Environmental Assessment Registration

Starfire Scientific Inc.

Prepared for:

Department of Municipal Affairs
And Environment

Environmental Assessment Division

Po Box 8700
St John's NL
Canada A1B 4J6

March 2017

Table of contents

1.0 Name Of The Undertaking

Name of the undertaking is Starfire Scientific Suborbital Flight Range.

2.0 Proponent

2.1 Name of Corporate Body :

Starfire Scientific Inc.

2.2 Address

66 Fitzgerald Lane
Kirkfield Ontario
Canada K0M 2B0

2.3 Chief Executive Officer

Name :	Richard Graf
Official Title :	President
Address :	66 Fitzgerald lane Kirkfield Ontario Canada K0M 2B0
Telephone :	(705) 438-1690
Email :	rgraf@starfirescientific.com

2.4 Principle Contact Person Purposes of Environmental Assessment

Name :	Richard Graf
Official Title :	President
Address:	66 Fitzgerald lane Kirkfield Ontario Canada K0M 2B0
Telephone :	(705) 438-1690
Email :	rgraf@starfirescientific.com

3.0 The Undertaking

3.1 Name of the Undertaking

The name of the Undertaking in Starfire Scientific Suborbital Flight Range.

3.2 Purpose of the undertaking

The purpose of the undertaking is to establish a Suborbital Space Flight Range for conducting high altitude suborbital space launches with the Starfire Space Cannon.

This is the first stage of a multi stage project that will eventually lead to the establishment of a Canadian domestic satellite launching service. As this project progresses additional Environmental Assessment Registrations will be submitted for each stage of expansion.

4.0 Description of the Undertaking

4.1 Geographic Location

The undertaking is located south of Cartwright Labrador, East of highway #530 beginning approximately 2.5 KM south on the White Hills Road. Please see the image 1.

This site was chosen as it provides a large unoccupied area, which will be used as a downrange safety zone for descending suborbital vehicles, and that it is well sited for future orbital launches. The nearby town of Cartwright provides regional infrastructure and it is also well suited to support the significant tourism that this project is expected to attract.

This location is outside of the municipal boundary of Cartwright Labrador and it is about 8.5 km outside of town.

Image 1

This site will be boundaried by the following markers as noted in image 2

Marker E 53° 38’ 25.99” N 56° 59’ 03.30” W
Marker F 53° 39’ 36.91” N 56° 56’ 23.65” W
Marker G 53° 39’ 32.85” N 56° 54’ 42.90” W
Marker H 53° 38’ 48.72” N 56° 53‘ 32.53” W
Marker I 53° 37’ 42.80” N 56° 45’ 06.66” W
Marker J 53° 37’ 29.26 N 56° 56’ 19.99” W

4.2 Physical Features

This undertaking comprises approximately 1541 hectares. The majority of this area will be used as a down range safety zone for descending flight vehicles to land in.

The launch system and other equipment will be set up at the western end of this undertaking.

There are no known buildings, pipelines, transmission lines, or other installations in this undertaking. The closest known structure is the airport which is about 6.5 km away. This site was recommended by Cartwright Mayor Dwight Lethbridge as a good location for this undertaking.

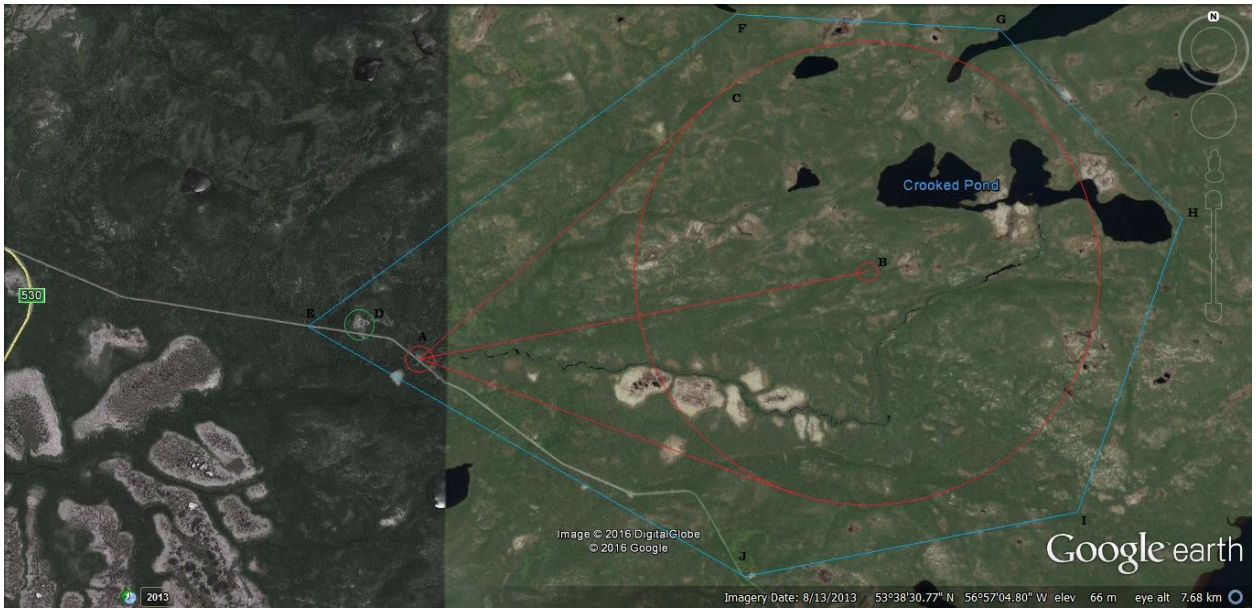


Image 2

Area A – This will be the location where the launch system will be set up. This location is a former construction camp.

Area B is the primary aim point.

Area C is a circle that proscribes the expected dispersion area for descending flight vehicles to land in.

Area D is a secondary equipment site. This is a former quarry.

Equipment will be set up at areas A and D only and the remainder of the area will be used as a safety zone for descending flight vehicles.

The White Hills Road runs through this area. This road is used occasionally by people in this area. We are **NOT** making a claim for the exclusive use of this road. As a matter of safety I would like to temporally close this road at Marker E and Marker J while suborbital flights are being conducted. At all other times this area will be open to other users.

The occupation of this site and the proposed work will only occur at areas A and D. The down range safety area will not be occupied. The down range safety area will only be entered for the purpose of retrieving experiments or flight vehicles after a launch. Every effort will be made for the minimal disturbance of the natural landscape during these recovery operations.

Biological description

This undertaking covers some of 15 km² and it is primarily undeveloped eastern boreal shield forest with the typical diversity of flora and fauna found in this region. There is no commercial timber in this area.

Area A and Area D, where the equipment is to be set up, are primarily a graded gravel base surrounded by sparse forest.

The down range safety area, comprising the majority of this undertaking, is a patchwork of features including exposed bedrock, sphagnum Bogs, small ponds, small streams and sparsely forested areas. Ground cover may consist of fir, Birch, spruce, alder, willow and a variety of shrubs. Wildlife may include moose, caribou, bear, fox, porcupine and a variety of smaller animals.

When it is considered that this undertaking only be conducting commercial flight operations on average two days a month, and that the majority of activities will take place in two confined locations (Area A and D) it is considered this undertaking will have a minimal effect on the local environment.

4.3 Construction

At this time the Starfire Space Cannon is configured as a fully self contained, road portable, suborbital launch system.

As a self-contained space launch system there is no need for the construction of facilities to accomplish our immediate goals which will be to complete the research and development

phase of this project. The launch system can be set up on any firm gravel or earth surface there is no need to install any concrete pads or buildings.

With the completion of the research and development phase we would like to begin Commercial Space Flight Operations.

Portable structures will be used during this undertaking as necessary for accommodations, workshops and as a visitor's center.

Area A is the primary location for setting up the Starfire Space Cannon Launch System and it is a former construction camp. Area A has approximately 90 meters of road frontage and is approximately 50 meters deep.

It may be necessary to perform a general clean up of Area A for fire safety which may include removing brush or other debris. It is considered that a cleanup can be accomplished in one day, by hand, and that no major construction will be necessary during 2017.

Area D is approximately 350 meters west of Site A and it is a former quarry. Area D has approximately 30 meters of road frontage and is approximately 100 meters deep. This area will be used as a secondary equipment site to area A. It may be necessary to perform a general clean up of Area D.

Every effort will be made for minimal disturbance of the natural landscape.

4.4 Operation

How the undertaking will operate

This undertaking is the first stage of a multi stage plan to develop a domestic Canadian Satellite launching service. In this plan we will complete the development of the Starfire space cannon and establish a commercial sub-orbital flight service followed by the development of a small satellite launching vehicle for the Starfire space cannon. As this project progresses we may reapply for additional undertakings as required.

The operational plan for 2017 is to complete the phase one and phase two testing of the Starfire Space Cannon Launch System.

Flight operations would begin around the end of May 2017 with our first phase one test series. The primary goal of this test series will to be to insure the mechanical integrity of the launch system firing in the vertical position for the first time. After the completion of Phase One testing, the Starfire Space Cannon Launch System will be returned to our workshop for a

complete inspection. If difficulties are encountered with the launch system during this testing it may be necessary to repeat these tests.

Successful phase one testing will lead into phase two testing. Phase two testing will consist of conducting up to four high altitude space flights using our mosquito flight vehicle.

We're currently scheduling up to five test series over the summer of 2017 although it may be possible to complete our goals in as few as two test series. Test series will be conducted at four to six week intervals. The town of Cartwright will be informed in advance of the test flights

During a typical test series we would arrive two or three days prior to the scheduled launch date providing time to deploy the launcher and set up additional equipment. In addition to setting up the launcher we would erect a number of tents to serve as accommodations and workshop.

On the day of the launch the White Hills Road would be temporarily closed to the west and to the east of the launch site for public safety and when the work for the day is completed the road would be reopened. Loading takes about 20 minutes and a flight takes about 5 minutes.

It is possible to conduct several launches in one day and we would typically spend two or three days over a one week period conducting flight operations.

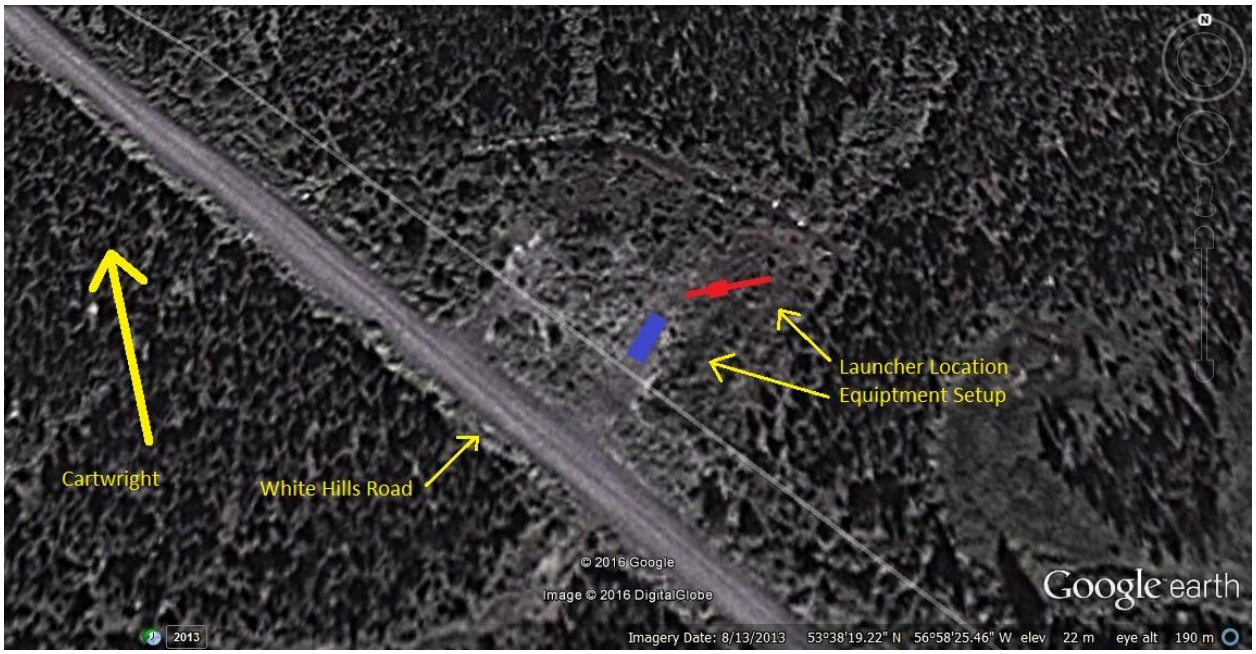
With the successful completion of phase two testing commercial suborbital flight operations may commence with the Starfire Space Cannon and the Mosquito flight vehicle. Commercial flight operations may begin as early as fall of 2017 but this depends entirely on customer demand.

The operations that we will conduct during 2017 will provide us with an opportunity to evaluate the suitability of this site for a long term commercial space launch operation.

It must be considered that no one has successfully established a commercial space launch operation in Canada and that not all of the factors which will affect this operation are readily apparent. Our operations during 2017 will also provide an opportunity to both the Municipality of Cartwright and the Province of Newfoundland and Labrador and to evaluate Starfire Scientifics' operations at this location.

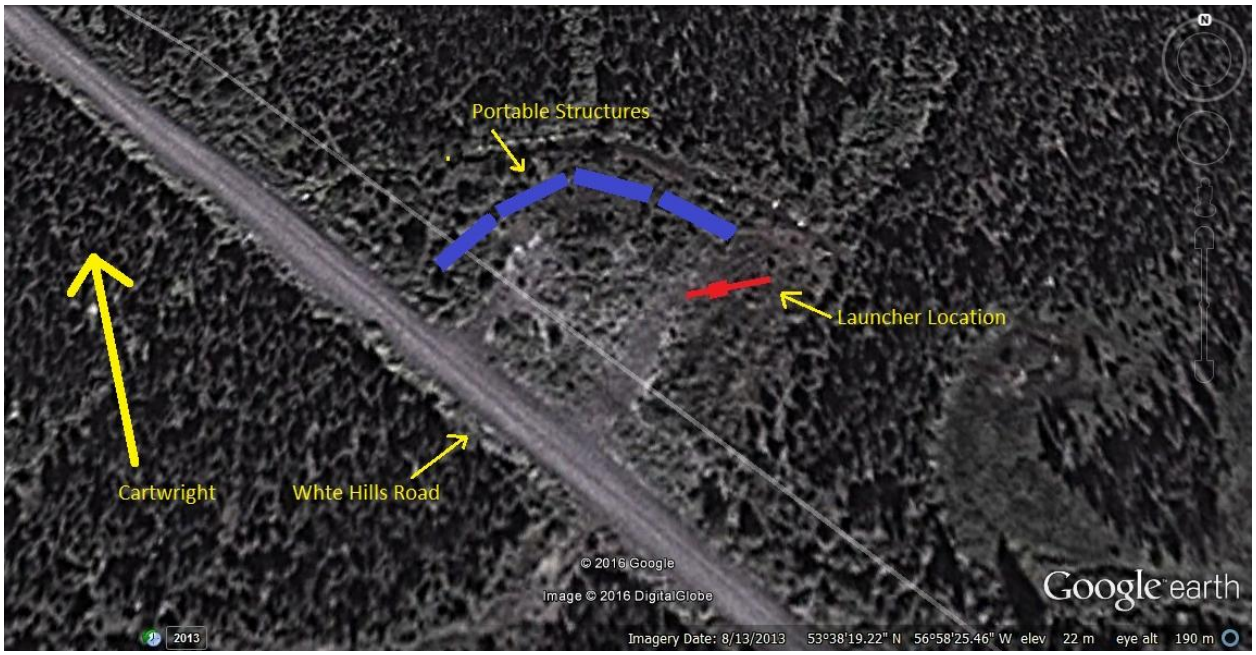
During 2018 Starfire Scientific will establish a more substantial presence at this site. This will include bringing in portable structures to serve as workshops, storage and a visitor's center. Starfire Scientific would also like to install a new Starfire Space Cannon at this site for suborbital flights and as an orbital launch system.

As the frequency of operations increase a water well may be drilled and a septic system may be installed in accordance with provincial regulations. Electricity will be provided by generators and a solar/battery systems.



Above is the expected layout during of the launcher and equipment During Phase One and Phase Two flight testing.

Below is the expected layout during the initial stages of commercial operations.



Potential sources of pollutants during Operation

-Sewage and Waste
-Scattered debris
-Risk of heating fuel and or petroleum release
-Noise pollution from general activities
-Noise and Emissions from launches
-Vehicle bodies
-Human activities

Mitigation measures during operations

Removing waste- All waste and debris generated on site is to be removed after each launch operation. As required, a septic system may be installed in accordance with provincial regulations.

Fire safety program – A fire safety program will be developed in consultation with the local Fire Department and, where required, the department of Natural Resources.

Fuel handling – Fuel, solvents and lubricates will be stored in accordance with provincial regulations. Fuel for generators will be stored portable jerry cans. Refueling of generators will be conducted in accordance with manufacturer's guidelines and proscribed safety practices. The use of solvents and lubricates, particularly in the cleaning and maintaining of the Starfire Space Cannon, will be conducted strictly in accordance proscribed safety practices. Basic petroleum spill cleanup equipment will be onsite and any releases will be promptly addressed. Any accidental spills or leaks will be promptly contained, cleaned up and reported to the 24 hour environmental emergencies report system.

Noise emissions from general activities- Generators, vehicles and other equipment will produce some noise. All equipment will be maintained to provide emissions standards designed for the equipment by the manufacturer. Exhaust systems will be maintained to ensure noise levels are within design specifications of the machinery.

Noise and emissions from launches- The Starfire Space Cannon uses a conventional nitrocellulose propellant. Nitrocellulose propellant emissions are primarily nitrogen gas, carbon dioxide and water vapor. A launch from the Starfire Space Cannon creates a loud noise when the cannon is fired. It is considered that this noise is equivalent to the detonation of approximately two sticks of dynamite and it is estimated that emissions will be in the range of 50db at 2km. Over the past decade more than 100 large caliber cannon tests have been conducted at our Ontario test site. It is our experience that there have been no long-term effects to wildlife during these operations. It is our experience that when a Cannon is fired the birds and insects in the immediate area go quiet for a short time and that they resume normal activities within a few minutes. We have found no decrease in the population of any local species adjacent to our Ontario test facility after more than a decade of operations.

Vehicle bodies - Starfire Scientifics' Mosquito Flight Vehicle is composed mainly of a steel body with a steel nose cone. Effort will be made to recover vehicle bodies from the down range safety zone where practical. Vehicle bodies and experiments are relatively light and can be carried out by one person. It is considered that much of the down range safety area is comprised of soft ground and that in general the vehicle would bury itself in the ground on impact. Since a spent vehicle body will basically be an empty steel tube it is considered that it would cause a greater disruption to the environment to excavate and recover a buried vehicle body than it would to leave the vehicle body in the ground were over time it would rust away and disintegrate.

Human activity- The majority of activity will take place in Area A, Area D and the road between them. There is no need to enter the down range safety area except to recover vehicles or experiments. Recovery operations will be conducted to minimize the disturbance to the natural environment. Visitors, tourists and clients will be confined to Areas A and D to minimize their impact on the environment.

4.5 Occupation

During commercial flight operations, based on 100 flights per year, it is expected that Starfire Scientific will employ four people at this site. This will include a Launch Site Manager (NOC #0714), two Launch System Operators (NOC #2232) and a Client Liaison (NOC #1123). Part time staff may be brought in during periods of heightened activity, particularly during the summer tourist season, as required.

All occupations are subject to qualifications and abilities and it is expected that all positions are open equally to men and women without regard to age or gender respecting equality rights for employment and respecting all aspects of employment equity.

The Starfire Space Cannon Launch System is a unique piece of machinery in the world today. It is expected that, even though some skills may apply to the operating of this launch system, that substantial specialised in house training will be necessary for each position. This training will emphasise the safe handling of materials and the safe operation of the launch system in accordance with all provincial and federal regulations.

4.6 Project related documents

Appendix A – Topographical map of the undertaking.
Appendix B – Starfire Scientific Presentation May 2016

5.0 Approval of the undertaking

The following are the approvals necessary to begin this Project.

Government of Newfoundland and Labrador, Ministry of Natural Resources - Licence to occupy

Government of Newfoundland and Labrador - business permit

Transport Canada, Launch Safety Office – Launch Authorization

6.0 Schedule

With approvals in place we would like to begin phase one testing at the end of May, 2017. Testing will continue throughout the year with up to five test series planed during the summer of 2017 at four to six week intervals. With the successful completion of Phase one and Phase two testing commercial flight operations may begin in the fall of 2017 or early 2018.

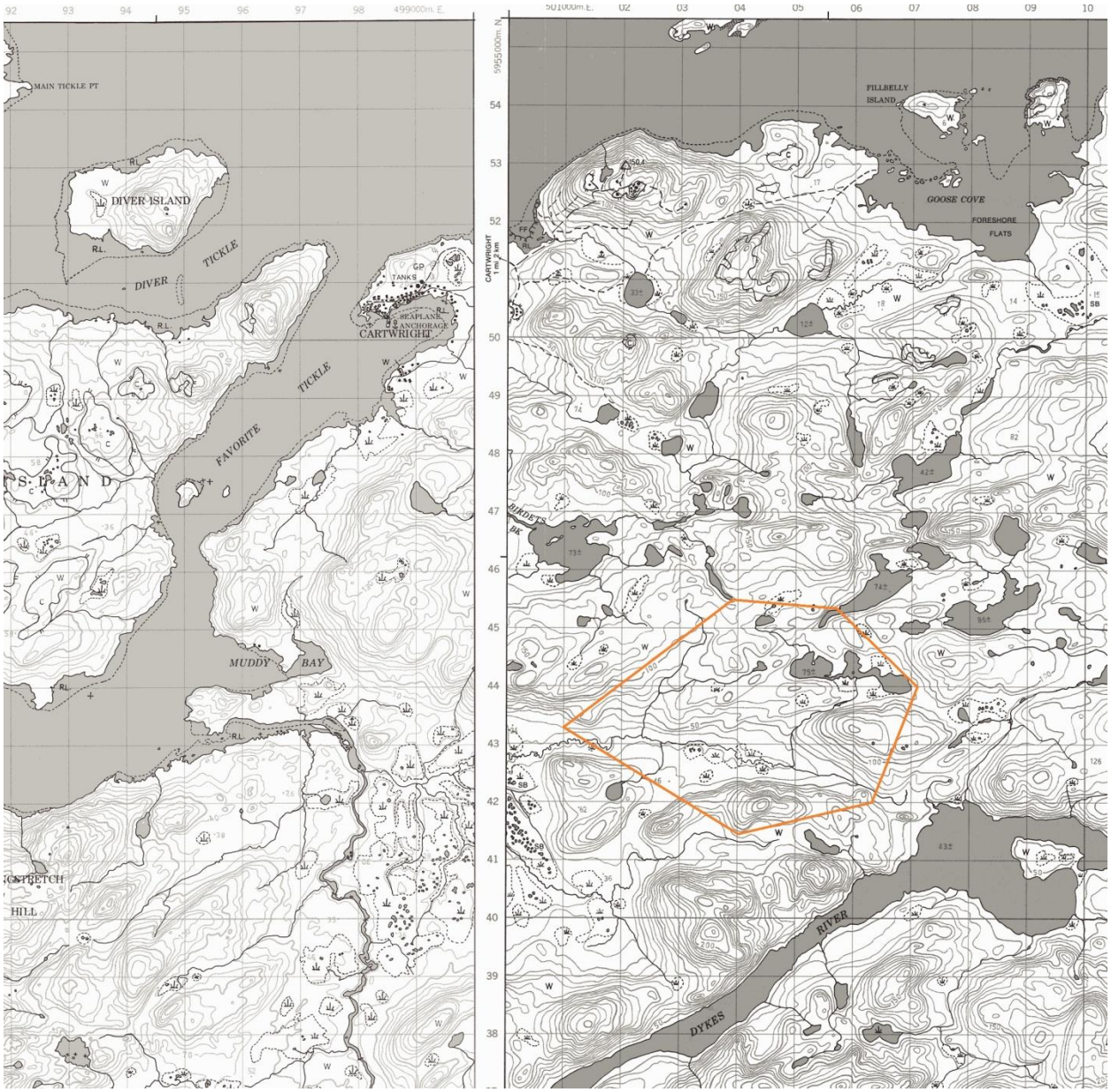
7.0 Funding

Pending the approval of all permits the proponents will not be seeking financial assistance. This project will be privately funded. It is estimated that the completion of the Phase One and Phase Two testing will be in the range of $60,000 and setting up for commercial operations is estimated to be in the range of $120,000. Additional private funding is available for the development of a satellite launching vehicle and for further launch site improvements.

8.0 Authorization

Signature of Chief Executive officer …….

Date …….



Appendix A - Topographical mapping, 1:50,000 scale, showing the location of the undertaking.

The town of Cartwright appears on the edge of map 13H11 and the launch site appears on the adjacent edge of map 12H10.

These maps were provided by the MNR and they were only available in black and white. These maps are the most up to date topographical maps available with Map 13H11 dated 1974 and map 12H10 dated 1968. These maps do not show features such as highway #530, the Cartwright Airport or the White Hills Road.

Appendix B - Starfire Scientific Presentation May 2016

Index

INTRODUCTION

Starfire scientific is currently seeking a launch site in Labrador, Canada to establish a suborbital space flight launch range. We have identified a site near the town of Cartwright, Labrador that we feel will suit our needs.

This range will be used to conduct high altitude suborbital launches with the Starfire Space Cannon and it will be Canada's only commercial space launch operation.

The Starfire Space Cannon launch system is the calumniation of more than twenty years of research and development and combines aspects of three previous gun launch systems. In comparison to currently available rockets, the Starfire Space Cannon is inexpensive. It is very inexpensive, and we are able to offer space flight services for significantly less than any conventional launch system.

This provides us with the opportunity to pursue both conventional markets as well as new and novel markets. Conventional markets may include experiments such as atmospheric research, astrophysical or materials research to hyper velocity experimentation. Novel markets may include launching and recovering simple items, such as business cards to conducting memorial flights. In the fall of 2016 we even had a request to launch artist's supplies that would later be used to create an exhibition.

This presentation is a brief over view of the Starfire Scientific' operations. Further details are available upon request.

THE STARFIRE SPACE CANNON

The Starfire space cannon is an 8” bore, 45’ long, multi-chambered, road portable artillery piece that has been custom designed to launch payloads into space.

What makes the Starfire Space Cannon special?

A conventional artillery piece uses one large propellant charge that, when ignited, produces a large pressure spike and high G loadings on the projectile. The Starfire Space cannon uses a multi-chambered system where the propellant charge is broken up into several smaller charges. These charges are fired sequentially producing much lower pressures and G loadings while still producing the same high velocities.

These lower pressures and G loadings allow us to use simpler construction for the launcher as well as commercial off the shelf components (COTS) to construct payloads.

These features combine to create the lowest cost space launch system available today.

The Starfire Space Cannon as a suborbital launch system

At this time the Starfire space canon is mounted on a road portable trailer and it is configured for suborbital space flights.

A suborbital space flight is a flight that travels to very high altitudes, the edge of space, and then comes down again. It does not go into orbit. Even though these flights go into space they do not stay there.

Sub-orbital space flights can be used for almost every application that a satellite can be used for with the advantage that it is far less expensive to launch a suborbital flight then it is to put a satellite into orbit.

Typical applications include atmospheric research, astrophysical or materials research and hyper velocity experimentation. As well there are many novel payloads that can be flown from launching novelty items for resale to launching memorial flights.

These flights will cover a region in space that has historically been difficult to access. This region starts at the maximum altitude that big research balloons can fly and goes to the minimal altitude that satellites can orbit. This opens up new research opportunities that were not previously available to scientists.

As a suborbital launch system the Starfire space cannon can only fire in the vertical position. If the system is reconfigured to launch at a lower angle the Starfire Space Cannon can be used to launch a small satellite into orbit. Ideally a Starfire Space Cannon launching satellites would be twice as long and the current launch system.

The development of a satellite launching vehicle for the Starfire space cannon is a future project and it is not covered under this presentation.

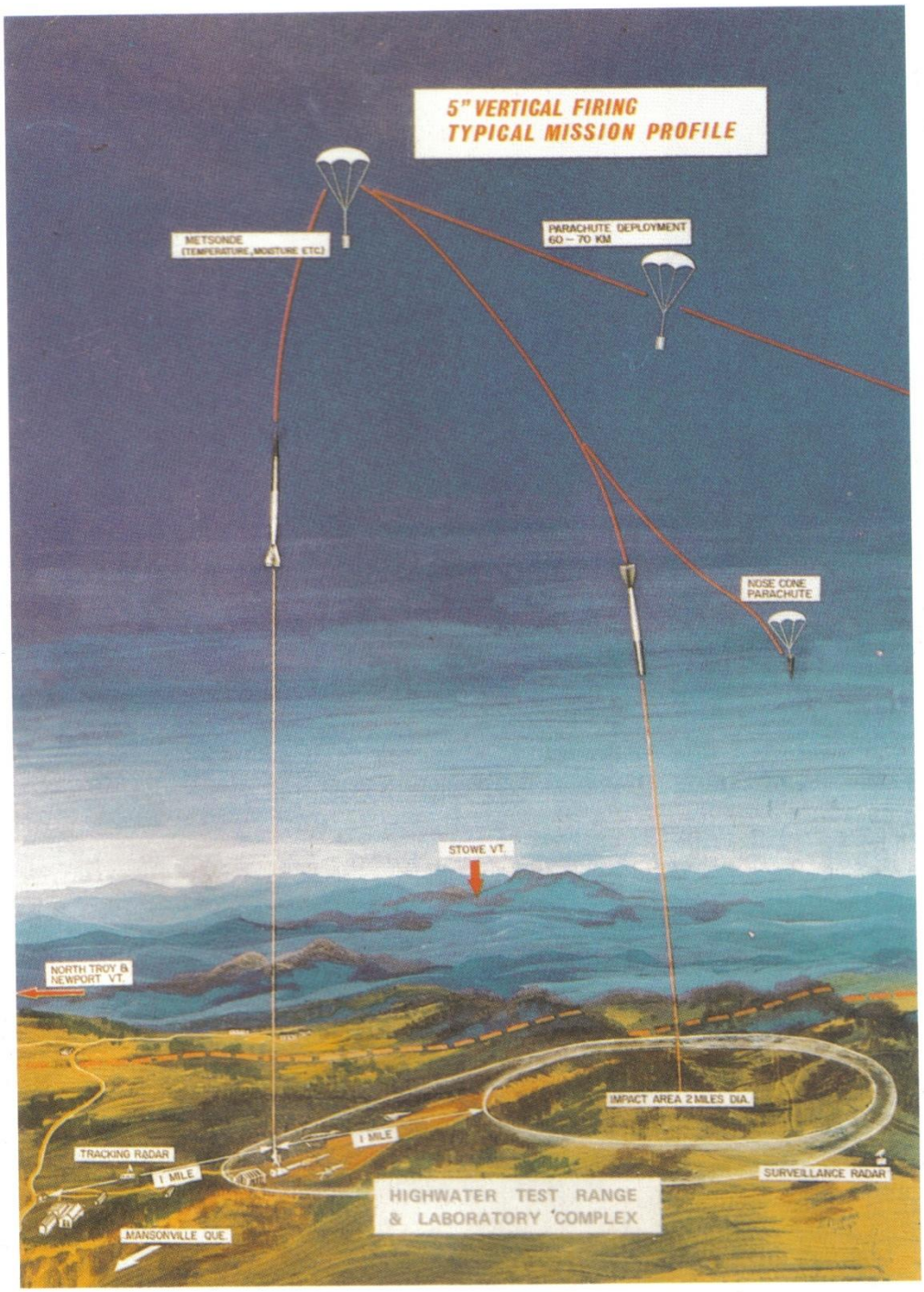
LAUNCH SITE AND RANGE SAFETY

One of the major advantages of a gun propulsion launch system is the accuracy of the flight path. Where a conventional rocket may veer off course and head in any direction a vehicle fired from a gun launcher follows a purely ballistic trajectory and, as with any firearm, the flight vehicle will follow an extremely predictable flight path. The bullet goes where you point the gun.

The design of the Starfire Space Cannon is heavily based on the space cannons used by the High altitude Research Project (HARP) during the 1960's. During the 1960's the HARP project conducted some three hundred flights identical to the type that we intend to fly and we expect the flight profile and the down range safety area to be nearly identical.

In fact our Mosquito flight vehicle is almost an identical copy of one of the HARP 5" flight vehicles.

The safety template of the HARP 5" flight vehicles is public information. Since our flight vehicle is a close copy of one of the HARP vehicles it is possible to present empirical flight data to describe the down range safety for our flights



The above image is a diagram of the HARP flight profile for the HARP 5" gun launcher. The impact zone is a circle 2 miles (3.2km) in diameter with its center two miles (3.2km) from the gun launcher. The total danger area is considered to be no more than 5km from the gun launcher. This diagram is taken from the book "The Paris Guns and Project HARP" (ISBN 3-8132-0304-2)

I will note that in this image the US/Canadian border (Orange dashed line) is only about one mile (1.6km) from the gun launcher. In the hundreds of flights conducted they never once landed a vehicle over the US Border. These flights had a maximum altitude of 72km and we are expecting an initial lower altitude of about 60km.

This information provides a good understanding of the flight profile and the impact zones for the mosquito flight vehicle.

Range safety

Range safety, is of course, our primary concern.

Since no one in Canada has ever successfully create a commercial space launch company in Canada before there is no established president for commercial safety regulations for space flight operations in Canada.

Because there are no established safety regulations for space flight operations in Canada it was necessary for Starfire Scientific to look outside of Canada.

Starfire scientific has chosen to adopt the standards established by the nation of Sweden for their Esrange rocket range. The Esrange is a major spaceport in Sweden that services the European Union.

The Esrange Range Safety Manuel was developed in cooperation with the Goddard Space Center in the USA and it copies the standards of the US space flight industry making it a world class publication.

Starfire Scientific has adopted the Esrange flight safety manual as the standard for range safety. In addition Regional health and safety regulations will be followed for all range operations.

All of the launches that we intend to conduct are regulated by Transport Canada. Transport Canada has an established approval process for sub-orbital space flights and it is expected that all aspects of a flight operation will be scrutinised by Transport Canada prior to giving their approval.

We have prearranged for liability insurance for these suborbital flights. It must be determined if our current offer for liability insurance is suitable for a launch site in Labrador.

LAUNCH PROGRAM OVERVIEW

At this time Starfire scientific is preparing to conduct the final operational testing of the Starfire Space Cannon. We would like to complete this testing in 2016 and to begin commercial space flight operations in 2017.

The initial testing of this launch system began in 2012 and over a two year period some two dozen tests were performed. These tests were used to prove the basic engineering premises as well as to prototype the basic ballistics.

All of these preliminary tests were performed on a private horizontal test range and were fired horizontally into a large earthen mound.

Even though these initial tests have given us a high degree of confidence in this launch system, testing will continue systematically building up on successes until our launch system is fully operational. The final operational tests will be conducted in two phases. The first phase will be used to prove the Starfire space cannon firing in the vertical position for the first time. In the second phase we will be flying our Mosquito flight vehicle.

Once a Starfire space cannon has been successfully demonstrated as a suborbital launch system we will be offering the Starfire space cannon as a commercial space flight service. At that time would like to re-evaluate this operation and move towards establishing a permanent launch site.

PHASE ONE TESTING

Phase one testing will test the gun launcher and all of the associated equipment with the primary goal being to insure the mechanical integrity of the launch system while firing in the vertical position for the first time.

For these shots we will be using Standard test slugs. These test slugs are a simple plywood box held together with short nails and filled with sand to provide a standard shot mass.

As we are launching at a velocity in the range of mach 3-5 and the slugs are not stabilized in any manner it is expected that they will tumble and tear themselves apart in the first 100 meters or so of flight and the pieces are expected to come down quite close to the launcher.

For these flights we are considering a maximum altitude envelope of 1000m although the pieces are not expected to come close to this.

We are planning for six test shots in the Phase One testing. If everything goes well we can complete these tests with four shots. If problems are encountered then we may need to add extra tests.

Standard Test Slug

PHASE TWO TESTING

The second phase of testing is to conduct up to four high altitude test flights.

The vehicle that we will be using is a ballistic glide probe, that we are calling the Mosquito, which will derive its entire propulsive impulse from the Starfire Space Cannon.

It is expected that these early flights will reach an initial altitude of approximately 60km, depending on launch velocity and other factors. The decent of these vehicles may be by free fall or by parachute decent, depending on the mission being performed.

The fins will be canted to induce spin and it is expected that the flight performance will very predictable and repeatable. Tracking will be by radio beacon and by GPS.

Flight time is expected to be about 300 seconds or about 5 minutes. Considering final flight preparations and the post flight operations we would need only about 15 minutes to conduct a flight.

Our Mosquito flight vehicle is basically the equivalent of the HARP 5.1 and 5.2 vehicles in performance. The flight profile of these HARP vehicles is well known and was established over more than 300 flights in the 1960's. For more

information about the HARP 5.1 and 5.2 vehicles please see my articles at the Encyclopedia Astronautica at http://www.astronautix.com/articles/abroject.htm

The Mosquito flight vehicle

Once we have empirical data from the early mosquito flights improvements will be made to both the Starfire Space cannon and the Mosquito flight vehicle with the goal of reaching an altitude of 100km.

With the completion of the phase two testing in 2016 we will begin marketing our services and in 2017 we will start conducting commercial flight operations.

COMMERCIAL FLIGHT OPERATIONS

With the completion of phase one and phase two testing Starfire scientific will be positioned two begin offering the Starfire space cannon as a commercial space flight service.

Initially this will be based around suborbital launch services and will progress two launching small satellites.

It is expected that Starfire Scientifics' very low cost service will attract customers worldwide. As well we are expecting a significant interest in our operations as a major tourist attraction.