REGISTRATION FORM

NAME OF UNDERTAKING: Use of Air Defence Countermeasures Chaff
at 5 Wing Goose Bay Military Training Area

PROPONENT:

(i) Name of Corporate Body:

Department of National Defence (DND)

(ii) Address:

Director Air Contracted Force Development (D Air CFG) / Foreign Military Training
Goose Bay (FMTGB)
National Defence Headquarters
Ottawa, Ontario
K1A 0K2

(iii) Section Head:

Name: M s. Kit Holmwood
Official Title: Section Head, Foreign Military Training Goose Bay
Telephone Number: (613) 949-1975

(iv) Principal Contact Person for Purposes of Environmental Assessment:
Name: Major John Martinello
Official Title: Head, Environmental Monitoring and Mitigation (CFG 6-3)
Telephone Number: (613) 998-4350
Facsimile Number: (613) 949-1971
Email martinello.jd@forces.gc.ca

TABLE OF CONTENTS

LIST OF APPENDICES

GLOSSARY AND LIST OF ABBREVIATIONS

AGL	Above Ground Level (flight altitude)
DND	Department of National Defence
D Air CFG	Directorate of Air Contracted Force Generation
EA	Environmental Assessment
FMTGB	Foreign Military Training Goose Bay
IEMR	Institute for Environmental Monitoring and Research
LLTA	Low Level Training Area
MCC	Military Coordination Centre
MOU	Memorandum of Understanding
MTA	Military Training Area
NM	Nautical Miles
PTA	Practice Target Area
VEC	Valued Ecosystem Component

1.0 INTRODUCTION

1.1 Identification of the Proponent

The Department of National Defence (DND) is the Responsible Authority for Foreign Military Training (FMT) activities conducted at 5 Wing Goose Bay. As signatories to agreements with the Government of Canada, air forces from foreign nations are authorized to conduct flight training in Canada. An implementation arrangement, known as a Memorandum of Understanding (MOU), identifies specific requirements and other terms and conditions relating to the training of the international participants at 5 Wing Goose Bay. The original MOU took effect in 1986 and was renewed for another ten-year term in 1996.

Current and prospective participants have indicated a need to achieve cost savings and training enhancements to assure their continued involvement in Goose Bay beyond the MOU expiration in 2006. DND considers this undertaking an important element for 5 Wing to remain viable as a training venue; - it is initiating this undertaking to satisfy a longstanding allied requirement.

1.2 Nature of the Undertaking

1.2.1 Background

Military training at Goose Bay has averaged 5,000 - 6,000 low level flights in past years, during the April to October flying season. However, activity levels have declined substantially during the last few years. Until recently, most training was comprised of low-level flights involving activity below 1000 feet and as low as 100 feet above all obstacles within a designated training area over the interior of the Quebec-Labrador peninsula. Figure 1.1 illustrates the training area, the entirety of which measures 130,000 square kilometres (the size of England). Seventy "camera targets" are dispersed throughout the Low-Level Training Area (LLTA); these are mock-up structures simulating enemy installations. Crews navigate between selected targets, often flying in river valleys and below natural ridge lines (terrain-masking) to avoid radar detection. They conduct simulated attacks using onboard cameras to verify their accuracy - no weapons or stores are launched against camera targets. Aircrew may conduct weapons training through the release of non-explosive practice weapons onto defined targets, but only within a four nautical mile radius Practice Target Area (PTA) shown at Figure 1.1.

There is only one permanent community (Churchill Falls, population 800) within the training area and it is protected from disturbance by a 16 nautical mile (NM) radius exclusion zone. A dozen small communities are situated some forty kilometres or more from the training area perimeter; members of these communities practice traditional hunter/ gatherer harvesting activities within the training area during different periods of the year. The training area straddles the boundary of Labrador and the province of Quebec.

In 2003, DND successfully completed the regulatory processes, including an environmental assessment, to introduce the use of practice Precision Guided Munitions at the PTA. This entailed the transfer of administration and control of a larger parcel of land from the Province to DND to establish a Safety Template Zone around the PTA. A 16 NM radius perimeter was marked on the ground by an 8-metre clear-cut vegetation slash, with signs posted in three languages.

In this instance, DND intends to further enhance allied training opportunities by authorizing practice Air Defence Countermeasures, consisting of the use of chaff and flare systems. This would be the first instance of aircrew deploying any materials from onboard the aircraft, other than within the PTA. To achieve ‘realistic’ training, aircrew must have the option to use these materials during most of their sortie. This requires the use of most, but not all, of the airspace within the LLTA. At least for the foreseeable future, DND intends to permit the activity only within the Labrador portion of the LLTA. This has the added benefit of facilitating a speedier review and approval process, and to devise research that can better discriminate comparative effects with an adjacent control area.

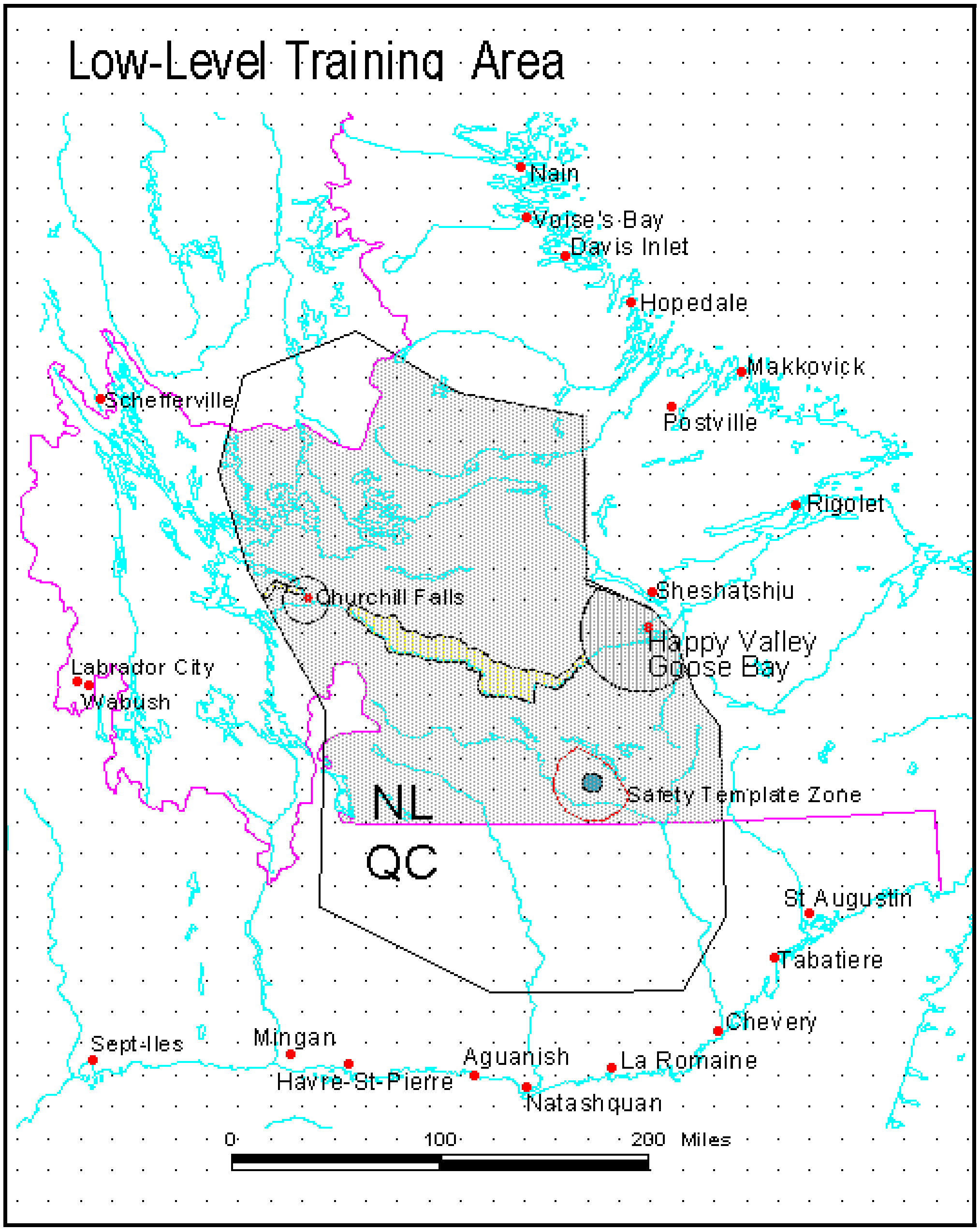


Figure 1.1 Location map; the shaded area represents the Labrador portion of the LLTA, intended to be used for RF Chaff defensive countermeasures training. A 25NM transition zone around the Goose Bay airport and 16 NM zone around the community of Churchill Falls will be excluded.

1.2.2 Previous Environmental and Administrative Processes

The training activity described above was referred to an independent environmental assessment panel for a public review under the federal Environmental Assessment and Review Process Orders guidelines. The Department of National Defence published an **Environmental Impact Statement (EIS) on Military Training Activities in Labrador and Quebec** (DND 1994), which provided the basis for subsequent technical and public hearings throughout the affected region. In 1995, the Government of Canada accepted the principal findings and recommendations of the panel, thus authorizing the continuation and controlled expansion of the activity.

In 1995, a **Transfer of Administration and Control of Crown Land to Her Majesty the Queen in Right of Canada** (Province of Newfoundland and Labrador Document No. 106234) formalized the establishment of the PTA lands as a "tactical air weapons range" under the administration and control of DND. This arrangement was modified in 2003 to accommodate the use of enhanced longer-range practice 'precision guided munitions', and the establishment of a Safety Template Zone.

As part of the comprehensive environmental management system, the federal government established the Institute for Environmental Monitoring and Research (IEMR) in 1996 to involve the major stakeholders and all levels of government agencies in conducting independent direct research on the effects of authorized training activities. DND retains the responsibility and accountability for mitigating any potential effects and for conducting any environmental assessments prior to the introduction of new training elements within the 5 Wing program. The work conducted by the IEMR to date confirms that any environmental impact is at or below the impact levels predicted in the EIS. Increasingly, DND and the IEMR have combined resources and worked collaboratively in designing research and monitoring studies. For the introduction of new training elements, such as Air Defence Countermeasures, DND has provided the IEMR with all its documentation to facilitate a review by stakeholders and its Scientific Review Committee.

DND publishes, on an annual basis, an Environmental Report and Mitigation Program relating to Foreign Military Training in Goose Bay. This report indicates the results of the environmental work conducted by FMTGB over the last period, outstanding issues to be addressed, consultations and collaborations with external groups, goals and objectives and the following year's workplan (roughly $1.5 million in expenditures annually). This report can be obtained online at www.goosebay.org. In 2003, FMTGB also achieved ISO 14001 certification, attesting to DND's comprehensive approach in addressing environmental issues relating to the training activity at 5 Wing.

1.3 The Undertaking

At any time during a combat mission, aircrew may be exposed to numerous types of threats from either air-based (opposing aircraft with missiles and guns) or ground-based (various surface-to-air missiles or anti-aircraft artillery) systems. These systems usually incorporate fire control and guidance components using either radar tracking and guidance or infrared (heat) seekers. To counter these threats, aircrew must manoeuvre the aircraft rapidly while deploying defensive counter-measure systems, such as radio frequency (RF) chaff and flares. Chaff is used to counter radar-controlled systems and is the subject of this

Registration; flares are used to counter infrared systems and are treated separately in another Registration document.

This undertaking seeks to initiate the use of chaff at 5 Wing Goose Bay for aircrew training in Air Defence Countermeasures. It represents an individual element within an overall training activity, which has already been approved under a previous federal environmental panel review process (DND 1994).

1.4 Need for the Undertaking

Almost all combat aircraft make use of defensive countermeasure to defeat anti-aircraft weapon systems. To do so effectively, aircrew need to incorporate their use as part of their flight training activities. Since this element was not incorporated among the activities in the EIS, the use of these countermeasures has not been permitted in the Military Training Area at Goose Bay, to date. Participating air forces have indicated that training with defensive countermeasures, such as RF chaff is vital for aircrew proficiency; not having this capability at Goose Bay is a significant detriment to their continued training at 5 Wing.

With the growing sophistication of anti-aircraft systems, the need to regularly conduct realistic defensive training also continues to grow. Survival in air combat demands that aircrew develop and maintain correct, instantaneous and intuitive responses to various anti-aircraft threats, including in-flight analysis of weapons; survey warning and defensive counter-measure sensors for adversaries; employ tactics and weapons for timely defensive countermeasures; assess the success of the measures and continue on with their assigned tasks.

In Canada, the use of chaff is permitted within the Cold Lake Air Weapons Range (CLAWR) in Alberta.

1.5 Alternatives to the Undertaking

The viability of the foreign military training program conducted at Goose Bay is entirely dependent on DND's ability to offer facilities and services that continue to satisfy the evolving requirements of participating air forces in a cost-effective and comprehensive manner. The inability to train in a crucial aspect of their operation could compromise the overall training value of their program in Goose Bay, and thus lead to the selection of alternative training venues elsewhere in the world. The employment and socio-economic benefits accruing from the allied training have been well documented in the 1994 EIS, and more recently, in studies sponsored by the Institute for Environmental Monitoring and Research. Over the past several decades, and for the foreseeable future, the military activity at Goose Bay represents an economic mainstay for the region.

1.6 Schedule for the Undertaking

DND intends to authorize use of chaff as soon as the environmental process is completed. The implementation of this undertaking does not require any new construction and/or modification within the Military Training Area, nor other licenses or approvals.

2.0 DESCRIPTION OF THE UNDERTAKING

2.1 Introduction

Since the 1980s, much of the training conducted at Goose Bay has focused on low-level flying. Such tactical employment of aircraft provided a degree of security to the crews, minimizing radar detection by flying in the valleys. This practice, known as terrain masking, is not always an operational option – crews may have to fly at higher altitudes, where they are more vulnerable to enemy fire. Advances in airborne and ground-based anti-aircraft detection and weapons systems are also posing an increasing threat to aircraft. To counter the threat from hostile radar tracking systems, the pilot must take evasive action, in conjunction with the deployment of RF chaff. The chaff reflects radar signals in various bands (depending on the length of the chaff fibres) and forms a large obscuring image or electronic "cloud". Hidden from radar detection by the cloud, the aircraft can safely manoeuvre and leave the threat area.

RF training chaff consists of extremely small strands of an aluminium-coated crystalline silica core. A detailed description of the composition, operation and toxicity of chaff is available at Appendix B.

The length of time RF chaff remains airborne, once ejected from the aircraft depends on the combination of local meteorological conditions and the altitude of deployment. Atmospheric residence times range from 10 minutes for the majority of chaff released at 100 metres to approximately 10 hours for chaff released at 10,000 metres. The higher the altitude, the greater the distance chaff will drift, resulting in a larger dispersal area on the ground or water, with a corresponding decrease in the concentration of the deposit.

2.2 Current and Future Usage

DND assumes that about half of the total sorties flown (or 2,500) would deploy RF chaff, with an estimated maximum of about 30 bundles of chaff (each weighing about 100 grams) per sortie. Accordingly, approximately 7500 kilograms of chaff would be dispersed annually.

2.3 Current Environmental Protection Procedures

As part of its extensive mitigation efforts, DND maintains a comprehensive monitoring program to identify sensitive areas in the MTA arising from human or wildlife activity on the ground. This information is gleaned from ongoing surveys, tracking of wildlife based on satellite and radio collars, and data collected through a community liaison program. Allied crews are notified by the Military Control Centre (MCC) of sensitive locations and protective buffer areas are established where flight activity is prohibited. As discussed in Section 4, this same avoidance program will be adopted to prevent the deployment of chaff directly over sensitive areas. .

As previously stated, the DND environmental program is conducted in cooperation with federal and provincial wildlife officials and the Institute for Environmental Monitoring and Research (IEMR), in consultation with interested aboriginal groups. This arrangement provides an effective mechanism to address issues that may arise with this undertaking at any time in the future. DND expects that the IEMR will undertake a program to monitor the actual impacts of chaff on the environment. For its part, DND intends to monitor for accumulations in soil and water.

2.4 Probability of Chaff Deployment Failure

Under normal conditions, upon release from an aircraft, chaff forms a cloud approximately 30 meters in diameter in less than one second. Quality standards for chaff cartridges require that they demonstrate ejection of 98 percent of the chaff in undamaged condition, with a reliability of 95 percent at a 95 percent confidence level. They must also be able to withstand a variety of environmental conditions that might be encountered during storage, shipment, and operation. Additional technical information on the ejection and characteristics of chaff is available at Appendix B..

2.5 Risk Assessment

The probability of chaff debris hitting a person on the ground is difficult to quantify. Such an event would be dependent on many variables (e.g., location of use, population density beneath airspace, frequency of use, etc). However, the ejected debris, depending on the ejection system (either mechanical or pyrotechnic) consists of the chaff itself, possibly a cardboard box, which contains the chaff, flat plastic package stiffeners, a small plastic piston, and a small plastic end cap. Under normal circumstances, these elements weigh so little, or create so much drag in comparison to their weight, that no injury could occur, even if a person were impacted. No incidences of injuries from falling chaff debris have ever been recorded.

The major chemical constituents of RF chaff (see Appendices A, B and C) are similar to that of commonly occurring minerals and soils. Thus, based on the amount of chaff that is likely to be released by the military aircraft during training, and the spatial extent over which this would be spread, this activity would not have any significant environmental impact on the fauna and biota of the region.

2.6 Timeframe for Operational Activity

The Memorandum of Understanding governing foreign training at 5 Wing provides for “a flying training season of up to 36 weeks for each Participant within a 39 week window during the period 01 March to 30 November inclusive.” In practice, while active and intense training periods are generally confined to the period April to October of every year, there is an increasing amount of short-term flying training during the winter months. DND proposes that implementation of training with chaff be included for the balance of the current 2004 – 2005 training cycle, and beyond.

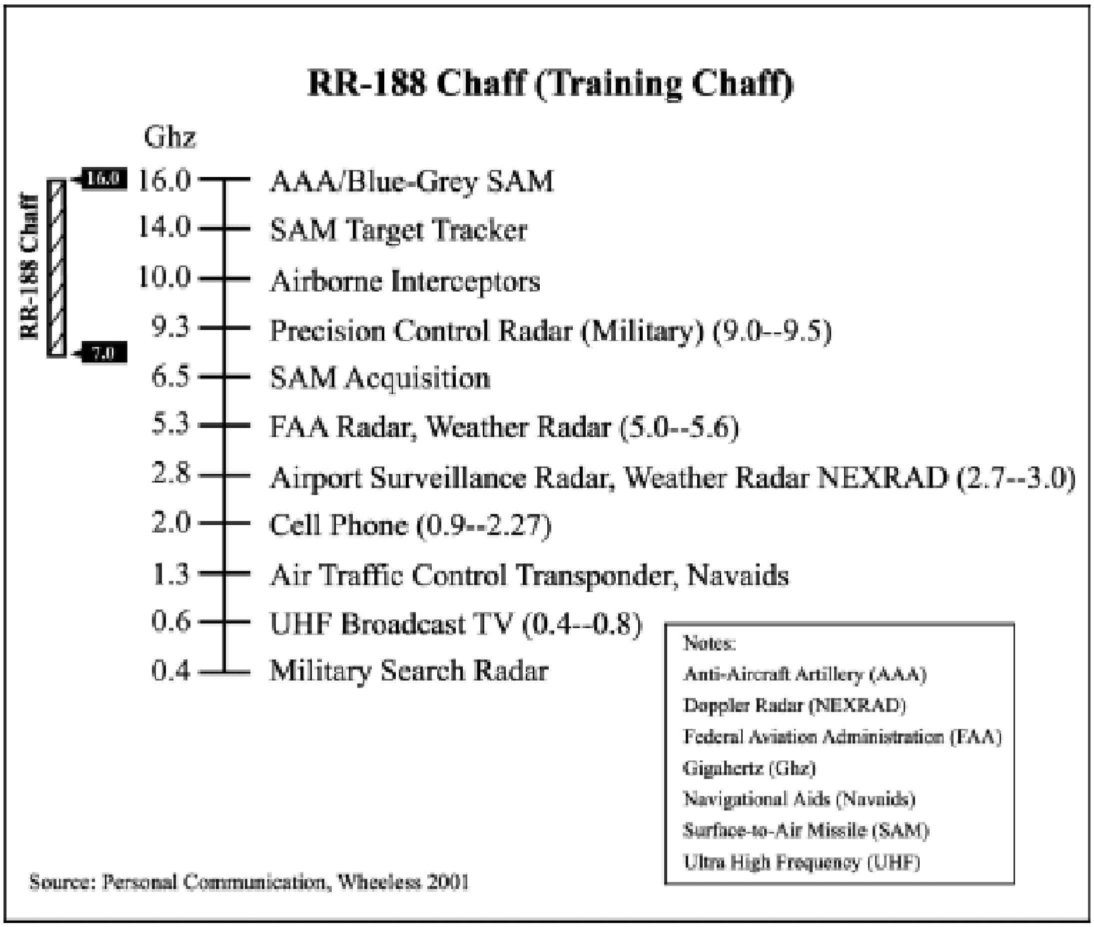
2.7 Implications on Civil Aviation

Military Control Centre (MCC) coordinates all military flights into the Military Training Area in accordance with visual and instrument flight rules and also acts as a liaison with locally based civilian air carriers. Operations staff at 5 Wing conducts a mass briefing for these air carriers annually in March, at which time all new activities relating to the military flying program and training areas are thoroughly described.

This undertaking will utilize the same airspace envelope currently authorized for foreign training. All of the restrictions on non-military airspace use that are currently in effect will remain, and no new airspace restrictions will be imposed.

The use of RF training chaff in the Military Training Area will not affect the command, control and communications capabilities of MCC, Nav Canada or the civilian air carriers. Nor will it obstruct in any manner commercial air traffic, weather radar systems or radio-telephone communications anywhere in the region. The following table indicates the assigned frequency spectrum for various communications equipment, in relation to the operating frequencies of the training chaff.

Table 3.2-1. Chaff Radar Frequency Coverage for RR-188 Chaff



2.9 Amendment to Military Flight Procedure

The proposed undertaking will not require any significant changes to existing mitigation, communications or coordination procedures.

3.0 ENVIRONMENTAL ASSESSMENT

3.1 Introduction

This section examines the potential interaction between the undertaking and the environment. Three resource categories were analysed to identify potential impacts:

- Physical resources (soils and water)
- Biological resources (vegetation and wildlife)
- Land use activity (Land management, use, and recreational resources)

Information from various sources has been utilized; these include: The Military Low Level Training Area Map MCE 820, 1:250K NTS sheets., and 1:50K NTS for selected area. The geomorphic and geological information has been derived from the topographic maps. This information has been supplemented with the Labrador Forest Inventory maps corresponding to each 1:50K NTS sheets produced by the Environment Canada. These maps were derived from the Landsat Thematic Mapper and provide information about the distribution of different types of land cover. For the sake of interpretation, some of the land cover categories have been merged. Additional information about the distribution of the different types of vegetation, as well as wildlife, has been obtained from the EIS (DND, 1994).

A great deal of the material used in the literature review is based on United States Air Force (USAF) reports, primarily because the preponderance of available data originates from that source. That documentation was helpful in identifying the issues and reviewing the various environmental impacts resulting from chaff.

Given the particular concern expressed by the Innu Nation on the use of chaff during the preparation of the Environmental Impact Statement (DND, 1994), DND opted to commission a parallel and independent study (Farrell and Scicilliano, 2004) to examine the specific environmental impacts that may be unique to the Goose Bay area (see Appendix A). While seemingly redundant to the reader, DND deemed it important to present an unedited text of that study report, as well as the in-house assessment presented in this section.

3.2 Issues and Concerns

RF training chaff is composed principally of inert materials, namely silica and aluminium, and does not contain any pyrotechnic materials. However, some varieties of chaff use a pyrotechnic initiation cartridge for ejection purposes. This device generates air emissions with potential air quality impacts. The chaff itself remains suspended in the air for a period, raising issues of air quality impacts, safety impacts from unintended interference with commercial air navigation radars or other radar or communications systems, safety risks to other aircraft engines, and impacts on birds and other fauna. Based on the nature and toxicity of the RF chaff constituents, there are concerns that its deposition may affect the physical and/ or chemical nature of the environment. Not all these pathways present significant risks, but they do require to be addressed in a comprehensive analysis.

If the chaff is deposited on terrestrial environment (land), then there are considerations that it may affect the nature of soils, and thus indirectly affect groundwater and vegetation. Issues concerning the toxic effects on wildlife through ingestion, inhalation, or dermal contact have been raised. Physical effects to be examined range from impacts on wildlife to impacts on land use and visual resources. Concerns on the aesthetics of an area by the accumulation of chaff, which could in turn affect certain types of land use, such as recreation, must be considered.

Chemical effects relate to the potential for chaff to cause chemical changes in the water and thereby affect water quality and biota. Physical effects pertain to accumulation of chaff particles and other debris either on the surface or on the bottom. This accumulation raises issues of potential effects on biota, habitat conditions, and aesthetics.

If the chaff is deposited on water (aquatic environment), the potential issues depend in part on whether the water body is the ocean or an inland water body, and then whether it is an enclosed body (pond or lake) or a running stream or river. If the body of water is a reservoir, issues of impacts on drinking water sources may also be raised.

Thus, primary areas of concern fall into one of two categories, namely the chemical effects and physical effects on the environment, and all of these concerns have been addressed in section 3 and appendices.

3.3 PHYSICAL RESOURCES

3.3.1 Geomorphology

The topography of the Military Training Area ranges from undulating to hilly with relatively large flat areas covered with various types of bogs. The area is punctuated by a number of small lakes and streams flowing to and from these lakes. In general, geomorphic features are oriented in NW-SE direction, and. most of these streams also flow to the southeast. A large water body, known as Churchill Reservoir is located in the northwestern part of the training area. There are quite a few broad U-shaped river valleys with more or less flat valley floors. The valley floor is covered with barren soil and/ or recent burns with few exceptions where trees of different types are present. Most of the region is covered with thin layer of glacial soils, with few outcrops (barren rocks). Small water bodies tend to occupy relatively flat areas, and are generally surrounded with bogs of various types (these have been classified in the Labrador Forest Inventory maps as -- open bog, string bog, tree bog, and wet sites). Some of the areas of recent burns have been re-vegetated.

3.3.2 Impacts on Soils and Water

The findings of the literature review on the potential impacts on soils and water resources are contained at Appendix C. Those effects are assessed as negligible, since chaff fibres would not accumulate to any significant extent on the surface of these resources. The chemical constituents of the RF chaff are chemically inert, and any accumulation of materials on soil surfaces would quickly decompose due to the humid conditions and acidity of the soils. The amount of chaff to be deployed in the area would not significantly alter the chemistry of the water bodies, and because there are no flammable components in the chaff, thus there are no chances of ground fires.

3.4 BIOLOGICAL RESOURCES

3.4.1 Vegetation

The Labrador Forest inventory maps provide information about the vegetation cover types. The land cover has been classified into 25 different categories, however in this report, the original land cover classes have been merged to produce composite and more descriptive land cover types. Further, some of the information about the nature and distribution has been corroborated from the study conducted for the EIS (DND, 1994). The land cover types used in this report are as follows (the original Environment Canada land cover types are given in parentheses):

- Spruce: (Heavily Stocked Spruce/ Fir Commercial Forest; Moderately Stocked Spruce/ Fir Commercial Forest; Sparsely Stocked Spruce (Sphagnum Cover) Non-Commercial; Sparsely Stocked Spruce (Lichen Cover) Non-Commercial; Immature Spruce/ Fir; Spruce/ Fir Regeneration)
- Hardwood: (Mixed wood Mature; Hardwood mature; Hardwood Successional; Hardwood Scrub)
- Barren Soil: (Lichen/ Barren Soil)
- Barren Rock: (Rock Barren)
- Recent Burn: (Lichen/ Recent Burn; Recent Burn)
- Bog: (Lichen Scrub/ Open Bog; Open Bog; String Bog; Tree Bog; Wet Sites)
- Cleared Land: (Cleared Land)
- Water: (Water Bodies)

The predominant land cover type is spruce forest, with varying degrees of density. In general, there is a greater diversity of land cover types particularly in the river valleys, where the valley floors is covered with thick soil, and this includes, patches of mixed-wood and deciduous forest, along with large areas of recent burn and barren soil. Moreover, depending upon the amount of precipitation received in the area, various parts of the stream bed are likely to be exposed and/ or covered with sand. Based on the amount of precipitation, these sand bodies (including sand bars) contain varying degree of moisture and are likely to be shifting, and thus providing a variety of land cover types. Around the small water bodies, there are a few bogs present as well.

Based on the total anticipated use of the RF chaff in the military training area, and the spatial extent over which it will be used, there is no impact on the vegetation due to the proposed activity.

3.4.2 Wildlife

A number of wildlife species are present within the boundaries of the proposed undertaking. The known wildlife species in the MTA (EIS, 1994) include the following:

a. Ungulates
   - Caribou
     - Migratory Caribou Herd-- George River Caribou Herd
     - Woodland Caribou – Red Wine Mountain Caribou Herd, Lac Joseph Caribou Herd, Other woodland caribou herd (Dominion Lake herd)
   - Moose

b. Fur-bearers

c. Birds
   - Raptorial Birds
   - Waterfowl

3.4.2.1 Species At Risk Considerations

The Species at Risk Act (Bill C-5) passed into law in 2002 “to prevent Canadian indigenous species subspecies and distinct populations of wildlife from becoming extirpated or extinct, to provide for the recovery of endangered or threatened species, to encourage the management of other species to prevent them from becoming at risk.” The Province of Newfoundland and Labrador also announced the provincial Endangered Species Act, identifying species at risk. The LLTA is known to contain some of these species and DND has put in place focused mitigation programs in consultation with the resource manager, where appropriate. These programs have served to gather significant wildlife population information in the region. DND will continue to work with the resource management agencies to prevent unacceptable impacts on particular species.

3.4.2.2 Wildlife Monitoring Activities

DND maintains an active wildlife monitoring program, designed to mitigate disturbance from aircraft noise over sensitive locations in the training area. This program is conducted in collaboration with IEMR, federal/provincial wildlife management agencies, as well as environmental consultants. Temporal and spatial data are collected through a series of real-time, or near real-time data-gathering programs specific to individual species. Extensive use is made of remote monitoring technology such as radio and satellite telemetry and aerial surveys for most of the monitoring programs.

The concept for wildlife mitigation is based on temporal and spatial separation between the flying activity and sensitive areas to ensure that the acoustic effects threshold (where significant effects may be expected to occur) is not exceeded. Each sensitive species is protected using pre-established criteria for avoidance; these are updated as additional information becomes available, through consultation with the resource management agencies and the IEMR.

3.4.3 Potential Impacts on Wildlife

The primary pathways for potential effects of chaff on biological resources include inhalation, ingestion, and direct body contact. Chemical alteration of soil and/or water resulting from chemical decomposition of chaff could also affect vegetation and aquatic life. Considering the physical and chemical characteristics of chaff, methods of employment, and the habitat requirements and sensitivities of biological resources, the following issues have been identified and addressed regarding the potential effects of chaff on biological resources:

- Startle effects on birds and other wildlife (behavioural response).
- Ingestion effects on wildlife (physiological response).
- Inhalation effects on wildlife (physiological response).
- Physical effects from external contact (physiological response).
- Interference with wildlife activities (behavioural/physiological response).
- Chemical effects on plants through soil (physiological response).
- Chemical effects on aquatic life (behavioural/physiological response).

Startle Effects— Military overflights often elicit startle responses from a wide variety of animals. Release of chaff from these aircraft could contribute minimally to that response. However, any sudden release of chaff would be accompanied by noise and visual effects of the aircraft dispensing the chaff, which would be more likely to elicit a response than the chaff itself Therefore, this issue was not addressed further.

Ingestion Effects— Selective ingestion of chaff does not appear likely, but inadvertent consumption of chaff fibres could occur during normal feeding activities by grazing animals, waterfowl, or aquatic organisms in areas beneath or downwind of locations where chaff is released during military aircraft operations. The primary issues include potential for toxic effects, disruption of digestive processes (e.g., blockage of the gastrointestinal system), and irritation of digestive membranes.

Chaff on dry land would tend to be blown about by wind, trapped by rocks and vegetation, and generally subject to disintegration due to abrasion from surface features. In contrast, chaff fibres that land on standing water could float and potentially accumulate on the leeward side of the water body, with little fragmentation due to abrasion. Because floating material (e.g., algal mats, wood, etc.) tends to accumulate on the leeward side of standing water bodies, surface-feeding animals also generally feed in those areas. Clumps of chaff within other debris could be ingested by surface-feeding ducks.

Inhalation Effects— Inhalation of chaff fibres could occur during chaff releases as the fibres drift to the ground or whenever wind or other activities resuspend them in the air. Chronic inhalation of chaff could cause an inflammatory response in the respiratory system, potentially resulting in silicosis. The diameter and length of the fibres is important in determining how far into the respiratory system they could penetrate and how easily they could be cleared out.

Physical Effects— Chaff is similar in form to fine human hair. Due to its flexible nature and softness, external contact with chaff would not be expected to adversely affect most wildlife. The hair or feathers covering wildlife bodies and their hooves or tough foot pads would minimize the potential for direct skin contact with chaff fibres. Consequently, it is very unlikely that chaff could become embedded in the skin and/or feet of most animals. It is possible, however, that chaff fibres on the ground or on plants could be picked up and used by birds and burrowing rodents in their nests. Since the young of these species have bare skin when they are born, the chaff fibres could cause skin irritation.

Interference with Wildlife Activities— Fairly dense clouds of falling chaff or clumps of chaff that did not deploy correctly could temporarily affect flying bats by creating clutter that could confuse them when using echolocation to avoid obstacles and to hunt for insects. Accumulation of chaff on the ground or on surface waters could cause wildlife to avoid these areas for foraging.

Chemical Effects on Plants— Chemical decomposition of chaff could have localized effects on soil chemistry from aluminium, silicon dioxide, stearic acid, or trace constituents in the chaff.

Chemical Effects on Aquatic Life— Chemical changes in surface waters as a result of chaff deposition are expected to be negligible. Natural concentrations of aluminium in fresh water bodies have been reported as high as 10 mg/litre. Only in acidic waters would dissolution of the aluminium in chaff be expected.

Previous studies have been conducted to address ingestion effects of chaff on animals. Cattle and goats apparently avoided eating clumps of chaff placed in their feed. Calves fed chaff in dry meal would consume the chaff only when it was coated with molasses and thoroughly mixed into the meal. A similar study using cattle and goats found that the animals avoided consuming intact chaff. No information was found documenting ingestion of chaff by terrestrial wildlife, waterfowl, or aquatic organisms in the wild.

Toxicity of the various chemical components of chaff (primarily aluminium, silicon dioxide, and stearic acid) have been addressed above. The data indicate that some components could be toxic to biological resources under certain conditions. Oral toxicity of aluminium is very low in animals, and silicon dioxide is inert. Stearic acid is a natural compound that can be metabolized by animals. High concentrations may be toxic, but the small amount present on chaff fibres would not cause toxic effects. No evidence of digestive disturbance or other clinical symptoms were observed in calves fed chaff. The experimental and control groups gained weight at the same rate, and blood samples showed no deviation from normal. Postmortem examinations of the digestive system and major organs showed no lesions of pathological significance that could be attributed to chaff.

Exposure of six marine organisms from Chesapeake Bay to chaff resulted in no significant increases in mortality for any of the species. The animals used were a benthic polychaete worm (Nereis succine), various life stages of the American oyster (Crassostrea virginica), the blue mussel (Mytilus edulis), the blue crab (Callinectes sapidus), the filter-feeding menhaden (Brevoortia tyrannus), and the killifish (F'unduhs heteroclitus). In the same study, Chesapeake Bay water spiked with chaff found no appreciable increase in the levels of aluminium, cadmium, copper, iron, or zinc after 13 days.

No reports were found documenting ingestion of chaff by waterfowl or aquatic organisms in nature. Nor were any studies found that addressed effects of chaff ingestion by waterfowl under laboratory conditions. No reports were found addressing effects of chaff on water quality in freshwaters, particularly acidic waters in bogs or lakes affected by acid rain.

Inhalation of chaff fibres is not expected to have any adverse effects on terrestrial wildlife due to the size of the fibres. A study on the potential for inhalation by livestock and humans showed that the chaff fibres are too large to penetrate the larynx and would be expelled through the nose or swallowed. No evidence of chaff affecting vegetation through changes in soil chemistry was found during the literature review. Plant tissues normally contain approximately 29 to 1,400 ppm of aluminium, depending on the species and location. Any uptake of aluminium attributed to the presence of chaff in the soil would be negligible.

3.4.3.1 Discussion

The literature review revealed that few conclusive studies concerning the effects of chaff on wildlife have been conducted. The two studies on the effects of chaff ingestion on cows concluded that chaff presented no health hazards to farm animals, while a study on the effects of chaff on the Chesapeake Bay ecosystem concluded that there were no environmental impacts from chaff on that system. There were no data describing the decomposition process for chaff under a variety of environmental conditions (e.g., arid, alkaline, wet, acidic, and anaerobic) or within the digestive systems of various animals.

Although the field surveys performed were of a limited duration and scope, areas selected for survey were chosen specifically to include locations with a high use of chaff. The areas were chosen to increase the probability that any potential wildlife use of chaff debris would be found. The field observations and results of laboratory analyses of soil samples allow a number of conclusions to be drawn regarding the effects of chaff use on wildlife.

Decomposition of chaff in aquatic environments is expected to have no adverse impacts on water chemistry and aquatic life. In alkaline to neutral waters, decomposition would be very slow. Under acidic conditions, decomposition would be faster, but the small amount of chaff expected to accumulate in the water would produce an incremental increase in aluminium relative to natural sources in these waters. No data are available to assess the decomposition rate under anaerobic conditions found at the bottom of some water bodies. However, the amount of chaff expected to accumulate in these areas is low, and the released chemicals would mix with those released from other sources in these waters. Aquatic life, other than anaerobic bacteria, would not be exposed to the released chemicals until the anaerobic waters mixed with aerobic waters. Such mixing would dilute the chemicals (from chaff along with all other sources), and no toxic effects would be expected from the chaff chemicals.

Based on the field survey results, chaff on land would generally be subject to disintegration due to abrasion from surface features in arid areas and chemical processes in wet, acidic environments. In wet temperate areas, vegetative growth and leaf litter would also cover chaff debris. Both aluminium and silica are major constituents of the earth's crust and occur commonly in soils. Silicon dioxide is inert and would have no effect on soils. Metallic aluminium oxidizes and combines chemically to form oxides, sulfides, and metallic salts. Aluminium and most of its common compounds are insoluble except in acidic conditions. Stearic acid is a natural compound that is biodegradable and is used as a carbon source for microorganisms in many laboratory experiments.

In arid areas, the slow chemical decomposition of chaff is expected to have no adverse effects on soil chemistry and plant growth. In wet, acidic environments, chemical decomposition is more rapid, but no adverse effects are predicted for several reasons. The small quantity of chaff accumulating on the ground would release minute amounts of chemicals (primarily aluminium and silicon dioxide) that are abundant in soils. The trace amounts of other chemicals in the fibres would be released in such small quantities that no effects would occur.

The dispersal and decomposition of chaff fibres on land would limit the exposure of grazing animals to chaff, making it unlikely that ingestion of quantities large enough to have adverse physiological effects would occur. Plastic caps and cartridges are not likely to be eaten by wildlife and would have no effect on them.

Animals are unlikely to inhale chaff particles during chaff releases as the filaments drift to the ground, due the size of the fibres and to the dispersal of the fibres in the air. Once on the ground, chaff fibres would tend to break up when agitated by wind or water or when crushed by the movements of humans, animals, or machinery. Any activity that would stir up dust could potentially resuspend the shorter chaff particles, rendering them available for inhalation by animals. Due to the diameter and length of the filaments, chaff would not penetrate far into the respiratory system and would be easily cleared out. Relative to the background concentrations of dust in the air, the amount of additional particles contributed by chaff fibres would be negligible, and no adverse effects on wildlife would be expected from inhalation of the fibres.

The low visible accumulation of chaff fibres on the ground, even in arid environments, makes it unlikely that wildlife would have enough direct contact to cause any skin irritation. Low visibility and low concentrations would also limit the likelihood of selective collection of chaff fibres for nesting material. Thus, exposure of young with no hair or feather covering to chaff fibres would be minimal.

The potential for chaff accumulation on the surface of standing water bodies would depend on site-specific conditions. For small standing water bodies not subject to wind chop, surface tension would tend to make chaff float longer than on larger water bodies such as lakes and rivers. Chaff fibres that land on standing water and float could potentially accumulate on the leeward side of the water body. It is likely that wildlife would avoid ingesting chaff, if possible, due to its unnatural appearance, but if a large quantity of chaff were mixed with plant material, it could be consumed by an animal while ingesting the vegetative matter. Thus, a surface-feeding or bottom-feeding animal might ingest chaff.

While some birds have developed gizzards that use ingested sand as a digestion aid, the gizzards of surface-feeding ducks are not effective in dealing with such foreign materials. In addition, while some bird species routinely regurgitate hair, feathers, and other foreign material commonly ingested during feeding, surface-feeders do not have this ability.

Ingested chaff would likely pass through the duck's digestive system as does fibrous plant material and not be harmful to the duck. However, if compaction of the chaff occurred in the gizzard, blockage of the digestive system could occur. Although individual animals could be affected, the number of incidents would be too low to impact species population. Impacts would be insignificant unless a protected species were affected.

This is a site-specific issue that could be of concern in areas where large quantities of chaff are dispensed over aquatic habitats heavily used by waterfowl. Impacts on aquatic species is a concern for waterfowl, particularly migratory species that are facing population declines as a result of habitat degradation or loss. It is also a concern where state or federally listed threatened or endangered species use the water bodies.

Chaff interference with wildlife activities is expected to be negligible based on information about chaff use, characteristics of chaff, and field observations of chaff accumulation. Any effects on bats would be short term because chaff dissipates in the air (i.e., is dispersed by winds and settles to the ground) and because the bats would recover quickly from the confusion. Bats would not likely misinterpret the chaff particles as insects and so would not be likely to consume them. Since there is no evidence of heavy accumulation of chaff on the ground or water, even in heavy use areas, avoidance of foraging areas by wildlife due to chaff is unlikely.

3.5 Assessment of Valued Ecosystem Components (VEC) Vulnerability

Based on the non-toxicity of chaff and the lack of potential risk of fire, the effects on vegetation, wildlife, and special-status species would be negligible. All types of sensitive species closures that are currently applied will remain effective with this new undertaking. The wildlife is protected either by spatial separation or altitude restrictions. Thus, impacts to wildlife from startle effect would not be expected due to chaff deployment. Wetlands are not expected to be impacted by residual components of chaff due to the large size of the training area used for deployment and the extremely low potential for accumulation of components in any one area. No impacts to these resources are expected under the proposed action and action alternatives.

The main source of disturbance to wildlife within the training area consists of noise and visual stimuli associated with the low-level aircraft. The new undertaking would not increase the noise levels. Moreover, along with this new training element, DND expects that there may be a growing shift away from low-level training to altitudes greater than 1000ft AGL.

In summary, the new undertaking will result in:

- no negative effects on the health of biota including plants, animals, and fish;
- no threat to rare or endangered species;
- no reductions in species diversity or disruption of food webs;
- no loss of or damage to habitats, including habitat fragmentation;

- no significant discharges or release of persistent and/or toxic chemicals, microbiological agents, nutrients (e.g., nitrogen, phosphorus), radiation, or thermal energy (e.g., cooling wastewater);
- no population declines;
- no loss of or damage to commercial species;
- no removal of resource materials (e.g., or resources; peat, coal) from the environment;
- no transformation of natural landscapes;
- no obstruction of migration or passage of wildlife;
- no significant negative effects on the quality and/or quantity of the biophysical environment (e.g., surface water, groundwater, soil, land, and air).

3.5 Human Land Use Activities

The principal resource users in the area are the Innu, Inuit, Métis, Settlers and other Labrador residents, visitors/tourists and clients to outfitting operations. Much of the activity is for subsistence or recreational purposes, with some commercial/business interests (e.g., caribou harvest, trappers and adventure and nature tourism operators). Industrial operations include hydro power generation/ transmission and development, some forest harvesting and the construction of the Trans-Labrador Highway.

3.6 Protection of Human Occupancy Areas

DND maintains an active monitoring and mitigation program in the LLTA. It remains aware of the human occupancy areas through its community liaison program and consultations with interested groups. The human occupancy areas are protected from aircraft overflights by environmental closures that are based on the noise threshold values, as well as on special considerations and direct consultations with regard to traditional land use. As an additional precaution in the context of chaff use, DND intends to maintain the current lateral separation specified in the environmental closure criteria (generally 2.5 nm, unless special provisions are arranged), while increasing the vertical separation to 2000 feet AGL.

With the avoidance measures in place, human occupancy may be negligibly affected due to rare sightings of chaff residual components (i.e., end caps).

3.7 Aboriginal Land Issues

The Department of National Defence has publicly committed to respect aboriginal land title as regards the use of land associated with the allied training activity in Goose Bay. Most of the land over which the proposed activity will take place is the subject of comprehensive land claims negotiations affecting two aboriginal groups. DND is engaging in technical discussions with the Innu Nation on chaff and other future training requirements and, once land claims are resolved, will conclude mutually agreeable arrangements as regards this activity over their land.

4.0. ENVIRONMENTAL MANAGEMENT

4.1 General

DND maintains a high standard of environmental management associated with the training activities in Goose Bay. A fully-functioning and certified (ISO 14001) Environmental Management System (EMS) governs the conduct of the activity to safeguard the environment. The FMTGB mitigation program benefits from its association with the provincial wildlife agencies of both provinces, the Institute for Environmental Monitoring and Research and other partnerships it has developed over the last ten years. National Defence will continue its monitoring program of the entire training area for as long as the allied forces train in Goose Bay. The public can access copies of the annual Environmental Report and Mitigation Program, the EMS, Mitigation Orders, study reports and other material directly from the FMTGB website (www.goosebay.org).

4.2 Avoidance Criteria

Avoidance criteria are the standard applied to establish protection areas for sensitive locations, and to exclude jet training activity. The criteria were initially developed in the early phase of the mitigation program, during the preparation of the EIS. At the time, the potential for impacts that might result from jet overflights at low-level was poorly understood. Avoidance criteria were based largely on perception and the adaptation of existing aeronautical restrictions. However, the scientific knowledge base has improved considerably, resulting in some changes to the criteria over the years. Some of these were based on work by the IEMR, which has conducted research focused specifically on the effects of military flight activity. To date, results of these studies clearly indicate that actual impacts of the training activity on the environment are minimal. Avoidance criteria are outlined in the FMTGB Mitigation Orders, available online.

4.3 Environmental Monitoring, Mitigation and Follow-up

Environmental monitoring and follow-up is an important part of the environmental assessment process, providing a means for verifying environmental effects predictions and examining the effectiveness of mitigation measures. It also provides assurances that environmental legislation, standards and commitments are being followed. Any environmental problems identified through a monitoring or follow-up program can be addressed in an effective and timely manner.

Based on the various considerations arising from the use of chaff in the 5 Wing training activity, DND proposes to implement the following measures within the mitigation program:

- only training chaff will be authorized for use in allied training;

- RF training chaff will only be deployed within the Labrador portion of the Military Training Area;

- to preclude any public concern, chaff will not be used within two areas of human concentration - a 25 nautical mile radius around the Goose Bay airport and a 16 nm radius around Churchill Falls;

- the existing FMTGB monitoring program and the associated environmental closures (within which aircraft are not authorized to fly) will also safeguard those sensitive areas form any flare use activity;

- the avoidance criteria currently in effect to safeguard sensitive wildlife locations will be sufficient to mitigate any risk of adverse impacts - the predicted toxicological effects on fauna are negligible;

- The closures for human activity, as currently defined for noise disturbance, but with an increased vertical separation to 2000 feet AGL, are deemed sufficient to preclude any risk to public safety, which has already been categorized as minimal or non-existent;

- given that no particular hazards are associated with the actual deployment of chaff, no operating altitude restrictions will be imposed on chaff use, other than in the identified environmental closures. Chaff may be used at all authorized training altitudes;

- DND will implement a periodic sampling program at selected locations to verify the validity of the predictions in this EA and will inform the IEMR of its findings; and

- Allies will maintain and submit records regularly to FMTGB via MCC on utilization (quantity/area) and incidents involving chaff – these records will be used to support research studies and to determine if other corrective measures are warranted in the future. DND will include information about quantity of chaff used and any related incidents in the annual report to the Province and the IEMR on FMTGB chaff use; and

- DND will expand its communications activity to include information on the use of chaff, the possible sighting of material on the ground and the fact that there is no risk to the environment or to public health and safety.

4.4. Site remediation

Based upon the annual usage of chaff and the area over which it will be distributed, chaff residual components are not expected to accumulate on soil or water surfaces, or change the chemistry of soil or water properties. Therefore, management and use of the lands would not change from existing conditions and no site remediation is required.

4.5 Cumulative Environmental Effects

Individual effects can combine and interact, resulting in cumulative environmental effects that may be different in nature or extent from the effects of individual activities. Cumulative environmental effects may result in combination with other projects or activities that have been or will be carried out. Cumulative environmental effects were considered for each of the VECs within the FMTGB monitoring program, according to

- spatial and temporal boundaries;
- interactions among the project's environmental effects;
- interactions between the project's environmental effects and those of both existing and planned projects and activities;
- mitigation measures used towards achieving a no-net-loss or a net-gain outcome.

First, in the context of the existing activity, the addition of training chaff will produce a net-gain environmentally. Generally, the introduction of defensive countermeasures, including chaff and flares, will tend to raise the altitude level at which training is conducted, thereby reducing the intensity of the aircraft noise dosage, which remains the primary concern associated with military training. Additional altitude restrictions are also being imposed to control the specific use of both chaff and flares. While chaff material will be deployed from the aircraft, even the worst-case scenario, depicted in Appendix A (which hypothesizes that all the chaff material would be released within a 16 nm radius of the PTA), is predicted to result in a deposition rate of 3.56 kg km^{-2} per year, which would have 'negligible' adverse environmental or health impact. There is no habitat modification or construction involved in this undertaking.

In addressing cumulative effects, the foremost consideration is that the existing mitigation program operates on a dynamic spatial and temporal basis, which precludes the risk of environmental impact by separating the activity from the seasonally-changing sensitive locations on the ground. Most of the other projects are based along the Churchill Falls corridor, or other road access, which are areas of relatively minor jet traffic. While the training area may encompass sites where other project activities exist or are planned, those sites will be avoided when occupied. The potential therefore, for physical or environmental interaction, given the nature of this undertaking, is minimal.

In the event that an environmental impact, direct or cumulative, were to arise, it would logically be detected through the ongoing monitoring programs, and appropriate measures taken to correct the situation, including the possibility of limiting or discontinuing the use of chaff.

Appendix D provides the existing (baseline) environment description for the principal VECs identified within the FMTGB Environmental Management System (EMS); it reflects the effects of past and ongoing human activities, including military flying, on the region's natural environment. Where appropriate, the current status of the VEC due to natural and/or anthropogenic factors is indicated (e.g., a statement is made as to whether a VEC population is declining, stable or increasing).

4.6 Consultations and Communications

Generally, most of the communications relating to this undertaking have occurred within the context of the DND's participation in the work of the IEMR, which has representation from all of the major stakeholders and aboriginal communities in the region. This interaction has occurred at the Board of Directors level, as well as within the Institute's Scientific Review Committee (SRC) forum, in which FMTGB has ex officio status. An initial presentation on the use of chaff and flares, as well as other possible future training requirements, was made at a full-day symposium dedicated to this topic, in conjunction with a Board meeting in Happy Valley-Goose Bay in September 2001. In November 2003, DND made another more detailed presentation in St. John's to update invited representatives from interested federal/ provincial departments and Innu Nation on future training requirements, including chaff and flares.

Early in 2004, DND provided CD copies of the reference material to the IEMR and the Province. In March 2004, the draft screening document on chaff use was made available for review by the SRC

In May 2004, DND concluded an MOU with the Innu Nation which, among other provisions, outlines the mechanism and DND support for consultations in these matters. Arrangements are in place for a meeting of a Technical Committee coincident with the provincial registration of this document.

4.7 Applicable Regulations and Processes

Control and coordination of commercial air navigation and communications is a federal responsibility under Nav Canada. Personnel from its Operations and Technical support, as well as from frequency spectrum analysis, were consulted by DND. Nav Canada have confirmed that the use of training chaff in the training area would not interfere with air traffic control or communications and that there are no objections to its use.

A review of CEAA legislation indicates that "use of air defense countermeasures chaff" for training activity does not constitute a project under any of the various provisions of the Act. As well, it does not constitute a "designated undertaking or exception" under Part III of the Province's Environmental Assessment Regulations 2000.

The Department of National Defence is committed to environmental stewardship and, as such, has a policy of conducting "due diligence" screenings to identify and mitigate any potential adverse impacts before a new activity is approved. Foreign Military Training Goose Bay also received ISO 14001 certification in 2003, which commits that activity to rigid environmental standards and external audit of its practices.

4.8 Project Related Options

Should it be determined that the undertaking cannot proceed, individual air forces will make their own determination on the value of the training offered at Goose Bay. This proponent will not pursue the undertaking, or some form of it, elsewhere.

4.9 Project Related Documents

Over the last year, FMTGB has conducted an extensive literature search on the subject of chaff and flares and in the process, has compiled a considerable library of reference material, which it has made available in CD format to provincial officials, the IEMR and interested aboriginal groups. Documents from the following list may be obtained from the DND contact officer:

Arfsten, D.P., and others, 2001; -- Characterization of the Ecotoxicity of Five Biodegredable Polymers Under Consideration by Navair for use in Chaff-Dispensing Systems, Report Prepared for Jon R. Trudel, U.S. Navy Naval Air Systems, Report No. TOXDET-01-03, Naval Health Research Center Detachment (Toxicology), Wright-Patterson Air Force Base, Ohio.

Barrett, B.B., and R.R. MacKay, 1972; The Ingestion of fiberglass chaff by cattle: Health of Animals Branch, Canada Department of Agriculture, March 1972.

Block, R.M., and S.C. Schiff, 1977; Effects of Aluminized Fiberglass on Representative Chesapeake Bay Marine Organism: Report by Systems Consultants, Inc., Prepared for Naval Research Laboratory, Washington, D.C.

Brunk, J., and others, 1972; Chaff Aerodynamics, Alpha Research, Incorporated, Prepared for: Air Force Avionics Laboratory, November 1975.

Carpenter, R.L., and C.L. Wilson, 1999; The Inhalation Toxicity of Glass Fibers – A Review of the Scientific Literature, Interim Report No. TOXDET 99-7, Naval Health Research Center Detachment (Toxicology), Wright-Patterson Air Force Base, Ohio.

Cataldo, D.A., and others, 1992; Environmental and Health Effects Review for Obscurant Fibers/ Filaments; Chemical Research, Development and Engineering Center, CRDEC-CR-126, U.S. Army Armament Munitions Chemical Command, January 1992.

Farrell, R.E., 1998; Environmental Degradability and Ecotoxicity of Chaff Fibers – Uncoated and Aluminum-Coated Degradable Vitreous Oxide (DVO) Chaff; Final Report, Contract No. DAANO2-98-P-8713, University of Saskatchewan.

Haley, M.V., and Kurnas, C.L., 1992; Aquatic Toxicity and Fate of Iron- and Aluminum-Coated Glass Fibers: Chemical Research, Development and Engineering Center, CRDEC-TR-422, U.S. Army Armament Munitions Chemical Command, September 1992.

Haley, M.V., and Kurnas, C.L., 1993; Aquatic Toxicity and Fate of Nickel Coated Graphite Fibers, with Comparisons to Iron and Aluminum Coated Glass Fibers: Edgewood Research, Development and Engineering Center, ERDEC-TR-090, U.S. Army Chemical and Biological Defense Agency, July 1993.

National Guard, 1990; Environmental Effects of Air National Guard Chaff Training Activities; National Guard Bureau, Environmental Division (NGB/DEV), Andrews Air Force Base, Maryland, November 1990.

Panel Report, 1999; Environmental Effects of RF Chaff --- A Select Panel Report to the Undersecretary of Defense for Environmental Security, Naval Research Laboratory, NRL/PU/6110—99-389, August 1999.

US GAO, 1998; Report to the Honorable Harry Reid, U.S. Senate, Environmental Protection – DOD Management Issues Related to Chaff; U.S. General Accounting Office, GAO/ NSIAD-98-219, September 1998.

USAF, 1978; Environmental Effects of Chaff; USAF Occupational and Environmental Health Laboratory, Aerospace Medical Division (AFSC), Brooks Air Force Base, Texas, December 1978.

USAF, 1993; Technical Reports on Chaff and Flares: Technical Report No. 1 – Review of Available Data, Prepared for U.S. Air Force, Headquarters Air Combat Command, Langley Ai Force Base, Virginia, March 1993.

USAF, 1994; Technical Reports on Chaff and Flares: Technical Report No. 5 – Laboratory Analysis pf Chaff and Flare Materials, Prepared for U.S. Air Force, Headquarters Air Combat Command, Langley Ai Force Base, Virginia, November 1994.

USAF, 1997; Environmental Effects of Self-Protection Chaff and Flares, Final Report, Prepared for: U.S. Air Force, Headquarters Air Combat Command, Langley Air Force Base, Virginia, August 1997.

USAF, 2001; Characteristics of chaff – appendix from the Defensive Training Initiative, Cannon Air Force Base, New Mexico: Prepared for: Air Combat Command, Langley Air Force Base, Virginia, September 2001.

USAF, 2001; Final Environmental Assessment for the Defensive Training Initiative, Cannon Air Force Base, New Mexico: Prepared for: Air Combat Command, Langley Air Force Base, Virginia, September 2001.

USAF, 2001; Elmendorf Air Force Base – Initial F-22 Operational Wing Beddown, Draft Environmental Impact Statement, April 2001.

USAF, 2003; Draft: Shaw AFB Chaff and Flare environmental assessment: United States Air Force, Air Combat Command, Shaw Air Force Base, October 2003.

Wilson, C.L., and others, 2000; Estimation of Aluminum Contributions of U.S. Navy Flight Training Operations in the Chesapeake Bay, Report No. TOXDET-00-4; Naval Health Research Center Detachment (Toxicology), Wright-Patterson Air Force Base, Ohio.

The following documents provide project information relevant to the training activity, National Defence Regulations, Orders and Procedures and previous associated environmental assessments:

- An Environmental Impact Statement on Military Flying Activities in Labrador and Eastern Quebec (DND, 1994)
- Transfer Administration and Control of Crown Land To Her Majesty The Queen in Right of Canada, 01 June 1995 (Lease Agreement) between DND and the Province of Newfoundland
- Wing Flying Orders – 5 Wing Goose Bay and 4 Wing Cold Lake
- Mitigation Orders for Foreign Military Training in Goose Bay

5.0 CONCLUSION

The foreign military training presence at Goose Bay has long been a “way of life” and a primary source of economic activity for the region. With time and advancing technology, the flying training requirements keep evolving to meet changing operational demands. The use of defensive countermeasures is a standard training requirement for operational air forces.

This undertaking presents no significant adverse environmental impacts. On the other hand, its rejection could have major socio-economic consequences for the region.

6.0 APPROVAL OF THE UNDERTAKING

The following permits and approvals may be required to commence training with Air Defense Countermeasures Chaff at 5 Wing Goose Bay Military Training Area.

Table 6.1 Permits, Approvals and Authorizations

Provincial, Permit, Approval or Authorization	Agency
Release from Newfoundland Environmental Assessment Act	Department of Environment

7.0 FUNDING

There are no incremental funding commitments anticipated for this undertaking. The Department of National Defence would assume any costs that may arise, consistent with arrangements established in a Memorandum of Understanding with participating air forces.

7.1 Signature

Colonel J. Hincke
Director Air Contracted Force Generation
National Defence Headquarters

Appendix A

Environmental Effects of Radio Frequency (RF) Chaff Released during Military Training Exercises: A Review of the Literature

"Environmental
Effects of Radio Freq

Errata: At page 4, the size of the 4nm radius Practice Target Area indicated is incorrect. The 2,000 km^2 area relates to the larger (16 nm) Safety Template Area surrounding the PTA

Appendix B

COMPOSITION, OPERATION AND TOXICITY OF TRAINING CHAFF

B1.0 CHAFF COMPOSITION

The RR-188 chaff used during training consists of extremely small strands (or dipoles) of an aluminium-coated crystalline silica core. The chaff components (silica, aluminium, and stearic acid) are generally prevalent in the environment. Silica (silicon dioxide) belongs to the most common mineral group, silicate minerals. Silica is inert in the environment and does not present an environmental concern with respect to soil chemistry. Aluminium is the third most abundant element in the earth's crust, forming some of the most common minerals, such as feldspars, micas, and clays. Natural soil concentrations of aluminium ranging from 10,000 to 300,000 parts per million have been documented. These levels vary depending on numerous environmental factors, including climate, parent rock materials from which the soils were formed, vegetation, and soil moisture alkalinity/acidity. The solubility of aluminium is greater in acidic and highly alkaline soils than in neutral pH conditions. Aluminium eventually oxidizes to Al_2O_3 (aluminium oxide) over time, depending on its size and form and the environmental conditions. Stearic acid is an animal fat that degrades when exposed to light and air.

The chaff fibres have an anti-clumping agent (Neofat – 90 percent stearic acid and 10 percent palmitic acid) to assist with rapid dispersal of the fibres during deployment (Air Force 1997). Chaff is made as small and light as possible so that it will remain in the air long enough to confuse enemy radar. The chaff fibres are approximately the thickness of a human hair (i.e., generally 25.4 microns in diameter), and range in length from 0.3 to over 1 inch. The weight of chaff material in the RR-188 cartridge is 95 grams (Air Force 1997).

A single bundle of chaff consists of the filaments in an 8-inch long rectangular tube or cartridge, a plastic piston, a cushioned spacer and a 1-inch by 1-inch plastic end cap that falls to the ground when chaff is dispensed. The spacer is a spongy material (felt) designed to absorb the force of release. Figure 1 illustrates the components of a chaff cartridge. Table 1 lists the components of the silica core and the aluminium coating. Table 2 presents the characteristics of RR-188 chaff.

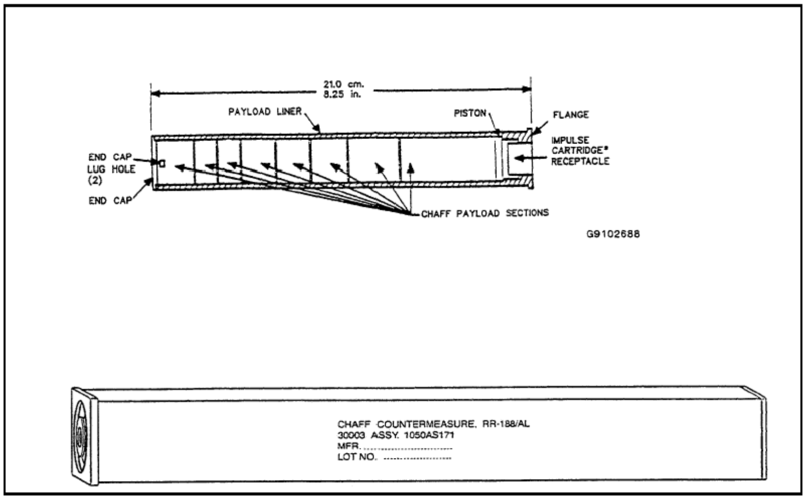


Figure 1. Diagram showing RR-188 Chaff Cartridge.

Table 1. Components of RR-188 Chaff

Element	Chemical Symbol	Percent (by weight)
Silica Core		
Silicon dioxide	SiO_2	52-56
Alumina	Al_2O_3	12-16
Calcium Oxide and Magnesium Oxide	CaO and MgO	16-25
Boron Oxide	B_2O_3	8-13
Sodium Oxide and Potassium Oxide	Na_2O and K_2O	1-4
Iron Oxide	Fe_2O_3	1 or less
Aluminum Coating (Typically Alloy 1145)		
Aluminum	Al	99.45 minimum
Silicon and Iron	Si and Fe	0.55 maximum
Copper	Cu	0.05 maximum
Manganese	Mn	0.05 maximum
Magnesium	Mg	0.05 maximum
Zinc	Zn	0.05 maximum
Vanadium	V	0.05 maximum
Titanium	Ti	0.03 maximum
Others		0.03 maximum

Source: Air Force 1997

Table 2. Characteristics of RR-188 Chaff

Attribute	RR-188
Aircraft	A-10, F-15, F-16
Composition	Aluminum coated glass
Ejection Mode	Pyrotechnic
Configuration	Rectangular tube cartridge
Size	8 x 1 x 1 inches (8 cubic inches)
Number. of Dipoles	5.46 million
Dipole Size (cross-section)	1 mil (diameter)
Impulse Cartridge	BBU-35/B
Other Comments	Cartridge stays in aircraft; less interference with FAA radar (no D and E bands)

B1.2 CHAFF EJECTION

Chaff is ejected from aircraft pyrotechnically using a BBU-35/B impulse cartridge. Pyrotechnic ejection uses hot gases generated by an explosive impulse charge. The gases push the small piston down the chaff-filled tube. A small plastic end cap is ejected, followed by the chaff fibres. The plastic tube remains within the aircraft. Debris from the ejection consists of two small, square pieces of plastic 1/8-inch thick (i.e., the piston and the end cap) and the felt spacer. Table 3 lists the characteristics of BBU-35/B impulse cartridges used to pyrotechnically eject chaff.

Upon release from an aircraft, chaff forms a cloud approximately 30 meters in diameter in less than one second under normal conditions. Quality standards for chaff cartridges require that they demonstrate ejection of 98 percent of the chaff in undamaged condition, with a reliability of 95 percent at a 95 percent confidence level. They must also be able to withstand a variety of environmental conditions that might be encountered during storage, shipment, and operation.

Table 3. BBU-35/B Impulse Charges Used to Eject Chaff

Component	BBU-35/B
Overall Size Overall Volume Total Explosive Volume	0.625 inches x 0.530 inches 0.163 $inches^3$ 0.034 $inches^3$
Bridgewire	Trophet A 0.0025 inches x 0.15 inches
Initiation Charge	0.008 cubic inches 130 mg 7,650 psi boron 20% potassium perchlorate 80% *
Booster Charge	0.008 cubic inches 105 mg 7030 psi boron 18% potassium nitrate 82%
Main Charge	0.017 cubic inches 250 mg Loose fill RDX ** pellets 38.2% potassium perchlorate 30.5% boron 3.9% potassium nitrate 15.3% super floss 4.6% Viton A 7.6%

B1.3 TOXICITY OF CHAFF MATERIALS

Based on reviews of numerous toxicological studies, the principal components of chaff (aluminium, silica glass fibres, and stearic acid) will not pose an adverse impact to human and environmental health. They are unlikely to have significant effects on humans and the environment, based upon the general toxicity of the components, the dispersion patterns, and the unlikelihood of the components to interact with other substances in nature to produce synergistic toxic effects. The primary source of the toxicological information obtained for this study is U.S. EPA's TOMES database, which comprises twelve individual databases.

The principal ingredient of foil type chaff and of the coating on the fiber chaff is aluminium metal, one of the most abundant metals in the earth's crust, water, and air. Although unlikely, humans and animals may be exposed to aluminium from chaff through ingestion or inhalation. In general, aluminium is regarded as relatively nontoxic. Aluminium compounds are often found as food additives and used in the treatment of potable water. Chronic exposure to aluminium as a result of inhalation of bauxite (Al_2O_3-$3H_2O$) fumes has provided evidence of links to development of pulmonary fibrosis. Inhalation of aluminium dust and fumes may also be linked to pneumoconiosis. Particles of aluminium deposited in the eye may cause necrosis of the cornea. The amount of potential aluminium exposure from chaff is difficult to predict, but chaff use does not approximate chronic occupational levels or durations for aluminium. Therefore, aluminium in chaff does not pose a health risk.

The aluminium alloy used to coat fiber chaff contains traces of silicon, iron, copper, manganese, magnesium, zinc, vanadium, and titanium (see Table I). Silicon and iron are abundant in nature. In general, acute exposures to silicon may result in mild eye irritation but otherwise do not contribute significantly to toxicity.

Iron is a nutritionally essential metal. High concentrations of iron can produce acute effects in a number of species; however, the small amounts of iron present in chaff will not contribute to environmental toxicity. Of the other trace elements contained in the aluminium alloy -- copper, manganese, zinc, and vanadium -- have CCME threshold standards. Therefore, no adverse health or environmental impact would result.
-

The primary component of the glass fibres in chaff is silicon dioxide (SiO_2), also known as silica. This is an abundant compound in nature that is prevalent in soils, rocks, and sand. Silica is practically nontoxic if ingested. Occupational studies of chronic inhalation exposure to crystalline silica have shown individuals to develop silicosis, a fibrosis of the lung. A study of foundry workers who developed pulmonary silicosis has described a gradual decrease in visual acuity due to cornea opacities in the pupillary area associated with high silicon content in the cornea. The Department of Health and Human Service's National Toxicology Program has proposed listing respirable size "glass wool" as a potential carcinogen; the listing is currently under review. The potential for chaff fibres to break up into respirable size is extremely low.

Additional elements present in the glass fibres include aluminium oxide (Al_2O_3), calcium oxide (CaO), magnesium oxide (MgO), boron oxide (B_2O_3), sodium oxide (Na_2O), potassium oxide (K_2O), and ferric oxide (Fe_2O_3). Each of these chemicals independently exerts toxic effects through various pathways of exposure. For example, both B_2O_3 and CaO exert toxicity primarily through ingestion (CaO is also a skin irritant), whereas toxicity studies on Fe_2O_3, show that exposure occurs mainly by inhalation. Furthermore, as independent chemicals, each may pose acute or chronic health effects depending on the dose and concentration of the chemical, exposure time, and metabolic activity of the recipient. For example, CaO, more commonly known as lye, causes bums on the mucous membrane and skin and can produce acute toxic effects upon ingestion of high doses. Minimal quantities of this compound are also used as supplemental food additives. Several chronic occupational exposure studies have shown ferric oxide to be linked to lung cancer, although occupational exposure studies do not accurately reflect the potential effects in the environment because occupational concentrations and exposure durations are much higher and longer than what would be expected in non-occupational settings. A number of laboratory studies on animals have shown that many of the above mentioned chemicals have produced toxicity to wildlife. However, the chemical additives in the glass fibres are fused together in a stable state, and it is unlikely that they will break down to their independent forms or react chemically with other environmental substances. Even if the fibres are not stable in the environment, the chemicals individually make up a small percentage of the fibres, and it therefore would not contribute significantly to environmental toxicity.

Stearic acid is the main component of the coating agent used to bond the chaff components. Toxicity and environmental fate data on stearic acid reveal that the chemical is essentially nontoxic. Steatic acid is naturally found as a glyceride in animal fat and in some vegetable oils. The chemical is virtually insoluble in water but can readily be solubilized by various types of chemical compounds including alcohols. Stearic acid has been shown to easily degrade through bacteriological processes. It lacks the propensity to penetrate skin or mucous membranes. Data on inhalation exposure is limited. Stearic acid is considered an irritant, but due to its lack of solubility capabilities, its ability to biodegrade, and the minimal quantity found in chaff it can be concluded that this will not pose a hazardous situation. Potential exposure to wildlife may primarily occur through ingestion; however, the quantities required to produce toxic effects are relatively high for most species. Literature review reveals that probable lethal oral dose (LD) for humans would be consumption of more than 2.2 pounds of stearic acid at any one time by an individual weighing 150 pounds. A bundle of chaff weighs about 3.4 to 4.4 ounces. A rough estimate of the amount of stearic acid is about 10 grams. Based on that estimate, it would require the consumption of the coating from almost 100 bundles of chaff to achieve a lethal dose of stearic acid.

In summary, the data indicate that the materials comprising the chaff dipoles are generally non-toxic in the quantities present. There is no realistic worst-case scenario under which sufficient quantities would be present in the environmental to pose a health risk.

APPENDIX C

PHYSICAL RESOURCES AND RELATED ISSUES

C1.1 PHYSICAL RESOURCES

The physical resources affected by the usage of chaff include the soils and water.

C1.2 ISSUES ADDRESSED

This section addresses potential effects of chaff on earth resources, primarily soils, and water resources. The principal issues include:

- Effects of chaff deposition on soil chemistry.
- Potential for chaff to accumulate in water bodies and sediments.
- Potential for chaff deposited on water bodies to leach toxic chemicals or change the chemical composition of the water.
- Effects of chaff on drinking water sources and systems.

Factors that influence the potential for chaff to change soil and water chemistry include the chemical composition of the chaff, the concentration of chaff deposited in a given area, the rate of chaff decomposition in the environment, the propensity of chaff to leach toxic chemicals under various soil and water conditions, and the background soil and water chemistry and conditions. Alteration of the natural soil chemistry of an area has the potential to affect vegetation and vegetative cover and, consequently, the stability of soil conditions, as well as the type and quality of habitat. Changes in soil composition can also affect groundwater and surface water bodies through chemical leaching and runoff. If chemicals leach from the chaff deposition in water bodies, such as rivers and wetlands, may have the potential to alter the chemical composition of the water and/or sediments and, consequently, the habitat value.

There are a number of laws and regulations to protect water quality that restrict what can be deposited directly into water bodies and onto land where groundwater or surface water quality may be indirectly affected through leaching or runoff.

The potential for chaff to have adverse effects on the physical environment depends on the quantity of material deposited in a particular area, the stability of the materials, the specific chemical conditions of the receiving soil and water, and the sensitivity of the environment to contaminants of concern. However, in any condition, the likelihood that a sufficient quantity of chaff would fall into a particular pond, stream, or estuary to measurably affect its chemical makeup is remote. The stability of the materials is important because it determines the rate of release of chemical constituents. The main factors influencing stability include the size of the particle (exposed surface area), the chemical environment, and the availability of water. The aluminium coating on glass fiber chaff is the least stable under acidic and extremely alkaline conditions; the glass core is more stable in acidic than alkaline environments. Dissolution will be greatest where water content is high. Thus, weathering will be more rapid in wet, acidic environments than in dry, neutral and alkaline environments.

C1.3 FIELD STUDY – SOIL AND SEDIMENT SAMPLE ANALYSIS

Glass fibre chaff was recovered from 57 and aluminium foil chaff from 30 of the 103 samples collected at the Nellis Air Force Range complex (Nevada). Glass fibre chaff was collected from all the samples that contained aluminium foil chaff. Concentrations of glass fibre chaff ranged from 0.02 to 251 mg/kg, with most of the samples containing less than 0.5 mg/kg. Concentrations of foil chaff ranged from 1.25 to 578 mg/kg, with most containing less than 10 mg/kg. It should be noted that the foil chaff weighs about 42 times as much as equivalent length of glass fibre chaff, so the higher weights of the foil chaff samples to not represent larger concentrations. The overwhelming majority of detections were in samples taken in range areas. Only three of the 28 samples taken in MOA areas contained chaff, all glass fiber type; two at concentrations of 0.08 mg/kg and one at 0.24 mg/kg.

Only six of the 96 samples collected at Townsend Range (Georgia) contained glass fiber chaff and none contained foil chaff Concentrations ranged from 0.03 to 0.9 mg/kg, with one sample of 29,661 mg/kg that contained a clump of chaff.

The pH of the soil solution was found to significantly affect the stability of the aluminium coating. Aluminium solubility is highest in solutions with pH less than 5.0 or more than 8.5. The glass core, on the other hand, was found to be more stable in acidic than alkaline environments. The Nellis samples were generally neutral to alkaline, and the Townsend samples were acidic. However, the Nellis environment is also arid and, although the pH may be high enough in places to solubilize the aluminium and silica, there is generally not sufficient water for the reaction to occur.

The microscopic observations found the most evidence of weathering in soil samples collected from Townsend. Four of the five samples examined showed evidence of weathering in the aluminium coating, ranging from minor effects to extensive surface pitting and dissolution. The pH of the samples ranged from 3.8 to 4.7. Though exposed in some areas, no apparent weathering of the silica core was observed in any of the samples.

Fibres from three of the five Nellis samples examined exhibited surface alteration. The surfaces differed from the smooth appearance of the control samples and were dominated by small “fuzzy” irregularities. The SEM scans and EDXA data revealed that the silica core was rarely exposed. The irregular surface morphology of the fibres is speculated to result from the formation of aluminium oxyhydroxides, sulfates, and carbonates on the aluminium coating. Like the hydroxide anion, carbonate and sulfate have strong affinity for AIS+ and are likely to be present in arid region soils.

Microscopic evaluations were also conducted of surrogate solution samples to compare with the field samples. These observations were generally consistent with the field sample results. Fiber subjected to the pH 10 treatment showed a portion of the aluminium coating dissolved and formation of crystals on the coating. The crystals were presumed to be synthetic gibbsite or bayerite ($Al(OH)_3$ polymorphs). This speculation is supported by documented formation of gibbsite in solution with 0H:Al ratios greater than 3:I. Incipient solution pits were seen, which agreed with the expected response of both aluminium and silica in high pH solutions. The pH 4-surrogate environment solution resulted in extensive pitting of the aluminium coating, consistent with the Townsend samples.

C1.4 SOIL CHEMISTRY

Elements of concern for chaff include aluminium, magnesium, copper, manganese, titanium, vanadium, zinc, boron, and silicon. Of these, only aluminium, magnesium, zinc, and boron were detected in the laboratory analysis. The absence of copper, manganese, titanium, and vanadium in the laboratory extracts may indicate that the chaff samples used did not contain these elements, but they may still occur and are therefore included in the analysis.

Aluminium, magnesium, and silicon occur naturally in relatively high concentrations in soils, and the probability of significant toxic effects are slight. The national average for natural aluminium concentration in soils is 72,000 mg/kg. Aluminium restricts root growth in some plants at soil solution concentrations as low as 1 mg/l. However, soil solution aluminium concentrations are reduced by ion exchange reactions, solid phase precipitation, and ligand exchange processes. Consequently, soil solution concentrations of aluminium in the toxic range are only likely to occur in extremely acid and very sandy soils. Potential plant toxicity would likely be limited to sensitive crops, since native vegetation will have adapted to local conditions, and liming, a common practice on acid agricultural soils, would reduce the potential for aluminium toxicity.

Based on the results of the pH 4 surrogate environment laboratory treatment, which produced the highest concentration of aluminium, an estimated 325,000 kilograms of chaff would have to be deposited on an acre of land to triple the aluminium concentration in the upper inch of soil, assuming a mean soil content of 72,000 mg/kg. This is equivalent to over 3 million chaff bundles and exceeds the total annual use by Air Combat Command (ACC) units nationwide.

Magnesium also occurs naturally in large concentrations in soil (mean content of 9,000 mg/kg). Magnesium deficiencies may occur in humid acidic soils, and toxicity occurs rarely in alkaline soils formed from ultra-mafic rocks. Correcting deficiencies or inducing plant toxicity would require the addition of readily available magnesium at the rate of several tons per acre.

Silicon is not known to be toxic to plants, and elevated uptake by plants has not been documented. The surrogate environmental laboratory tests did not detect dissolution of silicon in even the most acidic solution (pH 4).

Small quantities of copper, manganese, titanium, vanadium, and zinc may occur in the aluminium coating of chaff. Only zinc was detected in the laboratory tests. It is likely that the other trace metals were not present in the particular lot of chaff analyzed. Except for titanium, these trace elements are considered essential nutrients for either plant or animal growth. Toxic effects may occur at elevated concentrations in soil or plant tissue. Copper, manganese, titanium, and zinc have strong affinities to precipitate as hydroxyl oxides with oxygen and hydroxyl ligands under oxidized neutral and alkaline conditions. Under anaerobic conditions, they tend to precipitate as sulfides and carbonates, depending on pH. In addition, a number of other mechanisms may reduce the activity of these elements in solution, including ion exchange co-precipitation and chelation with natural organic compounds. In general, the mobility and availability of these metals increase with increasing acidity, which also tends to coincide with soil conditions likely to be deficient in these elements. In contrast, vanadium occurs as anions, and its mobility and availability may decrease with increasing acidity in some soils.

Boron is both an essential and toxic element for plants. Boron deficiencies are most likely to occur in humid, acid soils, and toxicity occurs in alkaline environments. Sensitive plants are affected by concentrations as low as 0.3 mg/l. In general, the availability of boron to plants decreases with increasing soil pH and under arid conditions. Increased availability corresponds with conditions most likely to be deficient in boron. Boron detection in the surrogate environment laboratory tests of chaff corresponded with pH. However, natural soil content is low (mean of 33 mg/kg), and the amount of chaff deposition required to raise soil concentration to triple background level is less than for any other element (estimated 571 kg/acre). Nevertheless, this represents about 2,500 bundles of chaff

In summary, the exposure of organisms to elements in chaff depends on the rate of release of these materials in the environment. The availability and mobility of metals in the soil will be reduced by a number of attenuation factors, including solid phase precipitation, ion exchange, coprecipitation, and complexation with iron and aluminium oxyhydroxides and organic matter. Retention of elements in soil will reduce their availability to organisms and the potential for ground water contamination. The results of the laboratory tests indicate that chaff is more susceptible to dissolution in wet, acid environments than under arid, alkaline or neutral conditions. Based on available data, broad-scale, significant accumulations of metals in soil would require extremely large releases of chaff.

C1.5 WATER RESOURCES

Freshwater aquatic environments are potentially more sensitive to chemicals released from chaff and flares than terrestrial environments for the following reasons: (1) dissolution of materials will be faster in water than on land, (2) chemicals are more mobile and more available to organisms, and (3) the thresholds of toxicity tend to be lower for sensitive aquatic species. The extreme pH levels used in the laboratory analysis are not directly applicable to aquatic environments because pH 4 is too acidic and pH 10 too basic for most aquatic organisms. These data, along with the more normal pH 7 test results, can, however, be used in a qualified fashion to indicate trends in solubility and toxicity.

Among the elements examined in chaff, only aluminium and copper have the potential for sufficiently high concentrations to be of concern in aquatic environments. Magnesium, boron, manganese, titanium, vanadium, and silicon concentrations are less than values known to cause toxicity to aquatic organisms.

Aluminium solubility and toxicity are highly pH dependent. The highest concentrations in the laboratory tests occurred at pH 4 (170 ppm) and the lowest at pH 7 (0.3 ppm). The freshwater acute value for aluminium is 1.496 ppm, and the chronic value is reported as 0.742 ppm for a pH range of 6.9 to 8.2. There are no data available on acute or chronic levels at the extreme pH levels of 4 and 10 used in the laboratory analysis. The extracts from the pH 7 samples, which lie within the 6.9-8.2 range, were approximately one-sixth the freshwater acute value for aluminium. These extract values represent a very high chaff-to-water ratio (1:20) which could not occur in the environment. Therefore, aluminium toxicity due to chaff is not a concern in aquatic environments.

The freshwater acute value for copper is 0.018 ppm. Although no copper was detected in the laboratory tests, which had a detection limit of 0.02 mg/l, it is possible that trace quantities of copper could occur in some lots and, if deposited on freshwater bodies, could leach out. The quantity of chaff that would have to be released over a given water body would have to be very large, however, to reach acute values. A worst-case calculation was used to assess the likelihood of causing concern.

Chaff disperses widely when employed from military aircraft. Depending on the altitude of release and wind speed and direction, the chaff from a single bundle can be spread over distances ranging from less than a quarter mile to over 100 miles. The most confined distribution would be from a low-altitude release in calm conditions. The chaff from one bundle could be expected to distribute over about a quarter mile area (160 acres). The average distribution for a bundle of RR-112A chaff (the largest model) would be about 69,000 chaff dipoles per acre. It contains a maximum of 1.8 $x10^{-6}$ gram of copper (at 0.05 percent of the aluminium coating). An entire bundle of 11 million dipoles could contain approximately 0.02 gram of copper. Thus, the worst-case condition would be an entire clump of undispersed RR-112A chaff falling in a small, confined body of water. Even in this worst-case situation, the amount of copper introduced would be equivalent to the copper in one penny.

A significant amount of training with chaff and flares occurs over the open waters. Although the vastness of the receiving waters and the resulting dilution of any materials or chemicals deposited make the potential for impact extremely remote, laboratory extraction tests were conducted using synthetic seawater to identify chemicals that could be released into the ocean. The results could be of interest in a more confined estuarine environment.

The concentrations detected for all elements of concern were low in the synthetic seawater solution. The high levels of magnesium detected are attributable to the magnesium in the extracting solution. As with freshwater aquatic environments, the only chemical of potential concern is copper. The marine chronic value for copper is 0.003 ppm, which is well below the laboratory detection limit of 0.02 mg/L. However, the quantity of copper involved, if any, is minute.

Neither chemical nor physical effects are expected to occur to drinking water sources exposed to chaff. The quantities of chemicals released are too small to be of concern, and filtering systems would remove any fibres.

APPENDIX D

REVIEW OF BIOLOGICAL RESOURCES

The biological resources, or Valued Ecosystem Components (VECs), currently monitored within the FMTGB Environmental Management System include:

D1.2Caribou

D1.2.1 George River Caribou Herd

The George River caribou herd routinely migrates across the northern portion of the Quebec- Labrador peninsula with calving occurring to the north of the LLTA. The period from pre-calving through to post-calving is most sensitive to potential noise disturbance from military activity. That portion of the LLTA that has had historical migration routes has the lightest aircraft activity (generally less than two flights per week). Given the low aircraft activity and the brief period that the herd may be exposed (usually April/May and August/September), the potential risk of population level impact is considered to be very low.

At present, the mitigation activities are based on “core area closures”, a protective (no fly) area around collared animals, which may vary in radius from 10-19 nm, depending on the seasonal sensitivity. While this approach is generally effective, it assumes that the collared animals are cantered in each group, that they represent large groups and that the closed area is sufficient to accommodate movements of the group between reporting cycles. With this undertaking, the current mitigation approach would continue; and as an additional level of mitigation, a core area closure will be applied whenever practical, effectively removing the north-western portion of the LLTA from active flying during the herd migration through the area.

D1.2.2 Red Wine Mountain Caribou Herd

The Red Wine Mountain caribou herd (RMCH) is a small woodland (sedentary or non-migratory) herd. With reconfiguration in 1996, the entire range of the herd became included within the new training area. Given the proximity to the airfield, the RMCH occupy a potentially high-use area for flying activity, which, without mitigation, could result in significant disturbance. A 2001 survey by DND showed that he RMCH herd has been in continuous decline and currently has about 97 animals. This decline was also noted in a parallel census of the Mealy Mountain Caribou herd, which is outside the training area, and is consistent with a continental decline that has resulted in woodland caribou being assigned a “threatened” status by COSEWIC. This status is consistent with the status assigned under the Provincial Endangered Species Act.

Unlike the George River herd, the Red Wine animals do not embark on extensive migrations or form large aggregations. Mitigation is presently designed around a radio-telemetry monitoring program with an enhanced sample of 15 transmitters deployed on the herd, and establishing a "core-use" area based on these collars. Considering the limited movement of woodland caribou and the large core area closure normally applied, the application of the core concept resulted in a closure for the herd of about 7-8000 km^2 throughout most of the flying training season. The current level of mitigation activities including the "core area closures" will continue with this undertaking.

DND is a member of the Recovery Team established by the provincial government as a result of the COSEWIC "threatened" designation of this and other woodland caribou herds. DND will support the team's efforts to assist in the recovery of these species.

D1.2.3 Lac Joseph Caribou Herd

The Lac Joseph Caribou herd (LJCH) is another woodland herd, and like the Red Wine Caribou herd, its status was also changed to 'threatened'. Given the location of the herd and the small numbers of animals inside the LLTA, as well as the relative lack of military activity (less than 2 flights per week) in that portion of the training area, little monitoring had been conducted in that general area. Instead, DND relied largely on block closures of the western portion of the LLTA.

In 2002,DND in partnership with the IEMR and the Wildlife Division, conducted a census of this herd, resulting in an estimate of 1,200 animals. Mitigation is based on these satellite telemetry units, with an 8 nm radius closure established around the collared animal. This is the same standard applied to define the core for the Red Wine Caribou herd, and provides a protected area of 700 km^2 for each collared animal/group. Considering the light activity and the exclusion of the core of the herd's range, the risk of significant (population level) impact, even without mitigation, is unlikely.

The Province of Newfoundland and Labrador is proposing to establish a nature preserve for the Lac Joseph Caribou herd. While the area designated is west of the LLTA, a small portion overlaps the LLTA. As the plans for this preserve evolve, DND will work with the Province to ensure mitigation measures are appropriate.

D1.2.4 Other Woodland Caribou

Other woodland caribou were also located in the southern portion of the LLTA, and one animal in a group of four was equipped with a satellite collar. It is still uncertain whether these animals are the remnants of the Dominion lake herd or dispersed Lac Joseph caribou. Regardless of the herd affiliation, as woodland caribou, they are designated as threatened. DND will maintain the monitoring program using satellite telemetry to monitor additional groups applying the same mitigation standard applied to Lac Joseph collar groups.

D1.3 Birds

D1.3.1 Raptorial Birds

The Raptorial Bird monitoring component includes cliff-nesting (Golden Eagles, Peregrine Falcons and Gyrfalcons), and woodland (Bald Eagles, Osprey) raptors. DND has conducted an annual raptor monitoring program since 1990 and has gathered a substantial database, including detailed distribution, habitat use and recruitment data.

In the LLTA, cliff areas with suitable nesting or perching habitat are limited, these areas will continue to be monitored for cliff-nesting raptors. It is not anticipated that Gyrfalcons or Peregrine falcons will be found, as there is no historical use within the reconfigured training area. Likewise, based on historical data, 1-2 active Golden Eagle nests may be active. Active nest sites will be confirmed, and a 2.5 NM radius protection area assigned to each active nest for the nesting period.

Bald Eagles comprise a small stable population, consisting of 6-8 active nests dispersed along the western boundary of the LLTA. DND will establish protection areas of 2.5 NM around all known active nest sites at the beginning of the nest initiation period and maintain these closures until the sites are confirmed to be inactive.

Since reconfiguration, Osprey have been the main focus of the program, due to their large population and dispersion across the training area. Based on the results of recent population, recruitment and behavioural studies, the Osprey population appears healthy, and expanding. Military activity does not appear to cause any negative effect. In a workshop sponsored by the IEMR to examine the DND's monitoring program that included the resource managers and species experts; it was agreed that the commitment to protection of individual nests could be terminated, and the level of effort dedicated to Osprey monitoring was significantly reduced. To ensure that longer-term effects do not go unrecognized, DND continued a monitoring program, using a sample of about 30 disturbed nests in the highest aircraft activity area and 30 non-disturbed nests on the adjacent Eagle Plateau, using the same monitoring protocol as in previous seasons.

D1.3.2 Waterfowl

Waterfowl are distributed in very low densities throughout the training area. They have previously been considered sensitive to disturbance, in varying degrees, during their moulting, staging and nesting periods. However, recent monitoring and disturbance research by DND, in cooperation with the Canadian Wildlife Service (CWS) and other studies, suggests sensitivity during the nesting period is less significant than initially perceived in the EIS. However, CWS has identified all high-use areas, which will be protected for the sensitivity period.

D1.3.3 Eastern Harlequin Ducks

Harlequin ducks have received special consideration in light of their status as an endangered species. With reconfiguration, most of the known prime habitat for the Harlequin duck is now outside the LLTA. Over the past few seasons, and with the cooperation of CWS, IEMR, the Voisey's Bay Nickel Company, the Lower Churchill Hydro Projects and the Department of Work Services and Transportation, DND has compiled an inventory describing the areas of use and occupancy periods for these ducks within the LLTA.

Harlequin Ducks have recently been downgraded from endangered to vulnerable in the recently released Provincial Endangered Species Act. This change is, to a large extent, due to the work done by DND, Voisey's Bay Nickel, CWS and others, resulting in a clearer picture of the population, distribution, nesting and migration patterns. The changed status of the Harlequin triggers a review of the mitigation requirement. DND will consult with the IEMR and the resource manager regarding the appropriate level of mitigation. Until then, DND will protect all known high-use nest areas.

D1.4 Moose Wintering Yards

The EIS, predicted that military flying training would result in a minor impact on Moose during the late winter period. The EIS further identified high, moderate and low habitat capability for this period, which was verified by DND. However, the distribution and population was less than expected in the EIS. Mitigation measures for moose are based on the avoidance criteria of 5 moose per square kilometre over a 10 square kilometre area.

During winter of 2000, IEMR in participation with the resource managers and DND conducted an aerial transect survey of the entire southern portion of the LLTA collecting distribution data on moose and caribou. However, the transects have not indicated that there were any high-density areas not already in our inventory for protection. Areas previously identified as high capability late winter habitat will be protected.

D1.5 Nocturnal Species

Nocturnal species received little attention during the preparation of the EIS, as there was little night flying activity and little literature available. As a result, there are no avoidance measures focused on nocturnal species. While the current night flying activity level is well below the approved level, there may be an increasing requirement. Accordingly, DND is reviewing the literature for this group to assess the current understanding of potential aircraft impacts, with a view to establishing new criteria, if necessary. DND hopes to collaborate on this project with the two Provinces and the IEMR.