, the conclusions on economic effects and migration pressure as illustrated by the matrix can be drawn.

Environmental targets	Location in:	Nuuk	Maniitsoq	Sisimiut
		Assessment	*Assessment*	*Assessment*
1. Economic activity in Greenland should, as far as possible, be spread geographically in an aim to achieve regional equality and balance		Large negative	Large positive	Positive
2. Economic activity in Greenland should, as far as possible, be concentrated in a strong growth centre in Nuuk		Large positive	Small negative	Small negative

Table 5- 1: Assessment by town

As mentioned this table is based on Niras' report. Unfortunately it is not possible at the present time in the light of existing figures and material to elaborate this table. To the extent that material can be found to elaborate the table attempts will be made to work it into the SEA 2008 report. Failing that it will as a minimum be clarified which further investigations can be pointed at for a more satisfactory and more pointing forward pinpointing of the problems.

Based on the available knowledge and the two environmental targets it is obvious that if you prefer environmental target 1, the aluminium smelter should not be located in Nuuk because the need for labour is largest in the rest of Greenland, and so is the migration need. Massive mitigation measures can be partially implemented, e.g. intermunicipal economic equalisation systems. However, this cannot neutralise the massive migration pressure that will be put on the rest of Greenland. If, on the other hand, you prefer environmental target 2, the location in Nuuk is clearly preferable. However, it is also evident that Nuuk will continue its very favourable economic development whether or not the smelter is located in Nuuk. Hence, economic activity will continue to be very heavily concentrated in Nuuk even if the aluminium smelter is located in one of the two other towns.
The simple matrix and only two and very simple environmental targets set out above illustrate that there are many very significant matters that we know nothing about and which should be clarified politically before a decision on the location of an aluminium smelter is taken. A matter of particular importance is the creation of a debate on national planning and regional development to establish how Greenlandic towns and settlements are to develop in relation to each other in future. A decision on the location of an aluminium smelter is in reality a choice of a regional, irreversible and path-dependent[3] development strategy although there is no real national development strategy for the Greenlandic regions.

It is of decisive importance to clarify politically the regional development that is desired to take place in the next century because the location of an aluminium smelter will have a great impact on the regional development and define the potentials and limitations of the future regional policy.

In addition to the above considerations of regional conditions, there are other significant economic conditions that are important to the project:

”On the available basis it is not possible to assess on economic criteria alone what location of the smelter is best for Greenland. Furthermore, the various possible locations of the smelter are likely to represent important differences in the need for public investment in infrastructure. This factor must also be included in the overall considerations. In the considerations of the location of the smelter it is also very important to evaluate the amount of investment required to connect the smelter to the neighbouring town since this connection

[3] Path dependence in connection with regional development is to be regarded as a regional development path which cannot be changed without great effort.

is necessary for daily commuting purposes. This applies even more so as there may be significant differences between the related expenditure amounts. In this connection, consideration should also be given to any additional perspectives associated with the individual locations in relation to urban development, transport pattern etc." (Niras 2007).

Under the auspices of Greenland Development several of these perspectives have already been subjected to closer elucidation. These new elucidations are expected to be ready in the beginning of 2008 and will thus be able to enter into the draft for decision at the spring Parliament meeting in 2008.

5.4 Recommendations

In the light of the ascertained lack of relevant professional knowledge it is recommended that prior to the political decision of siting of an aluminum smelter, more information on regional development is obtained.

The recommendation is among other things motivated on the fact that the coming political decision on siting of the smelter defines a course for the future development of society, which is irreversible in relation to regional development policy and spatial planning in Greenland.

As stated a number of amplifying investigations are already at present in progress. Theses will to the utmost extent possible be finished in order that they can enter into the foundation for a decision of siting of an aluminum smelter.

It is recommended that societal analyses are concentrated on so that a number of the areas where present knowledge is insufficient can be illuminated and this knowledge can enter into the further considerations on starting the aluminum smelter project. For example an analysis of the backgrounds for concrete migration patterns would be of great help. Bids on potential areas for investigation are given in the section on data basis.

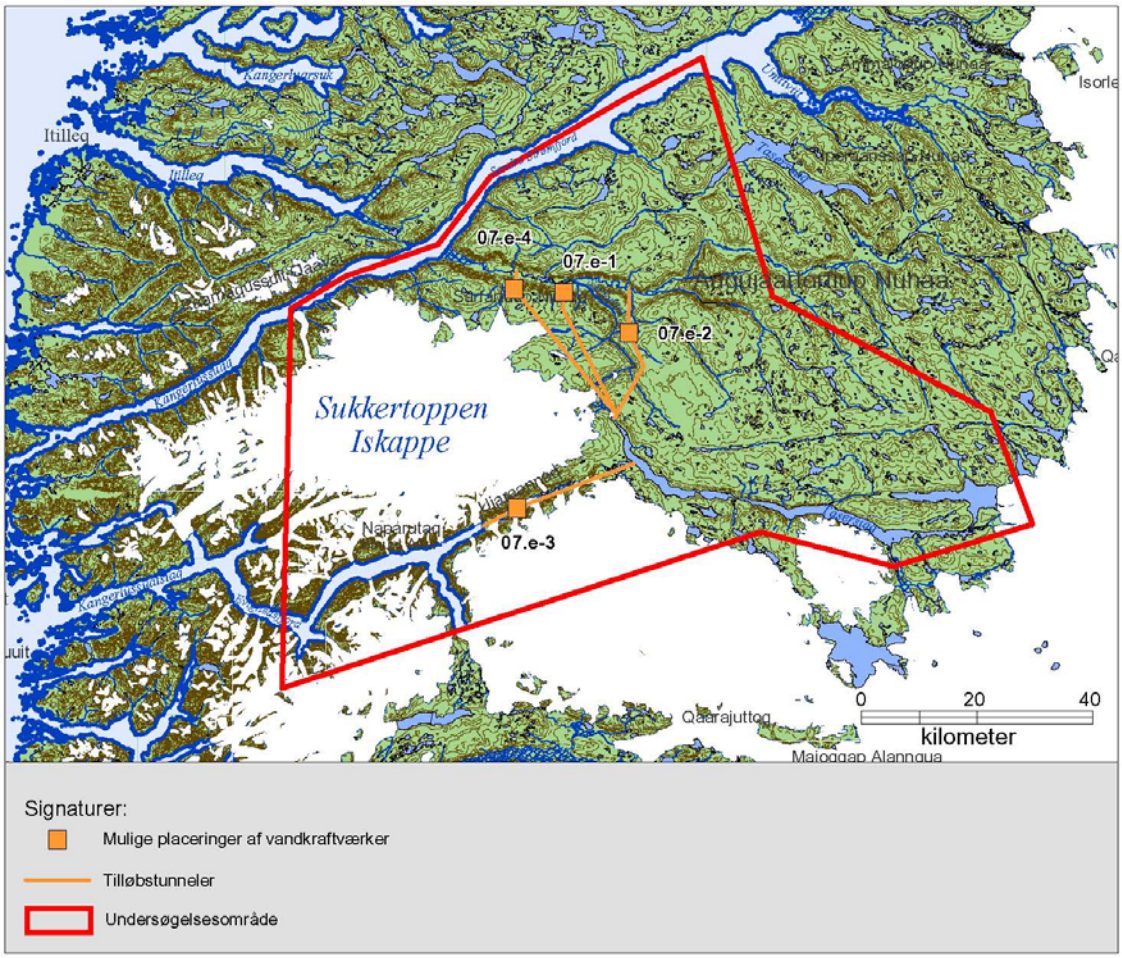
Under the auspices of SEA a seminar has been planned to take place in the last half part of January 2008 with a view to obtaining further relevant professional knowledge on the area. This seminar will consist of presentations from researchers and planners from among others Canada, Iceland and Sweden. The seminar will focus on topics such as growthcenters, specialised or diversified regional economies, ability to readjust in society and population etc.

When the results from the ongoing and planned investigations and seminars are available it will be necessary to consider whether it may be necessary with further professional illumination of particular issues. If so it will be recommended to carry them out during 2008.

6.0 Cumulative investigation – summary of chapter 6

6.1 Introduction

The Greenland Home Rule has contracted an alliance with the American aluminium company Alcoa Inc. on the study of possibilities of constructing an aluminium plant with a production capacity of 340,000 tonnes per year, and associated hydropower plants. This study will constitute the basis for the final choice of location and construction of the specific elements of the project.



Figur 6-1: Oversigtskort over projektområdet for kumulativ undersøgelse med angivelse af de fire forslag til placeringer af vandkraftværk.

As part of the study the Department of Environment and Nature, Greenland Home Rule, conducts a Strategic Environmental Assessment (SEA) of the alternative locations for the aluminium plant and associated hydropower plants.

For the area west of Maniitsoq Iskappe between Nuuk and Sisimiut (see Appendix 2), the SEA is carried out in four separate main themes: Environment and Nature, Health, Regional Development and Culture. Final reports will be produced for each theme at the end of the assessments.

In addition to the four main themes of the SEA, Grontmij | Carl Bro a/s has conducted a preliminary cumulative assessment of the planned hydropower plant at Lake Tasersiaq for Department of Environment and Nature. This cumulative assessment covers the area between Evighedsfjorden, Søndre Strømfjord and the Sarfartoq River (see Appendix 3). The aim of this assessment is to assess the cumulative impact of the hydropower plant and all other known and planned activities in the area, such as mineral exploitation and tourism, as the area is of great interest for such activities.

Four alternative locations of the hydropower plant and headrace tunnels from Tasersiaq have been proposed; named 07.e-1, 07.e-2, 07.e-3, and 07.e-4 in the statement of Nukissiorfiit on the hydropower potential in Greenland (see Appendix 3).

The location 07.e-2 has been excluded by Department of Environment and Nature due to its position in the protected Paradise Valley/Arnangarnup Qoorua. The present assessment therefore only includes the two northern locations at Sarfartoq Qoorua (07.e-1 and 07.e-4) and the southern location at Ujaraannaq/Evighedsfjorden (07.e-3).

According to Greenland Home Rule a harbour is planned for construction in Søndre Strømfjord at the mouth of Sarfartoq River independent of whether a northern or southern location is chosen for a hydropower plant.

6.2 Material and methods

Usually, a cumulative SEA would be conducted on the basis of data and assessments from the final reports of the four, above mentioned, themes. However, the current cumulative assessment has been conducted in parallel with the four other assessments, from which data and assessments have been extracted for the cumulative assessment. This procedure is not ideal, but has been necessary due to the deadlines of the entire SEA process. Consequently, this resulted in the cumulative SEA being conducted without the latest data and final conclusions and assessments from the four SEAs on Environment and Nature, Health, Regional Development and Culture.

The cumulative analysis has therefore been conducted on the basis of existing knowledge extracted from available literature, reports and GIS data, together with information obtained during meetings with relevant departments in the Greenland Home Rule, Greenland Institute of Natural Resources, Asiaq a/s, Nukissiorfiit, Greenland Development, National Environmental Research Institute (NERI) and the National Museum.

Furthermore, assessments of impacts on nature have been coordinated with NERI, the official advising body on natural resources to the Greenland Home Rule. This coordination was carried out to ensure that the assessments in the current document reflect contemporary assessments of NERI.

The assessment of potential human impact on archaeological remains has likewise been sent to the Greenland National Museum for comments.

All relevant parameters and potential impact of a hydropower plant, mineral activities, hunting and tourism on these parameters are listed in Appendix 1. The impact on each parameter is assessed as: none (0), low (1), moderate (2) or significant (3). All parameters with a moderate or significant impact assessment are discussed in the text together with possible mitigations.

6.3 Assessments

The cumulative SEA has identified the following parameters as potentially facing moderate to significant effects by one or more of the current and planned activities in the area. Further analyses and documentation of effects or operational monitoring programmes forming baselines for mitigation may be required in cases where significant problems are envisaged to arise.

Caribou and muskox are affected by hydropower plant, mineral activities, hunting and tourism.

The impact is mainly ascribed to increased disturbance from hunting and tourism as improved infrastructure associated with hydropower plant and mineral activities facilitate access to currently more or less undisturbed areas. Data indicate that populations of muskoxen in the area currently are close to carrying capacity. It has therefore been suggested that population dynamics may change in the near future, which in return will affect to which extent increased disturbance and hunting will affect the population.

Construction of buildings and infrastructure associated with the hydropower plant and mineral activities, as well as increased air traffic, hunting and recreational activities in the area may result in increased disturbance on both caribou and muskox.

Construction of buildings and infrastructure during the construction phase may influence the distribution of caribou and muskox in the area. However, animals will probably return to disturbed areas when construction work is completed, as long as human activities associated with operation of the plant are limited. Flying at low altitudes with airplanes and helicopters, and increased hunting and recreational activities in the area may on the other hand have long-term effects on caribou and muskox.

Additionally, construction of transmission lines, a harbour and infrastructure may potentially affect dispersal routes of both caribou and muskox.

Harbour seal is limited in numbers in Greenland and is red-listed in Greenland. Søndre Strømfjord is home of one of the few and most northern populations on the central part of the Greenlandic west coast. A haul-out site for harbour seals earlier existed at the mouth of the Sarfartoq River. The seals were believed to abandon this haul-out site due to intense hunting and disturbance by boats.

Currently, there is a haul-out area for harbour seal at the sand delta of the Watson River close to the Kangerlussuaq airport. Harbour seals thus still occur in the Søndre Strømfjord area, and the formerly used haul-out site at the mouth of the Sarfartoq River may, if left undisturbed, be utilised by seals in the future.

Regarding the small population size of harbour seal in the fiord, increased shipping on Søndre Strømfjord due to construction and operation of hydropower and mineral activities may be critical for the population, since even a single oil spill may lead to severe mortality in the population. Additionally, construction of a harbour near the previously used haul-out site at the mouth of the Sarfartoq River may prevent the population in Søndre Strømfjord from expanding in size from its current critically low level.

Greenlandic white-fronted goose: This subspecies is of special concern in Greenland, as all its breeding grounds are located in the country. Consequently, negative impact of a hydropower plant on the Greenlandic white-fronted geese should be avoided, if possible.

Current data indicate that white-fronted geese are most vulnerable to disturbance on their spring staging areas. Construction and operation of the hydropower plant may result in disturbance on the spring staging areas due to construction of infrastructure, increased air traffic and increased recreational activities by workers associated with the plant. In addition to human activities related to the hydropower plant, mineral prospecting and exploitation will result in cumulative disturbance effects on the staging geese.

The geese are also vulnerable to disturbance during their post-breeding moult. Moulting is highly energy demanding and the geese are therefore dependent on undisturbed foraging during this period. Surveys are needed to determine whether/to which extent moulting areas occur within the area, as such data are presently not at hand.

Harlequin duck is limited in numbers in Greenland and is categorised as ”near threatened” according to the Greenlandic red list, and breeding sites should therefore be protected. The harlequin duck is assumed to breed in the Paradise Valley, but no systematic investigation has been carried out.

During the breeding season, the harlequin duck is vulnerable to disturbance from traffic near nesting sites and from airplanes and helicopters flying at low altitudes. Independent of the location of the hydropower plant, the power plant project will create increased access to the Paradise Valley through an access road from the harbour at the mouth of the Sarfartoq River.

The influx of silt from Tasersiaq to the Sarfartoq River will cease if the hydropower plant is located at Evighedsfjorden. This may improve the breeding conditions for harlequin ducks, since a larger part of the river system will become silt free. A northern location of the power plant at 07.e-4 will also lead to a larger part of the Sarfartoq River clearing up as the influx of silt ceases.

Thick-billed murre and kittiwake breed within or in the vicinity of the study area in Evighedsfjorden. Thick-billed murre breeds in the outskirts of the study area but is included in the cumulative analysis since the Greenlandic population is declining, and Greenland has agreed to contribute to the monitoring and conservation of the arctic population of thick-billed murre. The population of kittiwakes within the study area is also vulnerable, since it is declining and a large part of the Greenlandic population (ca 1/3) breeds within Maniitsoq municipality.

Gulls and auks breeding in colonies are vulnerable to oil spills near their colonies, and spills may extirpate large parts of local breeding populations. Hydropower plant, mineral activities and tourist ships may all pose a potential risk for oil spills. Among the alternative locations of the hydropower plant, the southern power plant will pose the greatest risk of oil pollution, since this location will entail increased shipping on Evighedsfjorden. The risk of oil spills given a northern location of the power plant will, on the other hand, only affect Søndre Strømfjord and associated water systems, where no breeding colonies of gulls and auks currently are found. The risk of an extensive oil pollution may, however, be regarded as minimal if the international standards for shipping operations and the current regulations for handling of oils at sea are adopted.

Arctic char is common in lakes and rivers within the study area. The River Arnangarnup running through the Paradise Valley is home to a large population of arctic char that is important to local fishermen and to the angling tourism.

The course of the Sarfartoq River will be altered by damming Lake Tasersiaq in order to form a water reservoir for hydropower. If the power plant is located to the north, the water flow from Tasersiaq to the Sarfartoq River will be led through headrace tunnels. However, if the power plant is located at Evighedsfjorden, the water from Tasersiaq to the Sarfartoq River will cease more or less completely. The supply of silt from Tasersiaq to the Sarfartoq River will thus cease if the plant is located at Evighedsfjorden, and the Sarfartoq River will consequently attain low turbidity during its entire watercourse, but maintain a reduced water level.

The altered watercourse of the Sarfartoq River will affect its flora and fauna, but the extent of the impact and whether the effect will be mainly positive or negative is uncertain. Independent of the location of the power plant, the water level in the Sarfartoq River will probably still be sufficient to sustain a population of arctic char. Further analyses of the hydrology of the affected water systems and mapping of spawning areas of arctic char are needed before a the impact of a hydropower plant on arctic char can be assessed in more detail.

Flora: several rare plant species located within the study area may potentially be affected by construction and operation of a hydropower plant. Especially the Paradise Valley is home to several rare species.

The flora in the affected area will be affected irrespective of location of the hydropower plant. However, detailed vegetation mapping prior to construction

work will reduce potential conflicts between constructions and preservation of vegetation in the study area. With knowledge of the most important plant areas, these may hence be avoided during construction and operation of a hydropower plant.

Landscape: construction of a hydropower plant with associated transmission lines and infrastructure, and extensive mineral prospecting and exploitation will alter the landscape from pristine nature to a landscape impacted significantly by human activities. However, except for the transmission lines, most buildings and other technical elements may become more or less invisible in the large-scale Greenlandic landscape, e.g. when observed from a distance of few kilometres.

Additionally, there will be a significant impact from deposition of waste rock/rubble, and through altered silt flow into Søndre Strømfjord and Evighedsfjorden, where significant alterations in sedimentation and erosion will occur.

Surface waters, lakes, rivers and fiords: a southern hydropower plant at Evighedsfjorden will result in larger volumes of freshwater and silt being discharged into Evighedsfjorden, compared to the current situation where water and silt from Tasersiaq mainly is discharged into Søndre Strømfjord. Over time this may cause a disruption of the Sarfartoq delta in Søndre Strømfjord, and creation of a new or larger delta at Evighedsfjorden.

The part of the Sarfartoq River currently receiving silt from Tasersiaq will become less turbid and hence clear-watered, if a southern location of the power plant is chosen. This is, however, dependent on silt not being discharged into Sarfartoq from other water systems in the area.

Discharge of wastewater, percolate from waste areas, alteration of silt deposits, leaching of metals from deposited mine tailings and waste rock, and spills of environmental pollutants may combined result in considerable cumulative effects on the recipient water systems. The significance of this cumulative impact is dependent on the marine environment in the fiords and their robustness.

Culture and archaeology: construction of a hydropower plant and possible mineral exploitation will have significant impact on cultural remains in the area, since all remains located at construction sites of buildings and infrastructure, and in mining areas will be destroyed. Additionally, frequent traffic associated

with construction activities, mineral exploitation, hunting and tourism will lead to increased wear and tear of the archaeological remains in the area.

Tourism, recreational activities and hunting: Construction of the hydropower plant will lead to increased accessibility to the area for tourists and hunters. Establishing an access road from Søndre Strømfjord to Tasersiaq will facilitate access to large areas towards the ice cap. This is positive for hunters in the area, since it will facilitate transportation of caribou and muskox carcasses. The area will also become more accessible for tourists, including hikers, trophy hunters and anglers. However, many tourists visit Greenland because of its pristine nature, and the construction of a hydropower plant with associated infrastructure and transmission lines will likely make the area less attractive from a tourist perspective.

6.4 Differences between alternative locations of hydropower plant

Several types of impact are identical for the two northern (07.e-1 and 07.e-4) and the southern (07.e-4) location of the hydropower plant, since they all three would use the same access road from the harbour planned at the mouth of the Sarfartoq River in Søndre Strømfjord.

The additional studies proposed in this report may confer novel knowledge identifying further significant differences between the three alternative locations. However, given current levels of knowledge there are the following marked differences between the two northern and the southern location (see Appendix 1).

The southern location will result in following positive effects:

1. Construction of transmission lines north of Sukkertoppen Iskappe is not needed, and the scenic value of the landscape north of Sukkertoppen Iskappe will hence remain relatively unimpaired compared to a northern location of the plant. Additionally, conflicts between transmission lines and caribou and muskox may be avoided, as well as the risk of collisions by white-fronted geese, since these species have their main distribution within the study area north of Sukkertoppen Iskappe.

2. Reduced silt levels in the Sarfartoq River may improve the habitat of arctic char, provided that the water levels in the river remain sufficient for spawning and dispersal of arctic char. Decreased silt levels in the Sarfartoq River may also affect harlequin ducks in the area positively.

The southern solution will result in following negative effects:

1. A hydropower plant at Evighedsfjorden may hinder the dispersal of muskoxen to the south.

2. Termination of the water flow from Tasersiaq to the Sarfartoq River may destroy plant communities with special flora associated with the river.

3. Increased shipping (including cruise ships) on Evighedsfjorden may result in disturbance of gull and auk breeding colonies in the fiord, and increase the risk of oil pollution near these colonies.

4. Oil spills caused by increased traffic on Evighedsfjorden may also have negative effects on capelin spawning sites.

5. Increased silt levels in Evighedsfjorden may affect unique marine environments in the fiord. However, it is currently unknown whether any unique marine environments exist in the fiord.

The northern solution will result in following positive effects:

1. Volumes of discharged water and silt into the fiords will remain relatively unaltered, resulting in preservation of the delta of the Sarfartoq River and the current marine environments.

By choosing one of the northern solutions it will result in the following negative effects:

1. The area will be affected by a heavy landscape technical element and resulting landscape-aesthetical influences.

Note that in relation to the proposed studies in section 3.1, new information may be obtained, which can lead to amendment of the current assessments given in this report.