Memberships and Honors

- Meteorologist Distinguished Service Award, 2013, Weather Modification Association
- Member, Weather Modification Association (certified operator #78)
- Member, American Meteorological Society
- Iowa Central Community College Honor Society, inducted April 27, 2000
- Wilbur E Brewer Professionalism Award, 2007 North Dakota Cloud Modification Project

Field Address:	Olds-Didsbury Airport, Highway 2A, Olds, AB
Field Telephone no.	403-335-8359
Field personnel:	full time = 3 part time = 14

Daily records of activities: Custodian = Ms. Erin Fischer
WMI Project Operations Centre
Olds-Didsbury Airport, Highway 2A, AB T4H 1A1

All records are maintained June 1st -Sept. 15th annually.

- daily weather synopsis and forecast report
- radar echo storm data report and maps
- daily operations summary report
- chemical inventory report
- equipment status report
- aircraft flight track maps
- flight log report
- project aircraft maintenance report

PART 6. GENERAL INFORMATION CONCERNING PROPOSED ACTIVITY

Reasons for organization seeking modified weather: The hailstorm on Sept. 7, 1991 caused >$400 million damage in the City of Calgary alone. Hailstorms in the City of Calgary caused >$500 Million in 2010 and again in 2012. In addition, hailstorms have caused >$100 Million damage to crops annually since 2007 and the damage to crops was >$400 Million in 2012. Hailstorms have now become a billion dollar problem to the economy of Alberta. The 20 largest insurance companies and their affiliates have banded together to conduct hail suppression operations in the "hail alley" of central Alberta to combat urban hail damage in the Calgary to Red Deer area. The current program has conducted cloud-seeding operations in central Alberta each summer since 1996.

Specific modification sought: Diminish hail damage to property in central Alberta with special priority given to the urban areas of Calgary and Red Deer.

Quantitative estimate of modification expected: Even very small positive results (+1%) will be economically beneficial, however, it is hoped that reductions in damage on the order of 25% or greater will be realized. The insurance industry has been encouraged by the results, estimating a savings of several hundred-million dollars to the industry, paying out approximately 50% of what they expected.

Secondary effects anticipated: Reductions in crop damage due to hail should also be realized. Seeding may also provide an increase in precipitation according to recent analyses of radar data. The crop hail insurance data for the first 10 years of the project indicated a reduction in the loss-to-risk values compared with the historical 58 year average for the province as a whole. However, a recent analysis shows increased variability and an increasing trend in hail damage over the last 10 years both inside and outside the project area which is likely due to climate change. The effect of the seeding on crop damage is inconclusive at this time.

Geographic area affected (see attached map): The main project area is from Calgary to Red Deer, Alberta and west to the foothills of the Rocky Mountains.

Estimate of adjoining geographic area possibly affected: Areas downwind (east) of highway no. 2 to highway no. 21 may also benefit from the seeded storms.
Approximate total cost: approx. $3.1 million per year.

Funds to be expended in Canada: est. $600,000 per year.

General period of operation: June 1st - Sept. 15th annually.

PART 7. GENERAL INFORMATION CONCERNING OPERATIONS AND TECHNIQUES

A. GENERAL: The following text describes the methods to be used, general principles of techniques, description of specific techniques, and a brief description of typical operations:

OVERVIEW OF METHOD
For hail suppression, aircraft patrolling based upon forecasts and hourly weather reports will be used to initiate seeding as soon as appropriate conditions develop. Storms will be seeded if they have radar reflectivities of approximately 35 dBZ at heights above the -5°C temperature level, and are considered to be a potential hail threat to an urban or populated area. When large hail is forecast, seeding will commence when radar reflectivities reach approximately 20 dBZ in order to start the microphysical suppression process as early as possible within the potential hailstorms. Storms will be seeded by aircraft using either droppable AgI pyrotechnics and/or wing mounted AgI pyrotechnics or AgI-solution burners.

The amount of seeding material used will depend upon the lifetime and size of the cloud or storm and other meteorological conditions. The seeding rates are about double those used during the 1970's and 1980's in Alberta. Seeding will be focused on the feeder clouds of the storm's new growth zone and will be conducted at cloud top and cloud base. Further details of the seeding method are discussed below.

HAIL SUPPRESSION HYPOTHESIS
The cloud seeding hypothesis is based on the cloud microphysics concept of "beneficial competition". Beneficial competition assumes a lack of natural ice nuclei in the environment effective at temperatures warmer than -20°C and that the injection of AgI will result in the production of a significant number of "artificial" ice nuclei. The natural and artificial ice crystals "compete" for the available supercooled liquid cloud water within the storm. Hence, the hailstones that are formed within the seeded cloud volumes will be smaller and produce less damage if they should survive the fall to the surface. If enough nuclei are introduced into the new growth region of the storm, then it is possible that the hailstones will be small enough to melt completely before reaching the ground.

Cloud seeding operations are intended to alter the cloud microphysics of the treated clouds, assuming that the present precipitation process is inefficient due to a lack of natural ice nuclei. The seeding is based on a conceptual model of Alberta hailstorms that evolved from the studies of Chisholm (1970), Chisholm and Renick (1972), Barge and Bergwall (1976), Krauss and Marwitz (1984), English and Krauss (1986) and English (1986).

It is assumed that hail embryos grow within the time evolving "main" updraft of single cell storms and within the updrafts of developing "feeder clouds" or cumulus towers that flank mature "multi-cell" and "super-cell" storms (see e.g. Foote 1984). The growth to large hail is hypothesized to occur along the edges of the main storm updraft where the merging feeder clouds interact with the main storm updraft.

For hail suppression, seeding with a large amount of silver-iodide will dramatically increase the ice crystal concentration in thunderstorm clouds and compete for the available supercooled cloud water to prevent the growth of large, damaging, ice particles. Based on WMI's experience, the cloud seeding will be targeted on the feeder cloud updraft regions associated with the production of hail and will leave unseeded those regions of the storm associated with the production of rain only. This will make efficient use of the seeding material (AgI) and will reduce the possible risk of overseeding rain clouds.

CLOUD SEEDING METHODOLOGY - SEEDING TECHNIQUES

Convective cells (defined by radar) with maximum reflectivity approximately >35 dBZ within the cloud layer above the -5°C level, located within the project areas or within a 20 min travel time "buffer zone" upwind of the project area, will be seeded if they pose a potential threat of damaging hail for an urban or populated area. Radar observers/controllers will be responsible for making the "seed" decision and directing the cloud seeding missions.

Patrol flights will be launched before clouds within the target area meet the radar reflectivity seeding criteria. These patrol flights are meant to provide immediate response to developing cells. In general, a patrol is launched in the event of visual reports of vigorous towering cumulus clouds near Calgary or Red Deer, or when radar cells exceed 25 kft height over the higher terrain along the western border and begin moving towards the urban areas.

Launches of more than one aircraft are determined by the number of storms in each area, the lead time required for a seeder aircraft to reach the proper location and altitude, and projected overlap of coverage and on-station time for multiple aircraft missions. In general, only one aircraft can work safely at cloud top and one aircraft at cloud base for a single storm. The operation of three aircraft is recommended to provide uninterrupted seeding coverage at either cloud-base or cloud-top and to seed three storms simultaneously if required.

The program is designed to seed convective clouds, before they achieve radar reflectivities associated with hail, and deliver seeding material to regions of updraft and supercooled liquid water i.e. the primary conditions responsible for the growth of hailstones.

Factors that determine cloud top or cloud base seeding are: storm structure, visibility, cloud base height, or time available to reach seeding altitude. Cloud base seeding is conducted by flying at cloud base within the main inflow of single cell storms, or the inflow associated with the new growth zone (shelf cloud) located on the upshear side of multi-cell storms.

Cloud top seeding is conducted between typically between -5°C and -10°C. The pencil flares fall approximately 1.5 km (approximately 10°C) during their 35-40 second burn time. The seeding aircraft will penetrate the edges of single convective cells meeting the seed criteria. For multi-cell storms, or storms with feeder clouds, the seeding aircraft will penetrate the tops of the developing cumulus towers on the upshear sides of convective cells, as they grow up through the aircraft's altitude.

Occasionally, with embedded cells or convective complexes, there are no clearly defined feeder turrets visible to the flight crews or on radar. In these instances, at an altitude between -5°C and - 10°C, a seeding aircraft will penetrate the storm edge (region of tight radar reflectivity gradient) on the upshear side and burn a burn-in-place flare and inject droppable pencil flares when updrafts are encountered.

Seeding is effective only within cloud updrafts and in the presence of supercooled cloud water, i.e. the developing, and mature stages in the evolution of the classic thunderstorm conceptual model. The dissipative stages of a storm would be seeded only if the maximum reflectivity is particularly severe and there is evidence (visual cloud growth, or tight reflectivity gradients) indicating the possible presence of embedded updrafts.

SEEDING RATE

A seeding rate of one 20 g flare every 5 s is typically used during cloud penetration. A slightly higher rate is used (e.g. 1 flare every 2 s) if updrafts are very strong (e.g. > 2000 ft/min) and the storm is particularly intense. Calculations show that this seeding rate will produce >1300 ice crystals per litre which is more than sufficient to deplete the liquid water content produced by updrafts of 10 m/s (2000 ft/min), thereby preventing the growth of hailstones within the seeded cloud volumes.

A cloud seeding pass is repeated immediately if there are visual signs of new cloud growth or radar reflectivity gradients remain tight (indicative of persistent updrafts). A 5 to 10 min waiting period may be used, to allow for the seeding material to take effect and the storm to dissipate, if visual signs of glaciation appear or radar reflectivity values decrease and gradients weaken. This waiting period precludes the waste of seeding material and ensures its optimum usage.

For cloud base seeding, a typical seeding rate of 1 burn-in-place flare (150 g each) is used. Cloud seeding runs are repeated until no further inflow is found. Wing-tip seeding solution burners will also be used to provide continuous silver iodide seeding if extensive regions of weak updraft are observed at cloud base and the shelf cloud region. Base seeding is not conducted if only downdrafts are encountered at cloud base, since this would waste seeding material.

The cloud seeding flares are silver-iodide pyrotechnics with an ice nuclei effectiveness of approximately 10^{14} nuclei per gram of pyrotechnic, active at -10°C, as determined by independent cloud chamber tests at Colorado State University.

Sufficient dispersion of the particles is required for AgI plume overlap from consecutive flares by the time the cloud particles reach hail size for effective hail suppression. The work by Grandia et al. (1979) based on turbulence measurements within Alberta feeder clouds indicated that the time for the diameter of the diffusing line of AgI to reach the integral length scale (200 m) in the inertial subrange size scales of mixing, was 140 seconds. This is insufficient time for ice particles to grow to hail size. Therefore, dropping flares at 5 sec intervals should effectively deplete the supercooled liquid water and prevent the growth of hail particles. The use of the 20 gram flares and a frequent drop rate provides better seeding coverage than using larger flares with greater time/distance spacing between flare drops. In fact, the above calculations are conservative when one considers that the center of the ice crystal plume center will have a higher concentration of crystals.

B. EQUIPMENT

Type:

- one Advanced Radar Corporation C-band Doppler weather radar, 250 kw peak power, with 1.65 deg. beam width, located at the Olds-Didsbury airport, 50ft tower-mounted, including radome.
- Three Beechcraft C90 King-Air prop-jet aircraft (two in Springbank and one in Red Deer).
- Two Cessna 340 aircraft (one in Springbank and one in Red Deer).

C. MATERIALS TO BE EMITTED:

- Cloud top (ejectable) pyrotechnic flares are 20g AgI formulation manufactured by Ice Crystal Engineering (ICE) of Kindred, North Dakota, USA (www.iceflares.com)
- Cloud base (burn-in-place) flares are 150g AgI formulation manufactured by Ice Crystal Engineering (ICE) of Kindred, North Dakota, USA (www.iceflares.com)
- A solution of acetone, silver iodide, sodium perchlorate, paradichlorobenzene, and ammonium iodide will also be burned for continuous seeding at cloud base. The products of combustion yield silver iodide (AgI) ice nuclei, carbon dioxide (CO_2), and water (H_2O).

Activation tests performed at Colorado State University indicate greater than10^{14} ice crystals per gram of seeding agent burned, active at -10°C.

Total flight hours and quantities to be dispersed: We estimate the project may use 8,500 twenty-gram flares and 1,000 one hundred-fifty gram flares, plus approximately 250 gallons of the seeding solution

(2% AgI by volume) will be burned. The number of operational days, flights, and amount of seeding material dispensed over the past fifteen years is summarized in the attached table. No harmful effects from these materials is expected. This is based on years of studies (both in the USA and Canada) to detect silver in precipitation (above background levels) following cloud seeding. The amount of silver distributed by the cloud seeding is small compared to the output from industry. Silver amounts from cloud seeding are far, far less than the USA EPA guidelines.

PART 8. GENERAL INFORMATION CONCERNING USE OF AIRCRAFT.

- Three C90 King Air prop-jet aircraft, two in Springbank (N904DK and N518TS) and one based in Red Deer (N522JP).
- Two Cessna 340 aircraft, one in Springbank (N234PS) and one in Red Deer (N37356).

PART 9. GENERAL INFORMATION CONCERNING USE OF GROUND VEHICLES.

No special project ground vehicles will be deployed for the project. (Only private vehicles for personal transportation will be used.)

PART 10. GENERAL INFORMATION CONCERNING ANY MEASUREMENTS OR OBSERVATION INSTRUMENTATION.

No special surface observations are planned for this project. The primary instrumentation is the weather radar and special aircraft instrumentation. Daily weather charts will be recorded for documentation and reporting purposes.

AIRCRAFT TRACKING GLOBAL POSITIONING SYSTEM (GPS): The WMI weather radar control and communications center will be equipped to receive and record data from the GPS aircraft tracking system. The GPS system displays the exact position of aircraft superimposed on the radar display to enable the controller to accurately direct the seeding aircraft to optimum seeding locations within the storm system. The color-coded aircraft position on the PPI will be marked with a small symbol. Electronic coding will enable radar controllers to discriminate between all project aircraft.

TEMPERATURE INSTRUMENTATION: Each of the cloud seeding aircraft will have a temperature sensor to ensure that the cloud penetration seeding runs are conducted at the proper temperature levels.

WEATHER RADAR: The C-band Doppler radar will be equipped with a computerized radar recording and display system. The radar recording system will be capable of providing numerous cell statistics and colour products including plots of radar PPI displays and maximum reflectivity maps. The sophisticated radar tracking software called TITAN (Thunderstorm Identification, Tracking, Analysis, and Nowcasting) has been used since 1997 and has proved to be very useful. TITAN is licensed from the U.S. National Center for Atmospheric Research (NCAR).

PART 11. CERTIFICATION BY ORGANIZATION FOR WHOM ACTIVITY IS TO BE CONDUCTED:

State type of working agreement entered into with the weather modifier: Contract.

I HEREBY CERTIFY THAT ALL STATEMENTS MADE IN THIS NOTIFICATION OF INTENT TO ENGAGE IN WEATHER MODIFICATION ACTIVITIES ARE TRUE AND COMPLETE TO THE BEST OF MY KNOWLEDGE, AND REPRESENT IN SUBSTANCE AN ACCURATE DESCRIPTION OF A PROPOSAL TO UNDERTAKE WEATHER MODIFICATION ACTIVITIES ON BEHALF OF THE ORGANIZATION NAMED HEREIN.

Name of organization: Alberta Severe Weather Management Society

Full name of certifying officer and title:

Todd Klapak
President, Alberta Severe Weather Management Society
(403) 231-1357, Todd.Klapak@intact.net

Signature: Date: May 09, 2018

PART 12. CERTIFICATION BY PERSON PROPOSING TO CONDUCT ACTIVITY.

I HEREBY CERTIFY THAT INFORMATION PROVIDED IN THIS NOTIFICATION OF INTENT TO ENGAGE IN WEATHER MODIFICATION ACTIVITIES IS A TRUE AND COMPLETE DESCRIPTION OF MY PROPOSED PLANS TO ENGAGE IN THE SPECIFIC WEATHER MODIFICATION ACTIVITIES HEREIN DESCRIBED.

Name of organization: Weather Modification International

Full name of certifying officer:
Bruce A. Boe
Vice President of Meteorology
(701) 235-5500

Bruce A. Boe

Signature: Date: May 09, 2018

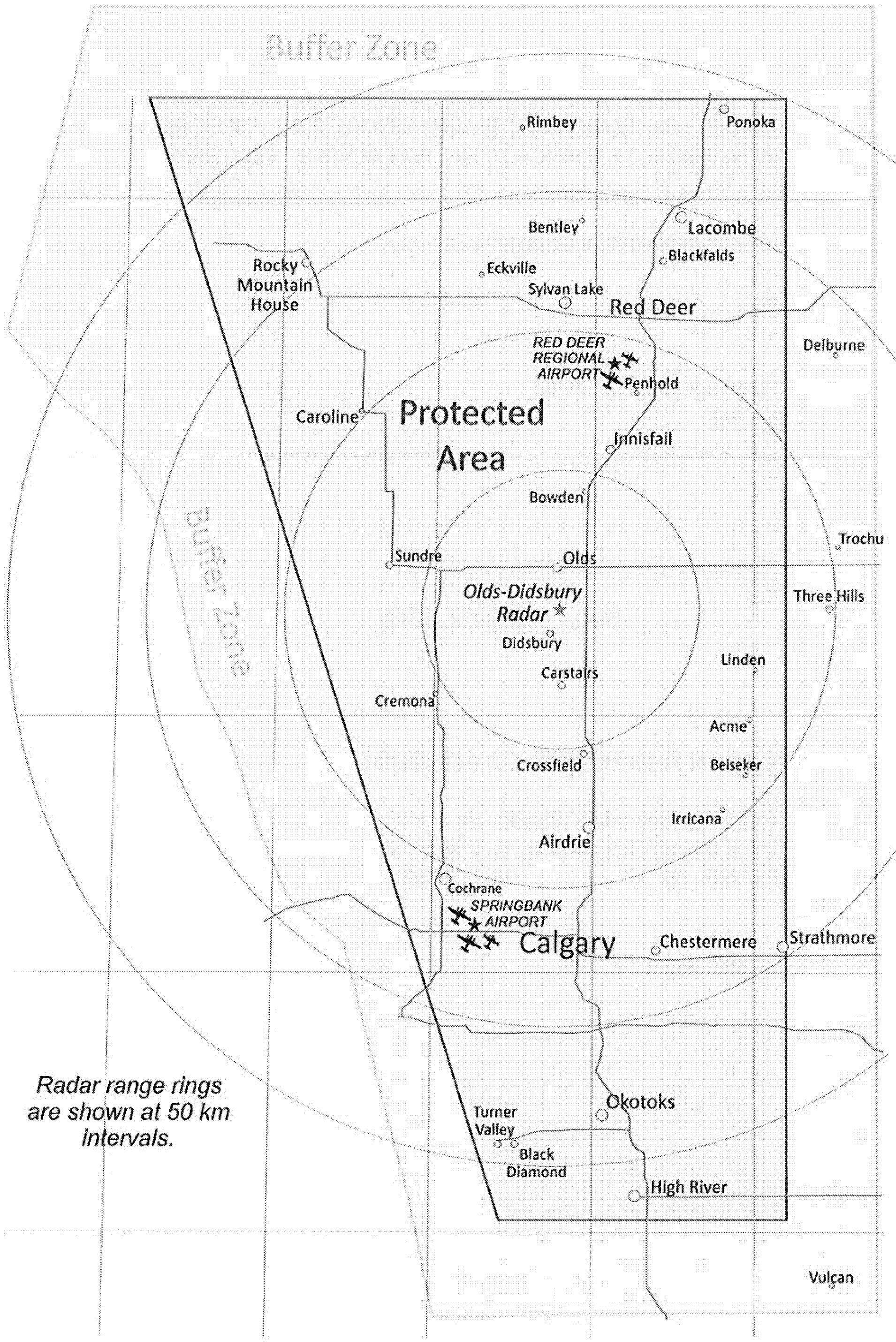

Figure 1: Map of south-central Alberta showing the project area, outlined in green, covered by the Hail Suppression activities.

Table 1. Seeding activity through 2017.

Season	Storm Days With Seeding	Aircraft Missions (Seeding & Patrol)	Total Flight Time (hours)	Number of Storms Seeded	Total Seeding Agent (kg)	Seeding Agent Per Day (kg)	Seeding Agent Per Hour (kg)	Seeding Agent Per Storm (kg)	Ejectable Flares	Burn-in-place Flares	Seeding Solutions (gallons)	Season Activity Rank
2017	25	107	224.5	64	255.4	10.2	1.14	3.99	5939	842	170.2	10
Mean	**31**	**105**	**216.2**	**91**	**220.1**	**7.1**	**1.03**	**2.52**	**5274**	**689**	**166.8**	
2016	35	139	277.1	96	294.9	8.4	1.06	3.07	6496	1000	246.9	6
2015	26	115	233.3	79	349.2	14.6	1.37	4.42	8127	1138	262.9	8
2014	32	128	259.5	101	382.5	12.0	1.47	3.79	10782	1020	228.6	3
2013	26	103	229.6	70	233.3	9.0	1.02	3.33	6311	636	131.7	13
2012	37	143	300.1	116	314.6	8.5	1.16	2.70	7717	914	260.3	2
2011	48	158	383.0	134	400.1	8.3	1.13	3.00	10779	1020	350.2	1
2010	42	115	271.8	118	263.8	6.3	1.10	2.20	5837	851	227.5	7
2009	20	38	109.3	30	48.4	2.4	0.84	1.60	451	237	56.5	22
2008	26	112	194.7	56	122.9	4.7	1.00	2.20	1648	548	113.5	17
2007	19	76	115.3	41	99.7	5.2	0.90	2.40	1622	413	77	21
2006	28	92	190.2	65	214	7.6	1.10	3.30	4929	703	145.4	14
2005	27	80	157.9	70	159.1	5.9	1.00	2.30	3770	515	94.2	19
2004	29	105	227.5	90	270.9	9.3	1.20	3.00	6513	877	132.7	9
2003	26	92	163.6	79	173.4	6.7	1.10	2.20	4465	518	92.6	16
2002	27	92	157.4	54	124.2	4.6	0.80	2.30	3108	377	80.3	20
2001	36	109	208.3	98	195	5.4	0.90	2.00	5225	533	140.8	11
2000	33	130	265.2	136	343.8	10.4	1.30	2.50	9653	940	141.3	4
1999	39	118	251.3	162	212.7	5.5	0.80	1.30	4439	690	297.5	5
1998	31	96	189.9	153	111.1	3.6	0.60	0.70	2023	496	193.8	12
1997*	38	92	188.1	108	110.8	2.9	0.60	1.00	2376	356	144.3	15
1996*	29	71	159.1	75	163.3	5.6	1.00	2.20	3817	542	80.5	18

**The 1996 and 1997 seasons began on June 15, not June 1, which has been the norm ever since.*

Annual Report of Alberta Severe Weather Management Society Hail Suppression Efforts

2019 Operations – June 1 through 15 September

Information prepared by Weather Modification LLC, dba Weather Modification International (WMI)
info@weathermod.com, www.weathermod.com

All cloud seeding flights were conducted in accordance with the scientific principles described in the *Notice of Intent to Engage in Weather Modification Activities* submitted to Environment Canada in May 2019, within the limits of the operations area delineated therein.

Accordingly, some acronyms used in the following tables require explanations, provided below.

Missions by Type (top left table)
Total time – the elapsed time from engine start to engine stop.
Air time – the elapsed time from takeoff to landing.
SEED – time flown on missions during which any seeding was conducted, regardless of amount.
PATROL – time flown in anticipation of encountering potential severe weather, when seeding did not occur.
REPO – (Reposition) time flown when aircraft were flown to other airports in anticipation of severe weather.
PR – flights made to the project operations centre for the purposes of the insurance industry-accredited lectures.
DUAL – flights flown for dual-mode seeding, that is, the combined use of ice-forming and drop-forming seeding agents.
MX – maintenance flights. Maintenance flights were to ensure functionality after repairs, and at the expense of WMI.

Aircraft Identifiers
Hailstop #1, HS1 – tail number N904DK, based in Springbank
Hailstop #2, HS2 – tail number N457DM, based in Springbank
Hailstop #3, HS3 – tail number N127ZW, based in Red Deer
Hailstop #4, HS4 – tail number N37356, based in Red Deer
Hailstop #5, HS5 – tail number N518TS, based in Springbank

Flare Usage (by aircraft, top right table)
BIP – burn-in-place flare, contains 150g of ice-forming seeding agent
HBIP – burn-in-place flare, contains 1000g of drop-forming seeding agent (salt)
EJ – ejectable flare, contains 20g of ice-forming seeding agent
BURNER MINS – the length of time wing-tip borne ice-forming seeding solution generators were operated
TOTAL GRAMS – the total mass of seeding agent released in each category, in grams.

Flight Time (by aircraft, by month, found below the *Flare Usage* table)
Self-explanatory.
TOTAL HOURS – the total time flown by all five Hailstop aircraft in each month, given in hours and minutes.

Operations Summary (the large table that comprises the remainder of the document)
 # Flights – the total number of flights flown for project purposes (not maintenance)
UTC DATE – Universal Time Coordinates, or UTC, is used worldwide for all meteorological and aviation purposes. UTC is six hours ahead of Mountain Daylight Time (MDT), so to convert UTC to MDT, subtract six hours.
HAILSTOP – the aircraft flying the mission, e.g. HS2 = Hailstop 2, based in Springbank (see Aircraft Identifiers, above)
OPS # -- The flight number for each specific aircraft, used only for administrative purposes.
ENGINES ON – the UTC time engines were started for that mission.
ENGINES OFF -- the UTC time engines were shut down after that mission.
TOTAL TIME – the time the engines ran, in hours and minutes.
MISSION TYPE – see *Missions by Type*, above.

EJ # – the number of ice-forming EJ flares expended on the mission.
BIP # -- the number of ice-forming BIP flares expended on the mission.
HYGRO # -- the number of droplet-forming hygroscopic (salt) flares expended on the mission.
Burner minutes – the length of time ice-forming solution was burned. Only Hailstop 2 and Hailstop 4 have burners, so there are never any burner minutes for the others.
TOTAL TIME FOR DAY – the total time accrued by all HS aircraft on each day.
EJ – the total number of EJ pyrotechnics (flares) used on each date.
BIP – the total number of BIP pyrotechnics (flares) used on each date.
BURNER MINS – the total minutes ice-forming solution was burned on each date.
AGI SEED AMOUNT PER DAY – the total mass of ice-forming seeding agent released on each date. This is the total of the amounts in the EJs, BIPs, and solution burned.
HYGROSCOPIC FLARES – the total number of droplet-forming (salt) flares burned on each date.
CaCl SEED AMOUNT PER DAY – the total mass of salt dispersed through the use of HYGRO flares on each date.
 # Storms – the total number of storm complexes seeded on each date.

WEATHER MODIFICATION INTERNATIONAL

ALBERTA HAIL SUPPRESSION PROJECT 2019 - ***Universal Time Coordinates***

Last Data Revision Date: 4/1/2020

www.weathermodification.com

	TOTAL TIME	AIR TIME
SEED	214:41	195:16
PATROL	29:13	24:03
REPO	7:21	4:37
PR	7:34	4:29
DUAL	9:21	8:16
MX	9:37	4:37
TOTALS	277:47	241:18

FLARE USAGE	HS1	HS2	HS3	HS4	HS5	TOTAL COUNT	TOTAL GRAMS
BIP (150g)	234	198	178	101	201	**912**	136800
HBIP (1000g)	22	0	0	0	15	**37**	37000
EJ (20g)	2808	0	2354	0	2358	**7520**	150400
BURNER MINS		2843		1673		**4516**	9158

FLIGHT TIME	HS1	HS2	HS3	HS4	HS5	TOTAL HOURS
JUNE	21:45	17:31	9:40	13:57	25:10	88:03
JULY	28:58	31:03	20:46	26:13	31:51	138:51
AUGUST	10:27	9:15	11:17	5:55	8:24	45:18
SEPTEMBER	1:59	2:06	0:45	0:45	0:00	5:35
TOTAL BY HS#	63:09	59:55	42:28	46:50	65:25	

HAILSTOP #1	**N904DK**
HAILSTOP #2	**N457DM**
HAILSTOP #3	**N127ZW**
HAILSTOP #4	**N37356**
HAILSTOP #5	**N518TS**

** Indicates pyrotechnic material expended for testing.*

STORM DAY SUB-TOTALS

(Storm-day chemical totals **ONLY include flares spent for seeding**).

(Storm-day totals **ONLY include flight hours for seed, patrol, and dual-mode**).

# Flights:	**158**				**277:47**		**7520**	**912**	**37**	**4516**	**TOTAL TIME FOR DAY**	**EJ**	**BIP**	**BURNER MINS**		**HYGROSCOPIC FLARES**		
UTC DATE	**HAILSTOP**	**OPS #**	**ENGINES ON (UTC)**	**ENGINES OFF (UTC)**	**TOTAL TIME (hh:mm)**	**MISSION TYPE**	**EJ (#)**	**BIP (#)**	**HYGRO (#)**	**Burner Minutes**					**AGI SEED AMOUNT PER DAY** (Grams)		**CaCl SEED AMOUNT PER DAY** (Grams)	**# Storms**
01-Jun-19	HS2	MX	20:00	20:28	0:28	MX					0:00				0	0	0	
04-Jun-19	HS4	HS4-1	19:31	21:06	1:35	SEED		5		82					0		0	
04-Jun-19	HS1	HS1-1	19:55	21:30	1:35	SEED	23				3:10	23	5	82	1376	0	0	1
08-Jun-19	HS1	HS1-2	19:39	21:11	1:32	SEED	22	7							0		0	
08-Jun-19	HS2	HS2-1	22:20	0:09	1:49	SEED		3		45					0		0	
08-Jun-19	HS5	HS5-1	22:21	2:28	4:07	SEED		26							0		0	
09-Jun-19	HS1	HS1-3	0:32	2:51	2:19	SEED	174	17							0		0	
09-Jun-19	HS1	MX	3:01	3:30	0:29	MX					9:47	196	53	45	11961	0	0	4
09-Jun-19	HS3	HS3-1	21:38	23:16	1:38	SEED	12	4			1:38	12	4		840	0	0	1
11-Jun-19	HS1	HS1-4	1:12	2:00	0:48	PATROL					0:48	0	0	0	0	0	0	
12-Jun-19	HS2	MX	19:15	19:47	0:32	MX					0	0	0	0	0	0	0	
13-Jun-19	HS1	HS1-5	17:58	20:10	2:12	SEED	32	8							0		0	
13-Jun-19	HS4	HS4-2	18:26	21:20	2:54	SEED		11		236					0		0	
13-Jun-19	HS5	HS5-2	19:09	22:54	3:45	SEED	289	27							0		0	
13-Jun-19	HS3	HS3-2	19:45	21:18	1:33	SEED	256	10							0		0	
13-Jun-19	HS2	HS2-2	21:20	23:28	2:08	SEED		17		180					0		0	
13-Jun-19	HS3	HS3-3	22:01	23:47	1:46	SEED	219	14							0		0	
13-Jun-19	HS4	HS4-3	23:42	0:30	0:48	REPO					14:18	796	87	416	29814	0	0	3
14-Jun-19	HS4	HS4-4	21:50	23:38	1:48	SEED				20					0		0	
14-Jun-19	HS5	HS5-3	22:13	23:37	1:24	PATROL					3:12	0	0	20	41	0	0	1
17-Jun-19	HS2	HS2-3	21:50	23:16	1:26	SEED		11		124					0		0	
17-Jun-19	HS5	HS5-4	21:51	0:12	2:21	SEED		12			3:47	0	23	124	3701	0	0	1
18-Jun-19	HS1	HS1-6	18:26	19:23	0:57	PATROL									0		0	
18-Jun-19	HS1	HS1-7	20:22	22:04	1:42	SEED	195	5							0		0	
18-Jun-19	HS2	HS2-4	20:25	22:38	2:13	SEED		10		222					0		0	
18-Jun-19	HS4	HS4-5	20:27	22:21	1:54	SEED		4		76					0		0	
18-Jun-19	HS3	HS3-4	21:35	0:29	2:54	SEED	258	15							0		0	
18-Jun-19	HS5	HS5-5	21:50	23:40	1:50	SEED	84	6							0		0	
18-Jun-19	HS1	HS1-8	22:55	3:15	4:20	SEED	297	36							0		0	
18-Jun-19	HS4	HS4-6	23:02	1:26	2:24	SEED		13		194					0		0	
19-Jun-19	HS5	HS5-6	0:44	3:31	2:47	SEED	142	13							0		0	
19-Jun-19	HS2	HS2-5	0:54	3:21	2:27	SEED		13		213					0		0	
19-Jun-19	HS3	HS3-5	1:03	2:52	1:49	SEED	227	18			25:17	1203	133	705	45440	0	0	7
20-Jun-19	HS1	HS1-9	15:18	15:51	0:33	PR									0		0	
20-Jun-19	HS1	HS1-10	21:42	22:05	0:23	PR					0	0	0	0	0	0	0	
23-Jun-19	HS4	HS4-7	19:20	20:38	1:18	PATROL									0		0	
24-Jun-19	HS5	HS5-7	2:10	3:16	1:06	PATROL					2:24	0	0	0	0	0	0	0
25-Jun-19	HS5	HS5-8	18:48	22:28	3:40	SEED	149	9							0		0	
25-Jun-19	HS2	HS2-6	18:56	21:54	2:58	SEED		9		46					0		0	
25-Jun-19	HS2	MX	23:02	23:12	0:10	MX					6:38	149	18	46	5773	0	0	2
26-Jun-19	HS5	HS5-9	19:27	23:37	4:10	SEED	288	16							0		0	
26-Jun-19	HS2	HS2-7	21:30	0:50	3:20	SEED		13		236					0		0	
26-Jun-19	HS1	HS1-11	23:32	0:51	1:19	SEED	60	6			8:49	348	35	236	12689	0	0	1
27-Jun-19	HS4	HS4-8	16:22	16:59	0:37	PR									0		0	
27-Jun-19	HS4	HS4-9	22:25	23:04	0:39	PR									0		0	
28-Jun-19	HS1	HS1-12	1:08	2:58	1:50	SEED	136	13			1:50	136	13	0	4670	0	0	1
28-Jun-19	HS1	MX	14:25	15:10	0:45	MX									0		0	
28-Jun-19	HS1	MX	21:54	22:20	0:26	MX									0		0	
28-Jun-19	HS1	MX	22:40	23:15	0:35	MX					0	0	0	0	0	0	0	
01-Jul-19	HS3	HS3-6	19:04	22:16	3:12	SEED	25								0		0	
01-Jul-19	HS4	HS4-10	19:05	20:54	1:49	SEED				4	5:01	25		4	508	0	0	1
04-Jul-19	HS1	MX	15:00	15:43	0:43	MX									0		0	
04-Jul-19	HS1	MX	21:10	22:00	0:50	MX					0	0	0	0	0	0	0	0
05-Jul-19	HS4	MX	17:23	17:48	0:25	MX									0		0	
05-Jul-19	HS2	MX	17:25	18:18	0:53	MX					0	0	0	0	0	0	0	0
06-Jul-19	HS5	HS5-10	19:44	23:45	4:01	SEED	232	11							0		0	
06-Jul-19	HS2	HS2-8	21:40	0:28	2:48	SEED		13		186					0		0	
06-Jul-19	HS1	HS1-13	22:16	0:52	2:36	SEED	35	9							0		0	
06-Jul-19	HS4	HS4-11	22:25	0:50	2:25	SEED		11		130					0		0	
06-Jul-19	HS3	HS3-7	22:56	1:38	2:42	SEED	212	16							0		0	
07-Jul-19	HS4	HS4-12	2:06	2:33	0:27	REPO									0		0	
07-Jul-19	HS3	HS3-8	2:51	3:15	0:24	REPO									0		0	
07-Jul-19	HS5	HS5-11	2:55	3:31	0:36	REPO					14:32	479	60	316	19221	0	0	3
07-Jul-19	HS1	HS1-14	17:52	20:46	2:54	SEED	200	10							0		0	
07-Jul-19	HS2	HS2-9	18:00	19:20	1:20	PATROL									0		0	
07-Jul-19	HS4	HS4-13	20:35	23:42	3:07	SEED		8		137					0		0	

07-Jul-19	HS5	HS5-12	20:40	22:38		1:58	SEED	130	10							0		0	
07-Jul-19	HS3	HS3-9	22:40	23:57		1:17	SEED	167	9							0		0	
07-Jul-19	HS2	HS2-10	23:44	1:30		1:46	SEED		14		166					0		0	
07-Jul-19	HS1	HS1-15	23:44	2:57		3:13	SEED	156	21							0		0	
08-Jul-19	HS5	HS5-13	0:08	3:56		3:48	SEED	144	12			19:23	797	84	303	29154	0	0	6
08-Jul-19	HS3	HS3-10	21:51	23:52		2:01	PATROL					2:01	0	0	0	0	0	0	0
10-Jul-19	HS3	HS3-11	0:18	3:30		3:12	DUAL	268	17	0						0		0	
10-Jul-19	HS5	HS5-14	0:15	2:25		2:10	DUAL		15	15						0		0	
10-Jul-19	HS1	HS1-16	2:00	6:07		4:07	SEED	281	11							0		0	
10-Jul-19	HS2	HS2-11	2:04	6:02		3:58	SEED		15		372					0		0	
10-Jul-19	HS4	HS4-14	2:06	6:00		3:54	SEED		12		274					0		0	
10-Jul-19	HS5	HS5-15	4:55	6:05		1:10	SEED		7			18:31	549	77	646	23840	15	15000	1
10-Jul-19	HS4	HS4-15	21:52	23:23		1:31	SEED		1		30					0		0	
10-Jul-19	HS3	HS3-12	22:47	0:41		1:54	DUAL	284	14	0						0		0	
10-Jul-19	HS1	HS1-17	22:47	0:52		2:05	DUAL		16	22						0		0	
10-Jul-19	HS2	HS2-12	23:51	1:33		1:42	PATROL									0		0	
10-Jul-19	HS5	HS5-16	23:50	1:30		1:40	PATROL					8:52	284	31	30	10391	22	22000	1
11-Jul-19	HS2	MX	17:50	18:50		1:00	MX									0		0	
11-Jul-19	HS2	HS2-13	23:00	0:34		1:34	PATROL					0	0	0	0	0	0	0	0
13-Jul-19	HS2	HS2-14	20:00	23:15		3:15	SEED		11		117					0		0	
13-Jul-19	HS1	HS1-18	20:00	23:27		3:27	SEED	191	11							0		0	
13-Jul-19	HS4	HS4-16	22:04	1:32		3:28	SEED		20		148					0		0	
13-Jul-19	HS5	HS5-17	23:10	2:08		2:58	SEED	304	9							0		0	
14-Jul-19	HS4	HS4-17	1:54	2:35		0:41	REPO					13:08	495	51	265	18087	0	0	4
14-Jul-19	HS1	HS1-19	18:12	20:52		2:40	SEED	123	8							0		0	
14-Jul-19	HS2	HS2-15	19:44	20:36		0:52	SEED		5		31					0		0	
14-Jul-19	HS5	HS5-18	19:56	23:13		3:17	SEED	42								0		0	
14-Jul-19	HS3	HS3-13	21:11	22:31		1:20	SEED	61								0		0	
14-Jul-19	HS4	HS4-18	21:16	22:18		1:02	PATROL									0		0	
14-Jul-19	HS2	HS2-16	22:45	0:55		2:10	SEED				36	11:21	226	13	67	6606	0	0	4
15-Jul-19	HS4	HS4-19	21:56	0:07		2:11	SEED				28	2:11	0	0	28	57	0	0	1
18-Jul-19	HS5	HS5-19	20:12	21:27		1:15	SEED	60	7							0		0	
18-Jul-19	HS2	HS2-17	20:31	21:28		0:57	SEED		4		60					0		0	
18-Jul-19	HS2	HS2-18	22:48	23:13		0:25	REPO					2:12	60	11	60	2972	0	0	1
20-Jul-19	HS1	HS1-20	22:31	23:31		1:00	PATROL									0		0	
20-Jul-19	HS2	HS2-19	1:05	2:54		1:49	SEED		8		150					0		0	
21-Jul-19	HS5	HS5-20	1:45	3:15		1:30	SEED	160	10			4:19	160	18	150	6204	0	0	1
23-Jul-19	HS4	HS4-20	20:02	20:37		0:35	REPO									0		0	
24-Jul-19	HS4	HS4-21	3:00	3:39		0:39	PATROL					0:39	0	0	0	0	0	0	0
24-Jul-19	HS4	HS4-22	20:12	21:18		1:06	PATROL									0		0	
24-Jul-19	HS3	HS3-14	21:03	22:10		1:07	PATROL					2:13	0	0	0	0	0	0	0
25-Jul-19	HS2	HS2-20	17:30	18:01		0:31	REPO									0		0	
25-Jul-19	HS5	HS5-21	17:40	18:15		0:35	REPO									0		0	
25-Jul-19	HS1	HS1-21	17:41	18:13		0:32	REPO					0	0	0	0	0	0	0	0
27-Jul-19	HS2	HS2-21	18:50	20:12		1:22	PATROL									0		0	
27-Jul-19	HS1	HS1-22	23:41	0:31		0:50	PATROL					2:12	0	0	0	0	0	0	0
29-Jul-19	HS2	HS2-22	0:15	1:05		0:50	REPO									0		0	
29-Jul-19	HS1	HS1-23	0:36	1:05		0:29	REPO									0		0	
29-Jul-19	HS5	HS5-22	0:47	1:15		0:28	REPO					0:00	0	0	0	0	0	0	0
30-Jul-19	HS5	HS5-23	20:50	23:25		2:35	PATROL									0		0	
30-Jul-19	HS1	HS1-24	23:07	23:58		0:51	PATROL					3:26	0	0	0	0	0	0	0
31-Jul-19	HS1	HS1-25	20:15	22:56		2:41	SEED	279								0		0	
31-Jul-19	HS2	HS2-23	20:19	0:10		3:51	SEED		14		220					0		0	
31-Jul-19	HS4	HS4-23	20:31	23:24		2:53	SEED		5		86					0		0	
31-Jul-19	HS5	HS5-24	20:25	0:15		3:50	SEED	258	7							0		0	
31-Jul-19	HS3	HS3-15	23:46	3:23		3:37	SEED	296	29							0		0	
01-Aug-19	HS1	HS1-26	0:00	2:10		2:10	SEED		8							0		0	
01-Aug-19	HS4	HS4-24	0:15	2:07		1:52	SEED		5		136					0		0	
01-Aug-19	HS4	MX	3:18	3:36		0:18	MX					20:54	833	68	442	27756	0	0	3
03-Aug-19	HS4	HS4-25	2:00	3:27		1:27	PATROL									0		0	
03-Aug-19	HS3	HS3-16	2:07	3:31		1:24	PATROL					2:51	0	0	0	0	0	0	0
06-Aug-19	HS1	HS1-27	20:52	22:35		1:43	SEED	26	7							0		0	
06-Aug-19	HS2	HS2-24	21:44	23:22		1:38	SEED		9		81	3:21	26	16	81	3084	0	0	2
08-Aug-19	HS1	HS1-28	6:35	7:33		0:58	SEED		5							0		0	
08-Aug-19	HS5	HS5-25	6:36	7:48		1:12	SEED	11	4			2:10	11	9	0	1570	0	0	1
08-Aug-19	HS2	HS2-25	16:18	16:57		0:39	PR									0		0	
08-Aug-19	HS2	HS2-26	22:25	22:51		0:26	PR									0		0	
08-Aug-19	HS1	HS1-29	23:20	2:49		3:29	SEED	198	15							0		0	
08-Aug-19	HS2	HS2-27	23:44	1:24		1:40	SEED				64					0		0	
09-Aug-19	HS2	HS2-28	2:20	5:10		2:50	SEED				83					0		0	
09-Aug-19	HS3	HS3-17	2:21	4:01		1:40	SEED		12			9:39	198	27	147	8308	0	0	3
14-Aug-19	HS4	MX	17:22	17:41		0:19	MX									0		0	
14-Aug-19	HS3	HS3-18	18:13	21:55		3:42	SEED	69	4							0		0	
14-Aug-19	HS5	HS5-26	21:22	0:37		3:15	SEED	65				6:57	134	4	0	3280	0	0	2
15-Aug-19	HS5	HS5-27	16:28	16:58		0:30	PR									0		0	
15-Aug-19	HS5	HS5-28	21:55	22:20		0:25	PR					0	0	0	0	0	0	0	0
20-Aug-19	HS2	MX	17:23	17:49		0:26	MX					0	0	0	0	0	0	0	0
21-Aug-19	HS3	HS3-19	15:14	16:23		1:09	PR									0		0	
21-Aug-19	HS3	HS3-20	22:14	22:40		0:26	PR					0	0	0	0	0	0	0	0
24-Aug-19	HS3	HS3-21	22:33	1:29		2:56	SEED		16							0		0	
24-Aug-19	HS1	HS1-30	22:47	0:54		2:07	SEED	108	9							0		0	
24-Aug-19	HS2	HS2-29	23:04	0:40		1:36	SEED		12		100					0		0	
24-Aug-19	HS4	HS4-26	23:25	1:24		1:59	SEED		6		92					0		0	
24-Aug-19	HS5	HS5-29	23:40	1:40		2:00	PATROL					10:38	108	43	192	8999	0	0	3
28-Aug-19	HS5	HS5-30	16:34	17:05		0:31	PR									0		0	
28-Aug-19	HS5	HS5-31	22:00	22:31		0:31	PR					0	0	0	0	0	0	0	0
02-Sep-19	HS2	HS2-30	3:53	5:26		1:33	SEED		17		111					0		0	
02-Sep-19	HS1	HS1-31	4:01	6:00		1:59	SEED	272	12			3:32	272	29	111	10015	0	0	2
05-Sep-19	HS3	HS3-22	16:28	16:53		0:25	PR									0		0	
05-Sep-19	HS3	HS3-23	22:04	22:24		0:20	PR					0	0	0	0	0	0	0	0
13-Sep-19	HS4		17:56	18:41		0:45	MX									0		0	
13-Sep-19	HS2		19:27	20:00		0:33	MX					0	0	0	0	0	0	0	0
												251:41	7,520	912	4,516	296,358	37	37,000	61
SEASON TOTALS												**Hours flown**	**EJ Flares, TOTAL**	**BIP Flares, TOTAL**	**AgI Solution Burners, minutes**	**AgI SEED Total** (Grams)	**Hygro Flares, TOTAL #**	**CaCl SEED AMOUNT** (Grams)	**# Storms**

Annual Report of Alberta Severe Weather Management Society Hail Suppression Efforts
2020 Operations – June 1 through 15 September
Information prepared by Weather Modification LLC, dba Weather Modification International (WMI)
info@weathermod.com, www.weathermod.com

All cloud seeding flights were conducted in accordance with the scientific principles described in the *Notice of Intent to Engage in Weather Modification Activities* submitted to Environment Canada on May 29, 2020, within the limits of the operations area delineated therein.

Accordingly, some acronyms used in the following tables require explanations, provided below.

Missions by Type (top left table)
Total time – the elapsed time from engine start to engine stop.
Air time – the elapsed time from takeoff to landing.
SEED – time flown on missions during which any seeding was conducted, regardless of amount.
PATROL – time flown in anticipation of encountering potential severe weather, when seeding did not occur.
REPO – (Reposition) time flown when aircraft were flown to other airports in anticipation of severe weather.
PR – flights made to the project operations centre for the purposes of the insurance industry-accredited lectures.
DUAL – flights flown for dual-mode seeding, that is, the combined use of ice-forming and drop-forming seeding agents.
MX – maintenance flights. Maintenance flights were to ensure functionality after repairs, and at the expense of WMI.

Aircraft Identifiers
Hailstop #1, HS1 – tail number N904DK, based in Springbank
Hailstop #2, HS2 – tail number N457DM, based in Springbank
Hailstop #3, HS3 – tail number N127ZW, based in Red Deer
Hailstop #4, HS4 – tail number N37356, based in Red Deer
Hailstop #5, HS5 – tail number N518TS, based in Springbank

Flare Usage (by aircraft, top right table)
BIP – burn-in-place flare, contains 150g of ice-forming seeding agent
HBIP – burn-in-place flare, contains 1000g of drop-forming seeding agent (salt)
EJ – ejectable flare, contains 20g of ice-forming seeding agent
BURNER MINS – the length of time wing-tip borne ice-forming seeding solution generators were operated
TOTAL GRAMS – the total mass of seeding agent released in each category, in grams.

Flight Time (by aircraft, by month, found below the *Flare Usage* table)
Self-explanatory.
TOTAL HOURS – the total time flown by all five Hailstop aircraft in each month, given in hours and minutes.

Operations Summary (the large table that comprises the remainder of the document)
 # Flights – the total number of flights flown for project purposes (not maintenance)
UTC DATE – Universal Time Coordinates, or UTC, is used worldwide for all meteorological and aviation purposes. UTC is six hours ahead of Mountain Daylight Time (MDT), so to convert UTC to MDT, subtract six hours.
HAILSTOP – the aircraft flying the mission, e.g. HS2 = Hailstop 2, based in Springbank (see Aircraft Identifiers, above)
OPS # -- The flight number for each specific aircraft, used only for administrative purposes.
ENGINES ON – the UTC time engines were started for that mission.
ENGINES OFF -- the UTC time engines were shut down after that mission.
TOTAL TIME – the time the engines ran, in hours and minutes.
MISSION TYPE – see *Missions by Type*, above.
EJ # – the number of ice-forming EJ flares expended on the mission.
BIP # -- the number of ice-forming BIP flares expended on the mission.
HYGRO # -- the number of droplet-forming hygroscopic (salt) flares expended on the mission.
Burner minutes – the length of time ice-forming solution was burned. Only Hailstop 2 and Hailstop 4 have burners, so there are never any burner minutes for the others.
TOTAL TIME FOR DAY – the total time accrued by all HS aircraft on each day.
EJ – the total number of EJ pyrotechnics (flares) used on each date.
BIP – the total number of BIP pyrotechnics (flares) used on each date.
BURNER MINS – the total minutes ice-forming solution was burned on each date.

AGI SEED AMOUNT PER DAY – the total mass of ice-forming seeding agent released on each date. This is the total of the amounts in the EJs, BIPs, and solution burned.
HYGROSCOPIC FLARES – the total number of droplet-forming (salt) flares burned on each date.
CaCl SEED AMOUNT PER DAY – the total mass of calcium chloride salt dispersed through the use of HYGRO flares on each date.
 # Storms – the total number of storm complexes seeded on each date.

At the bottom of the table, season totals are provided.

ALBERTA HAIL SUPPRESSION PROJECT 2020 - *Universal Time Coordinates*

Last Data Revision Date: 10/12/2021

WEATHER MODIFICATION INTERNATIONAL

	AIR TIME
SEED	199:51
PATROL	33:15
REPO	0:55
PR	0:00
DUAL	16:29
MX	5:52
FERRY	0:00
CUR	0:36
TOTALS	256:58

FLARE USAGE	HS1	HS2	HS3	HS4	HS5	TOTAL COUNT	TOTAL GRAMS
BIP (150g)	275	207	249	135	200	1066	159900
HBIP (1000g)	56	0	0	0	0	56	56000
EJ (20g)	2185	0	1878	0	2659	6722	134440.5
BURNER MINS		3180		2142		5322	10793

FLIGHT TIME	HS1	HS2	HS3	HS4	HS5	TOTAL HOURS
JUNE	12:06	17:58	13:17	18:15	27:16	88:52
JULY	32:39	31:21	19:36	25:29	37:22	146:27
AUGUST	7:20	5:07	14:07	16:55	7:09	50:38
SEPTEMBER	0:00	0:25	0:00	0:43	0:00	1:08
TOTAL BY HS#	52:05	54:51	47:00	61:22	71:47	

HAILSTOP #1
HAILSTOP #2
HAILSTOP #3
HAILSTOP #4
HAILSTOP #5

* *Indicates pyrotechnic material expended for testing.*

STORM DAY SUB-TOTALS

(Storm-day chemical totals ONLY include flares spent for seeding).
(Storm-day totals ONLY include flight hours for seed and patrol).

# Flights:	132			287:05		6722	1066	56	5322	TOTAL TIME FOR DAY	EJ	BIP	SEEDING SOLUTION		HYGROSCOPIC FLARES		
UTC DATE	HAILSTOP	ENGINES ON (UTC)	ENGINES OFF (UTC)	TOTAL TIME (hh:mm)	MISSION TYPE	EJ (#)	BIP (#)	HYGRO (#)	Burner Minutes				MINUTES BURNED	AGI SEED AMOUNT PER DAY (Grams)		CACl2 SEED AMOUNT PER DAY (Grams)	# Storms
03-Jun-20	HS2	18:47	19:18	0:31	MX	0	0	0	0	0:31	0	0	0	0	0	0	0
09-Jun-20	HS5	17:39	18:22	0:43	CUR	0	0	0	0	0:00	0	0	0	0	0	0	0
11-Jun-20	HS2	17:23	17:46	0:23	MX	0	0	0	0					0		0	
11-Jun-20	HS4	18:57	19:33	0:36	MX	0	0	0	0	0:00	0	0	0	0	0	0	0
12-Jun-20	HS5	20:55	1:24	4:29	SEED	19	13	0	0					0		0	
12-Jun-20	HS4	22:10	1:27	3:17	SEED	0	7	0	138					0		0	
12-Jun-20	HS2	22:53	2:21	3:28	SEED	0	12	0	240					0		0	
12-Jun-20	HS3	23:54	2:53	2:59	SEED	0	17	0	0					0		0	
13-Jun-20	HS1	0:08	1:03	0:55	MX	0	0	0	0	14:13	19	49	378	8497	0	0	4
13-Jun-20	HS5	23:39	2:39	3:00	SEED	304	0	0	0					0		0	
13-Jun-20	HS2	23:54	3:34	3:40	SEED	0	24	0	155					0		0	
14-Jun-20	HS4	0:35	3:13	2:38	SEED	0	15	0	226					0		0	
14-Jun-20	HS3	1:06	4:06	3:00	SEED	43	23	0	0	12:18	347	62	381	17013	0	0	3
14-Jun-20	HS3	15:13	15:38	0:25	REPO	0	0	0	0					0		0	
14-Jun-20	HS2	15:28	15:50	0:22	MX	0	0	0	0					0		0	
14-Jun-20	HS5	19:08	22:29	3:21	SEED	31	0	0	0					0		0	
14-Jun-20	HS3	21:55	23:27	1:32	SEED	95	3	0	0	4:53	126	3	0	2970	0	0	1
15-Jun-20	HS1	15:23	16:00	0:37	MX	0	0	0	0	0:00	0	0	0	0	0	0	0
16-Jun-20	HS1	17:24	18:06	0:42	MX	0	0	0	0	0:00	0	0	0	0	0	0	0
19-Jun-20	HS5	13:30	14:19	0:49	MX	0	0	0	0					0		0	
19-Jun-20	HS5	17:53	19:34	1:41	PATROL	0	0	0	0	1:41	0	0	0	0	0	0	0
20-Jun-20	HS2	22:10	23:20	1:10	PATROL	0	0	0	0					0		0	
21-Jun-20	HS4	1:32	2:58	1:26	SEED	0	0	0	48	2:36	0	0	48	97	0	0	1
21-Jun-20	HS4	15:25	15:50	0:25	REPO	0	0	0	0					0		0	
21-Jun-20	HS4	19:11	21:35	2:24	SEED	0	9	0	86					0		0	
21-Jun-20	HS5	19:52	23:09	3:17	SEED	272	18	0	0					0		0	
21-Jun-20	HS2	21:16	0:46	3:30	SEED	0	21	0	337					0		0	
21-Jun-20	HS3	21:26	0:37	3:11	SEED	101	9	0	0					0		0	
21-Jun-20	HS1	22:32	2:14	3:42	SEED	200	22	0	0					0		0	
21-Jun-20	HS4	23:31	0:11	0:40	PATROL	0	0	0	0	16:44	573	79	423	24168	0	0	4
24-Jun-20	HS4	18:08	20:36	2:28	PATROL	0	0	0	0					0		0	
24-Jun-20	HS5	18:40	22:20	3:40	PATROL	0	0	0	0					0		0	
24-Jun-20	HS1	22:00	1:46	3:46	SEED	0	21	0	0					0		0	
24-Jun-20	HS5	23:24	1:26	2:02	SEED	197	16	0	0					0		0	
25-Jun-20	HS2	0:11	1:54	1:43	SEED	0	8	0	92	13:39	197	45	92	10877	0	0	1
27-Jun-20	HS5	17:52	22:06	4:14	SEED	167	15	0	0					0		0	
27-Jun-20	HS4	17:58	21:08	3:10	SEED	0	3	0	108					0		0	
27-Jun-20	HS2	19:37	22:48	3:11	SEED	0	12	0	250					0		0	
27-Jun-20	HS1	21:12	23:36	2:24	SEED	182	19	0	0					0		0	
27-Jun-20	HS3	21:48	23:58	2:10	SEED	43	2	0	0					0		0	
27-Jun-20	HS4	21:58	23:09	1:11	PATROL	0	0	0	0	16:20	392	51	358	16216	0	0	5

# Flights:				287:05						TOTAL TIME FOR DAY	EJ	BIP	SEEDING SOLUTION		HYGROSCOPIC FLARES		
UTC DATE	HAILSTOP	ENGINES ON (UTC)	ENGINES OFF (UTC)	TOTAL TIME (hh:mm)	MISSION TYPE	EJ (#)	BIP (#)	HYGRO (#)	Burner Minutes				MINUTES BURNED	AGI SEED AMOUNT PER DAY (Grams)		CACI2 SEED AMOUNT PER DAY (Grams)	# Storms
04-Jul-20	HS5	18:04	20:55	2:51	SEED	106	3	0	0					0		0	
04-Jul-20	HS1	18:30	21:30	3:00	SEED	133	13	0	0					0		0	
04-Jul-20	HS2	18:31	21:00	2:29	SEED	0	11	0	224					0		0	
04-Jul-20	HS4	18:41	21:57	3:16	SEED	0	13	0	234					0		0	
04-Jul-20	HS3	19:33	21:38	2:05	SEED	0	12	0	0	13:41	239	52	458	13509	0	0	3
05-Jul-20	HS1	22:00	23:16	1:16	PATROL	0	0	0	0					0		0	
05-Jul-20	HS4	22:04	23:12	1:08	SEED	0	3	0	27					0		0	
05-Jul-20	HS1	23:40	3:15	3:35	DUAL	303	23	20	0					0		0	
05-Jul-20	HS3	23:52	3:25	3:33	DUAL	222	19	0	0					0		0	
06-Jul-20	HS5	1:26	4:43	3:17	SEED	232	18	0	0					0		0	
06-Jul-20	HS2	1:25	4:22	2:57	SEED	0	23	0	142					0		0	
06-Jul-20	HS4	2:24	4:57	2:33	SEED	0	10	0	154	18:19	757	96	323	30195	20	20000	4
06-Jul-20	HS5	22:00	1:39	3:39	SEED	212	6	0	0					0		0	
06-Jul-20	HS2	22:03	23:20	1:17	SEED	0	7	0	80					0		0	
06-Jul-20	HS4	22:06	0:06	2:00	SEED	0	3	0	54					0		0	
07-Jul-20	HS4	0:38	1:27	0:49	SEED	0	0	0	18					0		0	
07-Jul-20	HS3	0:44	1:38	0:54	PATROL	0	0	0	0	8:39	212	16	152	6948	0	0	3
07-Jul-20	HS4	14:52	15:36	0:44	MX	0	0	0	0					0		0	
07-Jul-20	HS2	17:26	18:04	0:38	MX	0	0	0	0					0		0	
07-Jul-20	HS4	18:03	18:30	0:27	MX	0	0	0	0					0		0	
07-Jul-20	HS1	21:00	23:43	2:43	PATROL	0	0	0	0	2:43	0	0	0	0	0	0	0
09-Jul-20	HS4	20:50	22:13	1:23	PATROL	0	0	0	0					0		0	
09-Jul-20	HS5	21:02	22:15	1:13	PATROL	0	0	0	0					0		0	
10-Jul-20	HS5	0:28	3:33	3:05	SEED	0	11	0	0					0		0	
10-Jul-20	HS2	0:29	3:36	3:07	SEED	0	11	0	226	8:48	0	22	226	3758	0	0	2
12-Jul-20	HS5	17:43	21:02	3:19	SEED	54	2	0	0					0		0	
12-Jul-20	HS4	17:44	19:13	1:29	SEED	0	17	0	122					0		0	
12-Jul-20	HS3	17:53	19:51	1:58	SEED	0	19	0	0					0		0	
12-Jul-20	HS2	18:31	20:41	2:10	SEED	0	0	0	104					0		0	
12-Jul-20	HS1	21:24	0:57	3:33	SEED	31	9	0	0	12:29	85	47	226	9208	0	0	8
16-Jul-20	HS4	21:05	21:37	0:32	MX	0	0	0	0					0		0	
16-Jul-20	HS3	21:12	0:17	3:05	SEED	293	24	0	0					0		0	
16-Jul-20	HS4	21:53	0:40	2:47	SEED	0	11	0	83					0		0	
16-Jul-20	HS1	22:05	0:42	2:37	SEED	132	15	0	0					0		0	
16-Jul-20	HS2	22:18	0:36	2:18	SEED	0	5	0	114					0		0	
16-Jul-20	HS5	22:22	23:10	0:48	PATROL	0	0	0	0					0		0	
17-Jul-20	HS4	2:15	3:00	0:45	REPO	0	0	0	0	11:35	425	55	197	17150	0	0	6
17-Jul-20	HS2	12:32	13:14	0:42	MX	0	0	0	0					0		0	
17-Jul-20	HS2	17:52	18:42	0:50	MX	0	0	0	0					0		0	
17-Jul-20	HS4	21:48	0:02	2:14	SEED	0	8	0	178					0		0	
17-Jul-20	HS1	22:20	2:10	3:50	DUAL	171	24	13	0					0		0	
17-Jul-20	HS5	23:15	1:10	1:55	DUAL	102	8	0	0					0		0	
18-Jul-20	HS2	0:34	4:16	3:42	SEED	0	24	0	334					0		0	
18-Jul-20	HS3	0:47	4:22	3:35	SEED	287	25	0	0					0		0	
18-Jul-20	HS4	0:51	2:13	1:22	PATROL	0	0	0	0	16:38	560	89	512	25588	13	13000	3
19-Jul-20	HS5	20:30	0:11	3:41	SEED	166	8	0	0					0		0	
19-Jul-20	HS2	21:45	1:45	4:00	SEED	0	24	0	276					0		0	
20-Jul-20	HS1	0:16	1:52	1:36	SEED	0	3	0	0	9:17	166	35	276	9130	0	0	2
22-Jul-20	HS1	20:12	21:36	1:24	SEED	60	9	0	0					0		0	
22-Jul-20	HS2	20:32	23:40	3:08	SEED	0	0	0	106					0		0	
22-Jul-20	HS5	22:16	2:15	3:59	SEED	170	5	0	0					0		0	
22-Jul-20	HS4	23:19	1:57	2:38	SEED	0	0	0	38					0		0	
23-Jul-20	HS4	2:22	3:44	1:22	SEED	0	8	0	80					0		0	
23-Jul-20	HS1	2:24	4:48	2:24	SEED	267	32	0	0	14:55	497	54	224	18494	0	0	4
23-Jul-20	HS1	19:30	21:00	1:30	SEED	224	12	0	0					0		0	
23-Jul-20	HS3	19:40	22:53	3:13	SEED	0	43	0	0					0		0	
23-Jul-20	HS5	20:26	0:22	3:56	SEED	257	37	0	0					0		0	
23-Jul-20	HS1	21:23	0:34	3:11	SEED	266	29	0	0					0		0	
23-Jul-20	HS2	23:30	0:45	1:15	SEED	0	0	0	52					0		0	
23-Jul-20	HS3	23:33	0:46	1:13	SEED	47	5	0	0	14:18	794	126	52	34885	0	0	4
24-Jul-20	HS5	22:28	0:42	2:14	SEED	91	9	0	0					0		0	
24-Jul-20	HS2	22:53	1:01	2:08	SEED	0	9	0	176					0		0	
24-Jul-20	HS1	22:57	0:57	2:00	SEED	193	0	0	0	6:22	284	18	176	8737	0	0	2
29-Jul-20	HS5	23:02	0:08	1:06	PATROL	0	0	0	0	1:06	0	0	0	0	0	0	0
31-Jul-20	HS5	0:19	2:38	2:19	PATROL	0	0	0	0					0		0	
31-Jul-20	HS2	0:20	1:00	0:40	PATROL	0	0	0	0	2:59	0	0	0	0	0	0	0

# Flights:				287:05						TOTAL TIME FOR DAY	EJ	BIP	SEEDING SOLUTION		HYGROSCOPIC FLARES		
UTC DATE	HAILSTOP	ENGINES ON (UTC)	ENGINES OFF (UTC)	TOTAL TIME (hh:mm)	MISSION TYPE	EJ (#)	BIP (#)	HYGRO (#)	Burner Minutes				MINUTES BURNED	AGI SEED AMOUNT PER DAY (Grams)		CACl2 SEED AMOUNT PER DAY (Grams)	# Storms
01-Aug-20	HS1	15:11	16:24	1:13	SEED	0	3	0	0					0		0	
01-Aug-20	HS2	15:34	16:21	0:47	PATROL	0	0	0	0					0		0	
01-Aug-20	HS4	22:52	2:40	3:48	SEED	0	11	0	186					0		0	
02-Aug-20	HS1	1:37	2:47	1:10	SEED	0	3	0	0	6:58	0	17	186	2927	0	0	3
03-Aug-20	HS4	18:41	21:12	2:31	SEED	0	10	0	196					0		0	
03-Aug-20	HS5	18:43	21:17	2:34	SEED	251	23	0	0					0		0	
03-Aug-20	HS2	18:59	22:23	3:24	SEED	0	16	0	272					0		0	
03-Aug-20	HS3	20:47	0:01	3:14	SEED	303	17	0	0					0		0	
03-Aug-20	HS1	20:52	23:15	2:23	SEED	23	15	0	0					0		0	
03-Aug-20	HS5	22:02	0:08	2:06	SEED	28	8	0	0					0		0	
03-Aug-20	HS4	22:12	0:28	2:16	SEED	0	0	0	78	18:28	605	89	546	26557	0	0	4
08-Aug-20	HS4	19:07	20:46	1:39	SEED	0	7	0	88					0		0	
08-Aug-20	HS3	19:09	20:29	1:20	SEED	155	8	0	0					0		0	
08-Aug-20	HS5	19:20	21:04	1:44	PATROL	0	0	0	0	4:43	155	15	88	5528	0	0	1
11-Aug-20	HS4	22:35	1:59	3:24	PATROL	0	0	0	0					0		0	
11-Aug-20	HS3	23:40	2:13	2:33	PATROL	0	0	0	0	5:57	0	0	0	0	0	0	0
13-Aug-20	HS1	2:10	4:44	2:34	DUAL	0	23	23	0					0		0	
13-Aug-20	HS3	2:18	4:44	2:26	DUAL	289	19	0	0	5:00	289	42	0	12080	23	23000	2
17-Aug-20	HS5	17:30	18:15	0:45	CUR	0	0	0	0					0		0	
18-Aug-20	HS3	0:52	2:13	1:21	PATROL	0	0	0	0	1:21	0	0	0	0	0	0	0
20-Aug-20	HS2	21:40	22:36	0:56	PATROL	0	0	0	0					0		0	
20-Aug-20	HS4	21:41	0:58	3:17	PATROL	0	0	0	0					0		0	
20-Aug-20	HS3	23:27	2:40	3:13	SEED	0	4	0	0	7:26	0	4	0	600	0	0	1
04-Sep-20	HS4	17:16	17:59	0:43	MX	0	0	0	0					0		0	
04-Sep-20	HS2	17:20	17:45	0:25	MX	0	0	0	0	0:00	0	0	0	0	0	0	0
										256:58	6722	1066	5322	305133	56	56000	71
SEASON TOTALS										HOURS FLOWN	EJ Flares, TOTAL	BIP Flares, TOTAL	Seeding Solution, Minutes Burned	Total Seeding Agent Dispersed (grams)	HYGRO Flares, TOTAL	CaCL SEEDING AGENT, TOTAL	TOTAL # OF STORMS SEEDED

Annual Report of Alberta Severe Weather Management Society Hail Suppression Efforts

2021 Operations – June 1 through 15 September
Information prepared by Weather Modification LLC, dba Weather Modification International (WMI)
info@weathermod.com, www.weathermod.com

All cloud seeding flights were conducted in accordance with the scientific principles described in the *Notice of Intent to Engage in Weather Modification Activities* submitted to Environment Canada on May 28, 2021, within the limits of the operations area delineated therein.

Accordingly, some acronyms used in the following tables require explanations, provided below.

Missions by Type (top left table)
Total time – the elapsed time from engine start to engine stop.
Air time – the elapsed time from takeoff to landing.
SEED – time flown on missions during which any seeding was conducted, regardless of amount.
PATROL – time flown in anticipation of encountering potential severe weather, when seeding did not occur.
REPO – (Reposition) time flown when aircraft were flown to other airports in anticipation of severe weather.
PR – flights made to the project operations centre for the purposes of the insurance industry-accredited lectures.
DUAL – flights flown for dual-mode seeding, that is, the combined use of ice-forming and drop-forming seeding agents.
MX – maintenance flights. Maintenance flights were to ensure functionality after repairs, and at the expense of WMI.

Aircraft Identifiers
Hailstop #1, HS1 – tail number N904DK, based in Springbank
Hailstop #2, HS2 – tail number N6111V, based in Springbank
Hailstop #3, HS3 – tail number N127ZW, based in Red Deer
Hailstop #4, HS4 – tail number N522JP, based in Red Deer
Hailstop #5, HS5 – tail number N518TS, based in Springbank

Flare Usage (by aircraft, top right table)
BIP – burn-in-place flare, contains 150g of ice-forming seeding agent
HBIP – burn-in-place flare, contains 1000g of drop-forming seeding agent (salt)
EJ – ejectable flare, contains 20g of ice-forming seeding agent
TOTAL GRAMS – the total mass of seeding agent released in each category, in grams.

Flight Time (by aircraft, by month, found below the *Flare Usage* table)
Self-explanatory.
TOTAL HOURS – the total time flown by all five Hailstop aircraft in each month, given in hours and minutes.

Operations Summary (the large table that comprises the remainder of the document)
 # Flights – the total number of flights flown for project purposes (not maintenance)
UTC DATE – Universal Time Coordinates, or UTC, is used worldwide for all meteorological and aviation purposes. UTC is six hours ahead of Mountain Daylight Time (MDT), so to convert UTC to MDT, subtract six hours.
HAILSTOP – the aircraft flying the mission, e.g. HS2 = Hailstop 2, based in Springbank (see Aircraft Identifiers, above)
OPS # -- The flight number for each specific aircraft, used only for administrative purposes.
ENGINES ON – the UTC time engines were started for that mission.
ENGINES OFF -- the UTC time engines were shut down after that mission.
TOTAL TIME – the time the engines ran, in hours and minutes.
MISSION TYPE – see *Missions by Type*, above.
EJ # – the number of ice-forming EJ flares expended on the mission.
BIP # -- the number of ice-forming BIP flares expended on the mission.
HYGRO # -- the number of droplet-forming hygroscopic (salt) flares expended on the mission.
TOTAL TIME FOR DAY – the total time accrued by all HS aircraft on each day.
EJ – the total number of EJ pyrotechnics (flares) used on each date.
BIP – the total number of BIP pyrotechnics (flares) used on each date.
AGI SEED AMOUNT PER DAY – the total mass of ice-forming seeding agent released on each date. This is the total of the amounts in the EJs and BIPs.

HYGROSCOPIC FLARES – the total number of droplet-forming (salt) flares burned on each date.
CaCl SEED AMOUNT PER DAY – the total mass of calcium chloride salt dispersed through the use of HYGRO flares on each date.
 # Storms – the total number of storm complexes seeded on each date.

At the bottom of the table, season totals are provided.

WEATHER MODIFICATION INTERNATIONAL

ALBERTA HAIL SUPPRESSION PROJECT 2021 *- Universal Time Coordinates*

Last Data Revision Date: 10/12/2021

	AIR TIME
SEED	122:03
PATROL	12:14
REPO	2:00
PR	0:00
DUAL	8:50
MX	2:52
FERRY	0:00
CUR	0:00
TOTALS	147:59
HAILSTOP #1	
HAILSTOP #2	
HAILSTOP #3	
HAILSTOP #4	
HAILSTOP #5	

FLARE USAGE	HS1	HS2	HS3	HS4	HS5
BIP (150g)	194	152	213	176	237
HBIP (1000g)	31	0	0	0	0
EJ (20g)	261	1656	832	27	615

FLIGHT TIME	HS1	HS2	HS3	HS4	HS5
JUNE	2:18	3:56	3:53	9:55	9:43
JULY	22:26	23:41	19:42	17:17	20:20
AUGUST	6:53	8:49	7:04	6:51	3:34
SEPTEMBER	0:00	0:00	0:00	0:00	0:00
TOTAL BY HS#	31:37	36:26	30:39	34:03	33:37

** Indicates pyrotechnic material expended for testing.*

STORM DAY SUB-TOTALS
(Storm-day chemical totals ONLY include flares spent for seeding).

UTC DATE	HAILSTOP	ENGINES ON (UTC)	ENGINES OFF (UTC)	TOTAL TIME (hh:mm)	MISSION TYPE	EJ (#)	BIP (#)	HYGRO (#)	SEEDING TIME PER DAY	GLACIO SEED AMOUNT PER DAY (Grams)	HYGROSCOPIC SEEDING: CACl2 SEED AMOUNT PER DAY (Grams)	# Storms
04-Jun-21	HS4	19:37	22:14	2:37	SEED	10	3	0	2:37	650	0	2
05-Jun-21	HS5	18:09	20:04	1:55	SEED	0	17	0		0	0	
05-Jun-21	HS3	23:43	0:28	0:45	PATROL	0	0	0	2:40	2550	0	2
09-Jun-21	HS4	23:30	0:30	1:00	MX	0	0	0	0:00	0	0	0
14-Jun-21	HS1	19:57	22:15	2:18	SEED	91	13	0		0	0	
14-Jun-21	HS3	20:46	21:59	1:13	SEED	0	10	0		0	0	
14-Jun-21	HS2	21:44	1:40	3:56	SEED	142	9	0		0	0	
14-Jun-21	HS5	23:41	4:33	4:52	SEED	0	40	0		0	0	
15-Jun-21	HS4	0:40	4:47	4:07	SEED	0	37	0	16:26	21010	0	4
15-Jun-21	HS3	14:44	16:39	1:55	SEED	0	34	0		0	0	
15-Jun-21	HS4	15:39	17:00	1:21	SEED	0	16	0		0	0	
15-Jun-21	HS5	22:43	1:39	2:56	SEED	20	4	0	6:12	8500	0	3
29-Jun-21	HS4	15:15	16:05	0:50	MX	0	0	0	0:00	0	0	0
01-Jul-21	HS2	17:30	18:15	0:45	MX	0	0	0	0:00	0	0	0
02-Jul-21	HS5	18:59	23:17	4:18	SEED	298	13	0		0	0	
02-Jul-21	HS4	19:09	20:26	1:17	PATROL	0	0	0		0	0	
02-Jul-21	HS1	19:11	23:45	4:34	SEED	0	36	0		0	0	
02-Jul-21	HS2	19:45	20:59	1:14	PATROL	0	0	0		0	0	
02-Jul-21	HS4	21:04	0:42	3:38	SEED	0	18	0		0	0	
02-Jul-21	HS2	21:56	1:49	3:53	SEED	161	26	0		0	0	
02-Jul-21	HS3	23:46	2:28	2:42	SEED	0	21	0		0	0	
03-Jul-21	HS1	1:45	2:28	0:43	REPO	0	0	0		0	0	
03-Jul-21	HS5	1:52	2:35	0:43	REPO	0	0	0		0	0	
03-Jul-21	HS4	4:55	5:30	0:35	REPO	0	0	0	21:36	26280	0	4

UTC DATE	HAILSTOP	ENGINES ON (UTC)	ENGINES OFF (UTC)	TOTAL TIME (hh:mm)	MISSION TYPE	EJ (#)	BIP (#)	HYGRO (#)	SEEDING TIME PER DAY	GLACIO SEED AMOUNT PER DAY (Grams)	HYGROSCOPIC SEEDING CACl2 SEED AMOUNT PER DAY (Grams)	# Storms
03-Jul-21	HS5	22:21	1:32	3:11	SEED	0	22	0		0	0	
03-Jul-21	HS1	22:20	1:06	2:46	SEED	159	15	0		0	0	
03-Jul-21	HS2	22:22	2:36	4:14	SEED	200	13	0		0	0	
03-Jul-21	HS4	23:17	1:53	2:36	SEED	0	23	0		0	0	
04-Jul-21	HS3	0:04	3:14	3:10	SEED	0	11	0		0	0	
04-Jul-21	HS1	2:04	3:32	1:28	SEED	11	5	0	17:25	20750	0	2
04-Jul-21	HS5	20:27	23:28	3:01	SEED	0	12	0		0	0	
04-Jul-21	HS2	20:31	23:21	2:50	SEED	0	12	0		0	0	
04-Jul-21	HS1	20:36	22:04	1:28	PATROL	0	0	0		0	0	
04-Jul-21	HS1	22:53	23:33	0:40	REPO	0	0	0	7:19	3600	0	1
05-Jul-21	HS3	22:16	23:16	1:00	MX	0	0	0	0:00	0	0	0
06-Jul-21	HS2	20:50	23:04	2:14	SEED	44	0	0		0	0	
06-Jul-21	HS5	21:53	23:11	1:18	PATROL	0	0	0		0	0	
06-Jul-21	HS3	22:10	1:08	2:58	PATROL	0	0	0		0	0	
07-Jul-21	HS2	0:47	2:49	2:02	SEED	214	17	0		0	0	
07-Jul-21	HS1	0:46	2:42	1:56	SEED	0	28	0		0	0	
07-Jul-21	HS5	1:14	2:43	1:29	SEED	0	24	0		0	0	
07-Jul-21	HS5	4:17	5:31	1:14	SEED	56	11	0	13:11	18280	0	3
07-Jul-21	HS5	20:45	21:16	0:31	PATROL	0	0	0		0	0	
08-Jul-21	HS2	2:08	3:53	1:45	SEED	217	11	0		0	0	
08-Jul-21	HS5	2:10	4:00	1:50	SEED	0	29	0		0	0	
08-Jul-21	HS1	2:10	4:30	2:20	SEED	0	26	0		0	0	
08-Jul-21	HS4	2:57	4:23	1:26	SEED	17	4	0	7:52	15180	0	1
10-Jul-21	HS3	21:21	22:43	1:22	PATROL	0	0	0	1:22	0	0	0
21-Jul-21	HS1	2:45	4:45	2:00	PATROL	0	0	0	2:00	0	0	0
22-Jul-21	HS3	1:41	4:19	2:38	SEED	189	30	0		0	0	
22-Jul-21	HS4	2:30	4:26	1:56	SEED	0	15	0	4:34	10530	0	1
22-Jul-21	HS4	18:16	20:52	2:36	SEED	0	19	0		0	0	
22-Jul-21	HS1	18:17	20:17	2:00	DUAL	0	11	14		0	0	
22-Jul-21	HS3	18:24	20:23	1:59	DUAL	163	8	0		0	0	
22-Jul-21	HS2	19:21	20:58	1:37	SEED	36	6	0	8:12	10580	14000	2
26-Jul-21	HS4	1:38	4:23	2:45	SEED	0	32	0		0	0	
26-Jul-21	HS3	1:39	5:32	3:53	SEED	271	44	0		0	0	
26-Jul-21	HS1	2:07	4:38	2:31	SEED	0	28	0		0	0	
26-Jul-21	HS2	2:29	5:36	3:07	SEED	133	30	0		0	0	
26-Jul-21	HS5	2:58	5:43	2:45	SEED	241	27	0		0	0	
26-Jul-21	HS4	5:22	5:50	0:28	REPO	0	0	0	15:01	37050	0	2
04-Aug-21	HS4	22:13	2:14	4:01	SEED	0	9	0		0	0	
05-Aug-21	HS2	0:38	2:50	2:12	SEED	139	2	0		0	0	
05-Aug-21	HS1	1:25	2:57	1:32	SEED	0	6	0	7:45	5330	0	2
21-Aug-21	HS2	17:39	18:00	0:21	MX	0	0	0		0	0	
21-Aug-21	HS5	17:40	18:10	0:30	MX	0	0	0		0	0	
21-Aug-21	HS1	18:09	18:47	0:38	MX	0	0	0		0	0	
21-Aug-21	HS4	19:00	19:46	0:46	MX	0	0	0		0	0	
21-Aug-21	HS3	20:15	20:52	0:37	MX	0	0	0	0:00	0	0	0
22-Aug-21	HS2	21:33	23:54	2:21	SEED	177	15	0		0	0	
22-Aug-21	HS3	21:44	1:24	3:40	DUAL	147	43	0		0	0	
22-Aug-21	HS1	23:26	1:38	2:12	DUAL	0	12	17		0	0	
22-Aug-21	HS4	23:40	1:44	2:04	PATROL	0	0	0	10:17	16980	17000	1
31-Aug-21	HS2	21:38	1:33	3:55	SEED	193	11	0		0	0	
31-Aug-21	HS5	21:44	0:48	3:04	SEED	0	38	0		0	0	
31-Aug-21	HS3	22:11	0:58	2:47	SEED	62	12	0		0	0	
31-Aug-21	HS1	23:15	1:46	2:31	SEED	0	14	0	12:17	16350	0	5
						3391	972	31	156:46	213620	31000	35
SEASON TOTALS						TOTAL EJ FLARES	TOTAL BIP FLARE	TOTAL HYGRO FLARES	HOURS FLOWN	TOTAL GLACIO-GENIC SEEDING AGENT	TOTAL CaCl SEEDING AGENT	TOTAL # OF STORMS SEEDED

NOTICE OF INTENT TO ENGAGE IN WEATHER MODIFICATION ACTIVITIES
PURSUANT TO THE WEATHER MODIFICATION INFORMATION ACT AND REGULATIONS
SCHEDULE I

PART 1. GENERAL IDENTIFICATION OF ACTIVITY

Date of notice:	May 7, 2019
Proposed starting date:	June 1st, 2019
Expected duration:	September 15th, 2019

Province and area to be affected: Central Alberta, covering the Red Deer to Calgary regions (see attached map showing project area which has remained essentially the same since 1996).

Weather elements to be modified:	Thunderstorms
Modification expected:	Hail Suppression
Class of operation:	Operational
Operating method:	airborne
Class of economy to benefit:	insurance industry: private and public property primary, agriculture secondary.

PART 2. GENERAL INFORMATION CONCERNING WEATHER MODIFIER

Organization name:	Weather Modification International (WMI) http://www.weathermodification.com/	
Parent Organization:	Weather Modification LLC 3802 20th Street North Fargo, ND USA 58102	
Chief Officer:	Mr. Neil Brackin, President nbrackin@weathermod.com	Tel: (701) 235-5500
Local Organization:	Weather Modification International Olds-Didsbury Airport, Highway 2A Olds, AB T4H 1A1	Tel. (403) 335-8359

Name and relevant qualifications of officer(s) designated in charge of project:

Chief Officer:	Mr. Daniel Gilbert, Chief Meteorologist B.S., 17 years' experience WMA Certified Weather Modification Operator #78 Office Tel: (403) 335-8359 (see Part 5 for details of qualifications and experience)
Vice President - Meteorology	Mr. Bruce Boe Project Manager/Meteorology, 44 years' experience Tel: (701) 235-5500

Primary activities of organization (see web page at www.weathermodification.com):
- cloud seeding
- atmospheric research
- air pollution monitoring
- meteorological radar monitoring
- equipment design and fabrication
- aircraft modifications

Amount of public liability insurance carried applicable to activity: CAD$50 million by the Alberta Severe Weather Management Society and US$5 million by Weather Modification LLC.

List of similar weather modification activities previously undertaken:

a. Canada: The Alberta Hail Project has been operating in its present form since 1996. The contractor (operator) for this entire period has been WMI.

b. Elsewhere:
- WMI has conducted the hail suppression cloud seeding in North Dakota for more than 50 years. This is an ongoing project.
- WMI conducted hail suppression in Mendoza, Argentina using 3 to 4 Cheyenne II aircraft and a Lear Jet 1998-2004.
- WMI conducted operational cloud seeding in Oklahoma for Rain Enhancement and Hail Suppression 1997-2001.
- WMI has conducted operational cloud seeding in Alberta, Burkina Faso, California, Colorado, Idaho, Mexico, UAE, India, Mali, Nevada, North Dakota, Saudi Arabia, Senegal, and Wyoming within the last 10 years.

4. References:

1. Dr. Terry Krauss
   Krauss Weather Services
   79 Irving Crescent
   Red Deer, AB T4R 3S3 Tel. 403-318-0400
2. Mr. Darin Langerud, Director
   State of North Dakota Atmospheric Resource Board
   900 E. Boulevard Ave.
   Bismarck, ND 58505 Tel. 701-328-2788
3. Dr. Ronald E. Rinehart
   3629 W. Gordon Drive
   Jefferson City, MO 65109 Tel. 816-344-0846
4. Dr. Paul L. Smith
   South Dakota School of Mines & Technology
   501 E. St. Joseph Street
   Rapid City, SD 57701-3995 Tel. 605-394-2291

List of subcontractors: WMI owns and operates its own fleet of aircraft and weather radars. No major sub-contractors are being used on the Alberta Hail project for aircraft or radar services. Solution Blend Services, Calgary, Alberta (403) 207-9840 will be handling and mixing seeding solutions for the project.

PART 3. GENERAL INFORMATION CONCERNING ORGANIZATION FOR WHOM ACTIVITY IS TO BE CONDUCTED.

Name of organization: Alberta Severe Weather Management Society (ASWMS)

Chief officers: Mr. Todd Klapak, President
todd.klapak@intact.net
Ms. Sherre Newell, Secretary-Treasurer
sherre.newell@aviva.com

Nature of organization: A not-for-profit society of the property and casualty insurers and brokers operating in Alberta. The society was formed for the purpose of collecting funds from its members to operate a hail suppression program to help reduce insurance payout due to hail and stabilize insurance rates throughout the province.

PART 4. GENERAL INFORMATION CONCERNING FIELD BASES OF ACTIVITY

Address and location of project primary field base:
Olds-Didsbury Airport, Alberta. tel. 403-335-8359
Address(es) and locations(s) of project secondary field base(s):

- Springbank Airport tel. 403-247-0001
- Red Deer Regional Airport tel. 403-886-7857

PART 5. GENERAL INFORMATION CONCERNING OPERATING FIELD PERSONNEL

Name and title of field officer in charge: Mr. Daniel Gilbert, Chief Meteorologist
Old-Didsbury Airport, Highway 2A
Olds, AB T4H 1A1

tel. & fax. 403-335-8359,
e-mail: dgilbert@weathermodifcation.com
home page: http://www.weathermodification.com/

Qualifications of field officer in charge (Gilbert):

Education
Bachelor of Science, Meteorology and Environmental Studies (double major) May 2004, Iowa State University, Ames, IA
Associate of Arts, Liberal Arts, May 2000, Iowa Central Community College, Fort Dodge, IA

Weather Modification Experience
Chief Meteorologist, Weather Modification International (Wyoming and Alberta) - November 2009 to present

Forecaster, radar operator, rawinsondes, direction of seeding aircraft. Case declarations, wintertime (Wyoming) research program.

Meteorologist, RHS Consulting (Fresno, CA) – November 2008-February 2009

Directed airborne and ground based cloud seeding operations over portions of the central and southern Sierra Nevada Mountains. Set up and performed routine maintenance of ground based ice nucleus generators. Provided daily forecasts for clients and project personnel.

Meteorologist, Independent Contractor, (Boise, ID) – October 2007 to April 2008

Provided meteorological services to support Idaho Power Company's winter cloud seeding project in West Central Idaho, directed airborne and ground seeding operations, directed rawinsonde releases, provided short-term operational forecasts and nowcasts for pilots, communicated with aircraft via two-way radio

Field Meteorologist, North Dakota Cloud Modification Project, (Stanley or Bowman, ND) – Summers, 2003-2009

Operated 5 cm weather radar equipped with TITAN software package, launched and directed seeding aircraft using two-way radio and GPS tracking, performed data recording and documentation of cloud seeding operations, prepared silver iodide seeding solution, assisted with radar calibrations, prepared forecasts and briefed pilots daily, supervised intern meteorologists, presented case studies for ground school, operated cloud condensation nuclei counter for joint research with South Dakota School of Mines

Forecaster, Atmospherics Incorporated, (Fresno, CA) - October 2006 - May 2007
Field Meteorologist, Atmospherics, Inc. (Modesto, CA) - November 2005 - April 2006
Field Meteorologist, Atmospherics, Inc. (Paso Robles, CA) - December 2004 - February 2005

Provided daily forecasts for seeding operations and/or clients, operated 5cm weather radar, directed winter cloud seeding operations over the Sierra Nevada utilizing both glaciogenic and hygroscopic seeding agents, traced radar overlays, performed data recording of operations, wrote monthly and annual reports

Memberships and Honors

- Meteorologist Distinguished Service Award, 2013, Weather Modification Association
- Member, Weather Modification Association (certified operator #78)
- Member, American Meteorological Society
- Iowa Central Community College Honor Society, inducted April 27, 2000
- Wilbur E Brewer Professionalism Award, 2007 North Dakota Cloud Modification Project

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Field Address: Olds-Didsbury Airport, Highway 2A, Olds, AB
Field Telephone no. 403-335-8359
Field personnel: full time = 3
part time = 14

Daily records of activities: Custodian = Ms. Erin Fischer
WMI Project Operations Centre
Olds-Didsbury Airport, Highway 2A, AB T4H 1A1

All records are maintained June 1st -Sept. 15th annually.

- daily weather synopsis and forecast report
- radar echo storm data report and maps
- daily operations summary report
- chemical inventory report
- equipment status report
- aircraft flight track maps
- flight log report
- project aircraft maintenance report

PART 6. GENERAL INFORMATION CONCERNING PROPOSED ACTIVITY

Reasons for organization seeking modified weather: The hailstorm on Sept. 7, 1991 caused >$400 million damage in the City of Calgary alone. Hailstorms in the City of Calgary caused >$500 Million in 2010 and again in 2012. In addition, hailstorms have caused >$100 Million damage to crops annually since 2007 and the damage to crops was >$400 Million in 2012. Hailstorms have now become a billion-dollar problem to the economy of Alberta. The 20 largest insurance companies and their affiliates have banded together to conduct hail suppression operations in the "hail alley" of central Alberta to combat urban hail damage in the Calgary to Red Deer area. The current program has conducted cloud-seeding operations in central Alberta each summer since 1996.

Specific modification sought: Diminish hail damage to property in central Alberta with special priority given to the urban areas of Calgary and Red Deer.

Quantitative estimate of modification expected: Even very small positive results (+1%) will be economically beneficial, however, it is hoped that reductions in damage on the order of 25% or greater will be realized. The insurance industry has been encouraged by the results, estimating a savings of several hundred-million dollars to the industry, paying out approximately 50% of what they expected.

Secondary effects anticipated: Reductions in crop damage due to hail should also be realized. Seeding may also provide an increase in precipitation according to recent analyses of radar data. The crop hail insurance data for the first 10 years of the project indicated a reduction in the loss-to-risk values compared with the historical 58 year average for the province as a whole. However, a recent analysis shows increased variability and an increasing trend in hail damage over the last 10 years both inside and outside the project area which is likely due to climate change. The effect of the seeding on crop damage is inconclusive at this time.

Geographic area affected (see attached map): The main project area is from Calgary to Red Deer, Alberta and west to the foothills of the Rocky Mountains.

Estimate of adjoining geographic area possibly affected: Areas downwind (east) of highway no. 2 to highway no. 21 may also benefit from the seeded storms.

Approximate total cost: approx. $5.0 million per year.

Funds to be expended in Canada: est. $1,000,000 per year.

General period of operation: June 1st - Sept. 15th annually.

PART 7. GENERAL INFORMATION CONCERNING OPERATIONS AND TECHNIQUES

A. GENERAL: The following text describes the methods to be used, general principles of techniques, description of specific techniques, and a brief description of typical operations:

OVERVIEW OF METHOD

For hail suppression, aircraft patrolling based upon forecasts and hourly weather reports will be used to initiate seeding as soon as appropriate conditions develop. Storms will be seeded if they have radar reflectivities of approximately 35 dBZ at heights above the -5°C temperature level, and are considered to be a potential hail threat to an urban or populated area. When large hail is forecast, seeding will commence when radar reflectivities reach approximately 20 dBZ in order to start the microphysical suppression process as early as possible within the potential hailstorms. Storms will be seeded by aircraft using either droppable AgI pyrotechnics and/or wing mounted AgI pyrotechnics or AgI-solution burners.

Subsequent to an independent (2018) review of the project science, limited seeding of a few less-intense storms with both glaciogenic and hygroscopic seeding agents will be conducted to assess the theorized positive effect of such treatment. The hygroscopic material used will be in the form of 1-kilogram calcium carbonate (CaCl) pyrotechnics, a salt.

The amount of seeding material used will depend upon the lifetime and size of the cloud or storm and other meteorological conditions. The seeding rates are about double those used during the 1970's and 1980's in Alberta. Seeding will be focused on the feeder clouds of the storm's new growth zone and will be conducted at cloud top and cloud base. Further details of the seeding method are discussed below.

HAIL SUPPRESSION HYPOTHESIS

The cloud seeding hypothesis is based on the cloud microphysics concept of "beneficial competition". Beneficial competition assumes a lack of natural ice nuclei in the environment effective at temperatures warmer than -20°C and that the injection of AgI will result in the production of a significant number of "artificial" ice nuclei. The natural and artificial ice crystals "compete" for the available supercooled liquid cloud water within the storm. Hence, the hailstones that are formed within the seeded cloud volumes will be smaller and produce less damage if they should survive the fall to the surface. If enough nuclei are introduced into the new growth region of the storm, then it is possible that the hailstones will be small enough to melt completely before reaching the ground.

Cloud seeding operations are intended to alter the cloud microphysics of the treated clouds, assuming that the present precipitation process is inefficient due to a lack of natural ice nuclei. The seeding is based on a conceptual model of Alberta hailstorms that evolved from the studies of Chisholm (1970), Chisholm and Renick (1972), Barge and Bergwall (1976), Krauss and Marwitz (1984), English and Krauss (1986) and English (1986).

It is assumed that hail embryos grow within the time evolving "main" updraft of single cell storms and within the updrafts of developing "feeder clouds" or cumulus towers that flank mature "multi-cell" and "super-cell" storms (see e.g. Foote 1984). The growth to large hail is hypothesized to occur along the edges of the main storm updraft where the merging feeder clouds interact with the main storm updraft.

For hail suppression, seeding with a large amount of glaciogenic seeding agent will dramatically increase the ice crystal concentration in thunderstorm clouds and compete for the available supercooled cloud water to prevent the growth of large, damaging, ice particles. Based on WMI's experience, the cloud seeding will be targeted on the feeder cloud updraft regions associated with the production of hail and will leave unseeded those regions of the storm associated with the production of rain only. This will make efficient use of the seeding material and will reduce the possibility of overseeding

To test the effects of seeding with both glaciogenic and hygroscopic seeding agents, a limited number of storms may be seeded with glaciogenic material at cloud top, and glaciogenic and hygroscopic agents in updrafts at cloud base. Hygroscopic agents (salts) are designed to encourage the formation of cloud droplets, which when frozen as a result of the simultaneous glaciogenic seeding, result in additional precipitation embryos, which then (as stated above) compete for the available supercooled liquid water.

CLOUD SEEDING METHODOLOGY - SEEDING TECHNIQUES

Convective cells (defined by radar) with maximum reflectivity approximately >35 dBZ within the cloud layer above the -5°C level, located within the project areas or within a 20 min travel time "buffer zone" upwind of the project area, will be seeded if they pose a potential threat of damaging hail for an urban or populated area. Radar observers/controllers will be responsible for making the "seed" decision and directing the cloud seeding missions.

Patrol flights will be launched before clouds within the target area meet the radar reflectivity seeding criteria. These patrol flights are meant to provide immediate response to developing cells. In general, a patrol is launched in the event of visual reports of vigorous towering cumulus clouds near Calgary or Red Deer, or when radar cells exceed 25 kft height over the higher terrain along the western border and begin moving towards the urban areas.

Launches of more than one aircraft are determined by the number of storms in each area, the lead time required for a seeder aircraft to reach the proper location and altitude, and projected overlap of coverage and on-station time for multiple aircraft missions. In general, only one aircraft can work safely at cloud top and one aircraft at cloud base for a single storm. The operation of three aircraft is recommended to provide uninterrupted seeding coverage at either cloud-base or cloud-top and to seed three storms simultaneously if required.

The program is designed to seed convective clouds, before they achieve radar reflectivities associated with hail, and deliver seeding material to regions of updraft and supercooled liquid water i.e. the primary conditions responsible for the growth of hailstones.

Factors that determine cloud top or cloud base seeding are: storm structure, visibility, cloud base height, or time available to reach seeding altitude. Cloud base seeding is conducted by flying at cloud base within the main inflow of single cell storms, or the inflow associated with the new growth zone (shelf cloud) located on the upshear side of multi-cell storms.

Cloud top seeding is conducted between typically between -5°C and -10°C. The pencil flares fall approximately 1.5 km (approximately 10°C) during their 35-40 second burn time. The seeding aircraft will penetrate the edges of single convective cells meeting the seed criteria. For multi-cell storms, or storms with feeder clouds, the seeding aircraft will penetrate the tops of the developing cumulus towers on the upshear sides of convective cells, as they grow up through the aircraft's altitude.

Occasionally, with embedded cells or convective complexes, there are no clearly defined feeder turrets visible to the flight crews or on radar. In these instances, at an altitude between -5°C and - 10°C, a seeding aircraft will penetrate the storm edge (region of tight radar reflectivity gradient) on the upshear

side and burn a burn-in-place flare and inject droppable pencil flares when updrafts are encountered.

Seeding is effective only within cloud updrafts and in the presence of supercooled cloud water, i.e. the developing, and mature stages in the evolution of the classic thunderstorm conceptual model. The dissipative stages of a storm would be seeded only if the maximum reflectivity is particularly severe and there is evidence (visual cloud growth, or tight reflectivity gradients) indicating the possible presence of embedded updrafts.

SEEDING RATE

A seeding rate of one 20 g flare every 5 s is typically used during cloud penetration. A slightly higher rate is used (e.g. 1 flare every 2 s) if updrafts are very strong (e.g. > 2000 ft/min) and the storm is particularly intense. Calculations show that this seeding rate will produce >1300 ice crystals per litre which is more than sufficient to deplete the liquid water content produced by updrafts of 10 m/s (2000 ft/min), thereby preventing the growth of hailstones within the seeded cloud volumes.

A cloud seeding pass is repeated immediately if there are visual signs of new cloud growth or radar reflectivity gradients remain tight (indicative of persistent updrafts). A 5 to 10 min waiting period may be used, to allow for the seeding material to take effect and the storm to dissipate, if visual signs of glaciation appear or radar reflectivity values decrease and gradients weaken. This waiting period precludes the waste of seeding material and ensures its optimum usage.

For cloud base seeding, a typical seeding rate of 1 burn-in-place flare (150 g each) is used. Cloud seeding runs are repeated until no further inflow is found. Wing-tip seeding solution burners will also be used to provide continuous silver iodide seeding if extensive regions of weak updraft are observed at cloud base and the shelf cloud region. Base seeding is not conducted if only downdrafts are encountered at cloud base, since this would waste seeding material.

If hygroscopic materials are used, one, burn-in-place 1-kg hygroscopic pyrotechnic will be burned at a time, simultaneously with one, burn-in-place glaciogenic pyrotechnic, so that the aerosols from the two flare types mix as they are ingested by the cloud.

The cloud seeding flares are glaciogenic pyrotechnics containing silver-iodide, with an ice nucleus effective yield of approximately 10^{14} nuclei per gram of pyrotechnic, active at -10°C, as determined by independent cloud chamber tests at Colorado State University.

Sufficient dispersion of the particles is required for glaciogenic plume overlap from consecutive flares by the time the cloud particles reach hail size for effective hail suppression. The work by Grandia et al. (1979) based on turbulence measurements within Alberta feeder clouds indicated that the time for the diameter of the diffusing line of seeding agent to reach the integral length scale (200 m) in the inertial subrange size scales of mixing, was 140 seconds. This is insufficient time for ice particles to grow to hail size. Therefore, dropping flares at 5 sec intervals should effectively deplete the supercooled liquid water and prevent the growth of hail particles. The use of the 20 gram flares and a frequent drop rate provides better seeding coverage than using larger flares with greater time/distance spacing between flare drops. In fact, the above calculations are conservative when one considers that the center of the ice crystal plume will have a higher concentration of crystals.

B. EQUIPMENT

Type:

- one Advanced Radar Corporation C-band Doppler weather radar, 250 kw peak power, with 1.65 deg. beam width, located at the Olds-Didsbury airport, 15.3 m tower-mounted, including radome.
- Three Beechcraft C90 King-Air prop-jet aircraft (two in Springbank and one in Red Deer).
- Two Cessna 340 aircraft (one in Springbank and one in Red Deer).

C. MATERIALS TO BE EMITTED:

- Cloud top (ejectable) pyrotechnic flares are 20g mass of glaciogenic formulation, ICE-EJ®, manufactured by Ice Crystal Engineering (ICE) of Kindred, North Dakota, USA (www.iceflares.com)
- Cloud base (burn-in-place) flares are 150g glaciogenic formulation, ICE-EB®, manufactured by Ice Crystal Engineering (ICE) of Kindred, North Dakota, USA (www.iceflares.com)
- A solution of acetone, silver iodide, sodium perchlorate, paradichlorobenzene, and ammonium iodide will also be burned for continuous seeding at cloud base. The products of combustion yield silver iodide-silver chloride-salt (AgI-AgCl-NaCl) ice nuclei, carbon dioxide (CO_2), and water (H_2O).
- The hygroscopic flares to be used produce a hygroscopic (water-attracting) nuclei comprised of calcium chloride (CaCl), a common salt, but a salt lacking the adverse effects of sodium chloride (NaCl) on clay soils.

Activation tests performed at Colorado State University indicate greater than10^{14} ice crystals per gram of seeding agent burned, active at -10°C.

Total flight hours and quantities to be dispersed: We estimate the project may use 8,500 twenty-gram flares and 1,000 one hundred-fifty gram flares, plus approximately 250 gallons of the seeding solution (2% AgI by volume) will be burned. The number of operational days, flights, and amount of seeding material dispensed over the past 23 years is summarized in the attached table. No harmful effects from these materials is expected. This is based on years of studies (both in the USA and Canada) to detect silver in precipitation (above background levels) following cloud seeding. The amount of silver distributed by the cloud seeding is small compared to the output from industry. Silver amounts from cloud seeding are far, far less than the USA EPA guidelines.

PART 8. GENERAL INFORMATION CONCERNING USE OF AIRCRAFT.

- Three C90 King Air prop-jet aircraft, two in Springbank (N904DK and N518TS) and one based in Red Deer (N127ZW).
- Two Cessna 340 aircraft, one in Springbank (N457DM) and one in Red Deer (N37356).

PART 9. GENERAL INFORMATION CONCERNING USE OF GROUND VEHICLES.

No special project ground vehicles will be deployed for the project. (Only private vehicles for personal transportation will be used.)

PART 10. GENERAL INFORMATION CONCERNING ANY MEASUREMENTS OR OBSERVATION INSTRUMENTATION.

No special surface observations are planned for this project. The primary instrumentation is the weather radar and special aircraft instrumentation. Daily weather charts will be recorded for documentation and reporting purposes.

AIRCRAFT TRACKING GLOBAL POSITIONING SYSTEM (GPS): The WMI weather radar control and communications center will be equipped to receive and record data from the GPS aircraft tracking system. The GPS system displays the exact position of aircraft superimposed on the radar display to enable the controller to accurately direct the seeding aircraft to optimum seeding locations within the storm system. The color-coded aircraft position on the PPI will be marked with a small symbol. Electronic coding will enable radar controllers to discriminate between all project aircraft.

TEMPERATURE INSTRUMENTATION: Each of the cloud seeding aircraft will have a temperature sensor to ensure that the cloud penetration seeding runs are conducted at the proper temperature levels.

WEATHER RADAR: The C-band Doppler radar will be equipped with a computerized radar recording and display system. The radar recording system will be capable of providing numerous cell statistics and colour products including plots of radar PPI displays and maximum reflectivity maps. The sophisticated radar tracking software called TITAN (Thunderstorm Identification, Tracking, Analysis, and Nowcasting) has been used since 1997 and has proved to be very useful. TITAN is licensed from the U.S. National Center for Atmospheric Research (NCAR).

A limited number of upper air observations (weather balloons) perhaps one dozen or so, will be made during the project season. These instrumented balloons measure the vertical profiles of temperature, humidity, and winds.

PART 11. CERTIFICATION BY ORGANIZATION FOR WHOM ACTIVITY IS TO BE CONDUCTED:

State type of working agreement entered into with the weather modifier: Contract.

I HEREBY CERTIFY THAT ALL STATEMENTS MADE IN THIS NOTIFICATION OF INTENT TO ENGAGE IN WEATHER MODIFICATION ACTIVITIES ARE TRUE AND COMPLETE TO THE BEST OF MY KNOWLEDGE, AND REPRESENT IN SUBSTANCE AN ACCURATE DESCRIPTION OF A PROPOSAL TO UNDERTAKE WEATHER MODIFICATION ACTIVITIES ON BEHALF OF THE ORGANIZATION NAMED HEREIN.

Name of organization: Alberta Severe Weather Management Society

Full name of certifying officer and title:

Todd Klapak
President, Alberta Severe Weather Management Society
(403) 231-1357, Todd.Klapak@intact.net

Signature: T. K [signature] Date: May 9, 2019

PART 12. CERTIFICATION BY PERSON PROPOSING TO CONDUCT ACTIVITY.

I HEREBY CERTIFY THAT INFORMATION PROVIDED IN THIS NOTIFICATION OF INTENT TO ENGAGE IN WEATHER MODIFICATION ACTIVITIES IS A TRUE AND COMPLETE DESCRIPTION OF MY PROPOSED PLANS TO ENGAGE IN THE SPECIFIC WEATHER MODIFICATION ACTIVITIES HEREIN DESCRIBED.

Name of organization: Weather Modification International

Full name of certifying officer:
Bruce A. Boe
Vice President of Meteorology
(701) 235-5500

Bruce A. Boe

Signature: Date: May 9, 2019

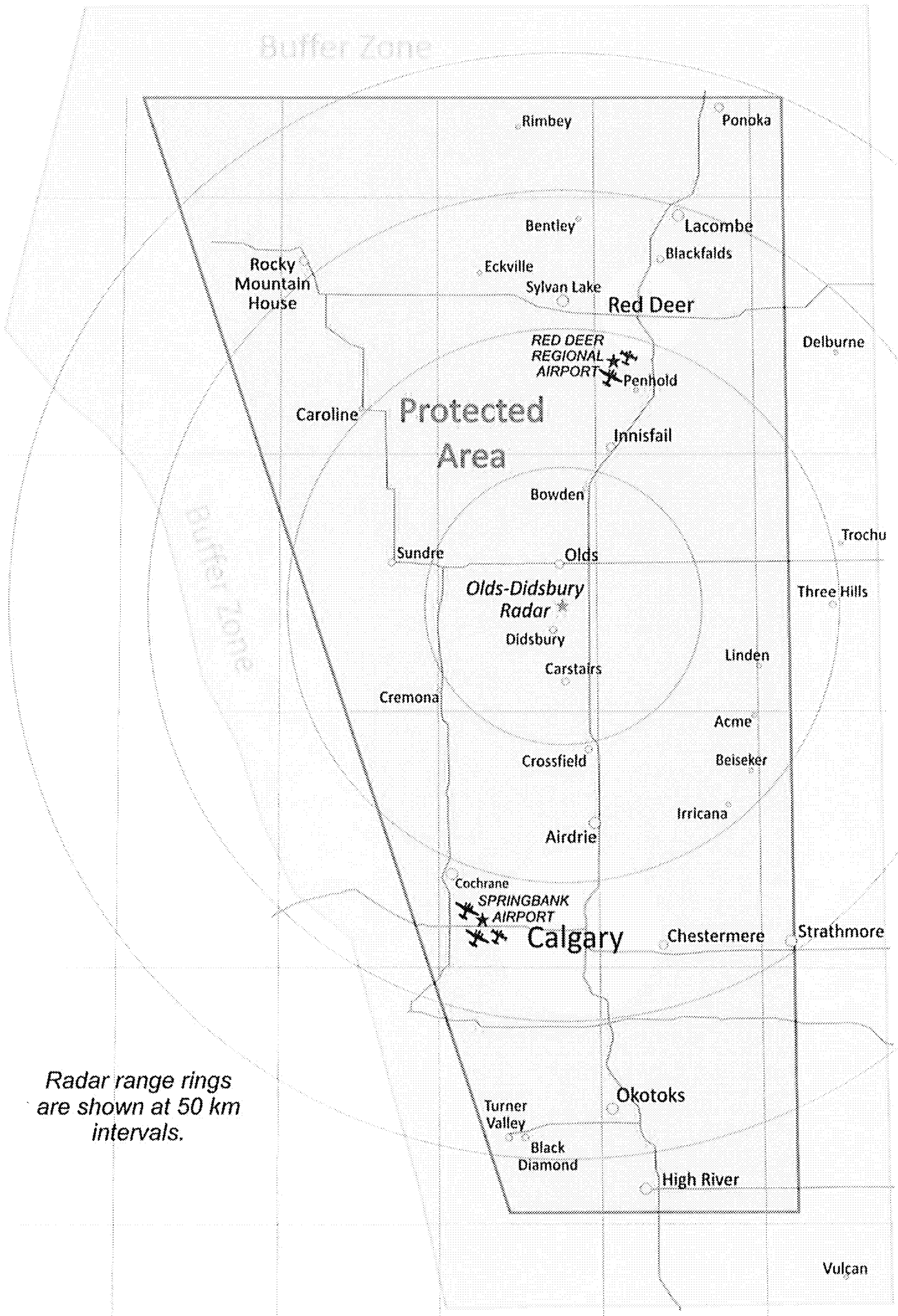

Figure 1: Map of south-central Alberta showing the project area, outlined in green, covered by the Hail Suppression activities.

Table 1. Seeding activity through 2018.

Seeding Activity by Season, 1996-2018												
Season	*Storm Days With Seeding*	*Aircraft Missions (Seeding & Patrol)*	*Total Flight Time (hours)*	*Number of Storms Seeded*	*Total Seeding Agent (kg)*	*Seeding Agent Per Day (kg)*	*Seeding Agent Per Hour (kg)*	*Seeding Agent Per Storm (kg)*	*Ejectable Flares*	*Burn-in-place Flares*	*Seeding Solutions (gallons)*	*Season Activity Rank*
2018	26	127	262.5	77	248.0	9.5	0.94	3.22	4663	951	198.0	9
Mean	31	106	218.2	90	221.4	7.2	1.02	2.55	5247	701	168.1	
2017	25	107	224.5	64	255.4	10.2	1.14	3.99	5939	842	170.2	11
2016	35	139	277.1	96	294.9	8.4	1.06	3.07	6496	1000	246.9	6
2015	26	115	233.3	79	349.2	14.6	1.37	4.42	8127	1138	262.9	8
2014	32	128	259.5	101	382.5	12.0	1.47	3.79	10782	1020	228.6	3
2013	26	103	229.6	70	233.3	9.0	1.02	3.33	6311	636	131.7	14
2012	37	143	300.1	116	314.6	8.5	1.16	2.70	7717	914	260.3	2
2011	48	158	383.0	134	400.1	8.3	1.13	3.00	10779	1020	350.2	1
2010	42	115	271.8	118	263.8	6.3	1.10	2.20	5837	851	227.5	7
2009	20	38	109.3	30	48.4	2.4	0.84	1.60	451	237	56.5	23
2008	26	112	194.7	56	122.9	4.7	1.00	2.20	1648	548	113.5	18
2007	19	76	115.3	41	99.7	5.2	0.90	2.40	1622	413	77	22
2006	28	92	190.2	65	214	7.6	1.10	3.30	4929	703	145.4	15
2005	27	80	157.9	70	159.1	5.9	1.00	2.30	3770	515	94.2	20
2004	29	105	227.5	90	270.9	9.3	1.20	3.00	6513	877	132.7	10
2003	26	92	163.6	79	173.4	6.7	1.10	2.20	4465	518	92.6	17
2002	27	92	157.4	54	124.2	4.6	0.80	2.30	3108	377	80.3	21
2001	36	109	208.3	98	195	5.4	0.90	2.00	5225	533	140.8	12
2000	33	130	265.2	136	343.8	10.4	1.30	2.50	9653	940	141.3	4
1999	39	118	251.3	162	212.7	5.5	0.80	1.30	4439	690	297.5	5
1998	31	96	189.9	153	111.1	3.6	0.60	0.70	2023	496	193.8	13
1997*	38	92	188.1	108	110.8	2.9	0.60	1.00	2376	356	144.3	16
1996*	29	71	159.1	75	163.3	5.6	1.00	2.20	3817	542	80.5	19
**The 1996 and 1997 seasons began on June 15, not June 1; the latter has been the norm ever since.*												

NOTICE OF INTENT TO ENGAGE IN WEATHER MODIFICATION ACTIVITIES
PURSUANT TO THE WEATHER MODIFICATION INFORMATION ACT AND REGULATIONS
SCHEDULE I

PART 1. GENERAL IDENTIFICATION OF ACTIVITY

Date of notice: May 4, 2020
Proposed starting date: June 1st, 2020
Expected duration: September 15th, 2020

Province and area to be affected: Central Alberta, covering the Red Deer to Calgary regions (see attached map showing project area which has remained essentially the same since 1996).

Weather elements to be modified: Thunderstorms
Modification expected: Hail Suppression
Class of operation: Operational
Operating method: airborne
Class of economy to benefit: insurance industry: private and public property primary, agriculture secondary.

PART 2. GENERAL INFORMATION CONCERNING WEATHER MODIFIER

Organization name: Weather Modification International (WMI)
http://www.weathermodification.com/
Parent Organization: Weather Modification LLC
3802 20th Street North
Fargo, ND USA 58102
Chief Officer: Mr. Patrick Sweeney, President Tel: (701) 235-5500
pat@weathermod.com
Local Organization: Weather Modification International Tel. (403) 335-8359
Olds-Didsbury Airport, Highway 2A
Olds, AB T4H 1A1

Name and relevant qualifications of officer(s) designated in charge of project:

Chief Officer: Mr. Daniel Gilbert, Chief Meteorologist
B.S., 18 years' experience
WMA Certified Weather Modification Operator #78
Office Tel: (403) 335-8359
(see Part 5 for details of qualifications and experience)

Vice President - Meteorology Mr. Bruce Boe
Project Manager/Meteorology, 46 years' experience
Tel: (701) 235-5500

Primary activities of organization (see web page at www.weathermodification.com):

- cloud seeding
- atmospheric research
- air pollution monitoring
- meteorological radar monitoring
- equipment design and fabrication
- aircraft modifications

Amount of public liability insurance carried applicable to activity: CAD$50 million by the Alberta Severe Weather Management Society and USD$5 million by Weather Modification LLC.

List of similar weather modification activities previously undertaken:

a. Canada: The Alberta Hail Project has been operating in its present form since 1996. The contractor (operator) for this entire period has been WMI.

b. Elsewhere:
- WMI has conducted the hail suppression cloud seeding in North Dakota for more than 50 years. This is an ongoing project.
- WMI conducted hail suppression in Mendoza, Argentina using 3 to 4 Cheyenne II aircraft and a Lear Jet 1998-2004.
- WMI conducted operational cloud seeding in Oklahoma for Rain Enhancement and Hail Suppression 1997-2001.
- WMI has conducted operational cloud seeding in Alberta, Burkina Faso, California, Colorado, Idaho, UAE, India, Mali, Nevada, North Dakota, Saudi Arabia, Senegal, and Wyoming within the last 10 years.

4. References:

1. Dr. Terry Krauss
   Krauss Weather Services
   79 Irving Crescent
   Red Deer, AB T4R 3S3 Tel. 403-318-0400
2. Mr. Darin Langerud, Director
   State of North Dakota Atmospheric Resource Board
   900 E. Boulevard Ave.
   Bismarck, ND 58505 Tel. 701-328-2788
3. Dr. Ronald E. Rinehart
   3629 W. Gordon Drive
   Jefferson City, MO 65109 Tel. 816-344-0846
4. Dr. Andrew Detwiler
   South Dakota School of Mines & Technology
   501 E. St. Joseph Street
   Rapid City, SD 57701-3995 Tel. 605-394-2291

List of subcontractors: WMI owns and operates its own fleet of aircraft and weather radars. No major sub-contractors are being used on the Alberta Hail project for aircraft or radar services. Solution Blend Services, Calgary, Alberta (403) 207-9840 will be handling and mixing seeding solutions for the project.

PART 3. GENERAL INFORMATION CONCERNING ORGANIZATION FOR WHOM ACTIVITY IS TO BE CONDUCTED.

Name of organization: Alberta Severe Weather Management Society (ASWMS)

Chief officers: Mr. Todd Klapak, President
todd.klapak@intact.net
Ms. Sherre Newell, Secretary-Treasurer
sherre.newell@aviva.com

Nature of organization: A not-for-profit society of the property and casualty insurers and brokers operating in Alberta. The society was formed for the purpose of collecting funds from its members to operate a hail suppression program to help reduce insurance payout due to hail and stabilize insurance rates throughout the province.

PART 4. GENERAL INFORMATION CONCERNING FIELD BASES OF ACTIVITY

Address and location of project primary field base:
Olds-Didsbury Airport, Alberta. tel. 403-335-8359
Address(es) and locations(s) of project secondary field base(s):
- Springbank Airport tel. 403-247-0001
- Red Deer Regional Airport tel. 403-886-7857

PART 5. GENERAL INFORMATION CONCERNING OPERATING FIELD PERSONNEL

Name and title of field officer in charge: Mr. Daniel Gilbert, Chief Meteorologist
Old-Didsbury Airport, Highway 2A
Olds, AB T4H 1A1

tel. & fax. 403-335-8359,
e-mail: dgilbert@weathermodifcation.com
home page: http://www.weathermodification.com/

Qualifications of field officer in charge (Gilbert):

Education
Bachelor of Science, Meteorology and Environmental Studies (double major) May 2004, Iowa State University, Ames, IA
Associate of Arts, Liberal Arts, May 2000, Iowa Central Community College, Fort Dodge, IA

Weather Modification Experience
Chief Meteorologist, Weather Modification International (Wyoming and Alberta) - November 2009 to present
Forecaster, radar operator, rawinsondes, direction of seeding aircraft. Case declarations, wintertime (Wyoming) research program.
Meteorologist, RHS Consulting (Fresno, CA) – November 2008-February 2009
Directed airborne and ground based cloud seeding operations over portions of the central and southern Sierra Nevada Mountains. Set up and performed routine maintenance of ground based ice nucleus generators. Provided daily forecasts for clients and project personnel.
Meteorologist, Independent Contractor, (Boise, ID) – October 2007 to April 2008
Provided meteorological services to support Idaho Power Company's winter cloud seeding project in West Central Idaho, directed airborne and ground seeding operations, directed rawinsonde releases, provided short-term operational forecasts and nowcasts for pilots, communicated with aircraft via two-way radio
Field Meteorologist, North Dakota Cloud Modification Project, (Stanley or Bowman, ND) – Summers, 2003-2009
Operated 5 cm weather radar equipped with TITAN software package, launched and directed seeding aircraft using two-way radio and GPS tracking, performed data recording and documentation of cloud seeding operations, prepared silver iodide seeding solution, assisted with radar calibrations, prepared forecasts and briefed pilots daily, supervised intern meteorologists, presented case studies for ground school, operated cloud condensation nuclei counter for joint research with South Dakota School of Mines
Forecaster, Atmospherics Incorporated, (Fresno, CA) - October 2006 - May 2007
Field Meteorologist, Atmospherics, Inc. (Modesto, CA) - November 2005 - April 2006
Field Meteorologist, Atmospherics, Inc. (Paso Robles, CA) - December 2004 - February 2005
Provided daily forecasts for seeding operations and/or clients, operated 5cm weather radar, directed winter cloud seeding operations over the Sierra Nevada utilizing both glaciogenic and hygroscopic seeding agents, traced radar overlays, performed data recording of operations, wrote monthly and annual reports

Memberships and Honors

- Meteorologist Distinguished Service Award, 2013, Weather Modification Association
- Member, Weather Modification Association (certified operator #78)
- Member, American Meteorological Society
- Iowa Central Community College Honor Society, inducted April 27, 2000
- Wilbur E Brewer Professionalism Award, 2007 North Dakota Cloud Modification Project

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Field Address: Olds-Didsbury Airport, Highway 2A, Olds, AB
Field Telephone no. 403-335-8359
Field personnel: full time = 4
part time = 14

Daily records of activities: Custodian = Ms. Erin Fischer
WMI Project Operations Centre
Olds-Didsbury Airport, Highway 2A, AB T4H 1A1

All records are maintained June 1st -Sept. 15th annually.

- daily weather synopsis and forecast report
- radar echo storm data report and maps
- daily operations summary report
- chemical inventory report
- equipment status report
- aircraft flight track maps
- flight log report
- project aircraft maintenance report

PART 6. GENERAL INFORMATION CONCERNING PROPOSED ACTIVITY

Reasons for organization seeking modified weather: The hailstorm on Sept. 7, 1991 caused >$400 million damage in the City of Calgary alone. Hailstorms in the City of Calgary caused >$500 Million in 2010 and again in 2012. In addition, hailstorms have caused >$100 Million damage to crops annually since 2007 and the damage to crops was >$400 Million in 2012. Hailstorms have now become a billion-dollar problem to the economy of Alberta. The 20 largest insurance companies and their affiliates have banded together to conduct hail suppression operations in the "hail alley" of central Alberta to combat urban hail damage in the Calgary to Red Deer area. The current program has conducted cloud-seeding operations in central Alberta each summer since 1996.

Specific modification sought: Diminish hail damage to property in central Alberta with special priority given to the urban areas of Calgary and Red Deer.

Quantitative estimate of modification expected: Even very small positive results (+1%) will be economically beneficial, however, it is hoped that reductions in damage on the order of 25% or greater will be realized. The insurance industry has been encouraged by the results, estimating a savings of several hundred-million dollars to the industry, paying out approximately 50% of what they expected.

Secondary effects anticipated: Some reductions in crop damage due to hail should also be realized. Seeding may also provide a slight increase in precipitation according to recent analyses of radar data. The crop hail insurance data for the first 10 years of the project indicated a reduction in the loss-to-risk values compared with the historical 58 year average for the province as a whole. However, a recent analysis shows increased variability and an increasing trend in hail damage over the last 10 years both inside and outside the project area which is likely due to climate change. The effect of the seeding on crop damage is inconclusive at this time.

Geographic area affected (see attached map): The main project area is from Calgary to Red Deer, Alberta and west to the foothills of the Rocky Mountains.

Estimate of adjoining geographic area possibly affected: Areas downwind (east) of highway no. 2 to highway no. 21 may also benefit from the seeded storms.

Approximate total cost: approx. $5.0 million per year.

Funds to be expended in Canada: est. $1,000,000 per year.

General period of operation: June 1st - Sept. 15th annually.

PART 7. GENERAL INFORMATION CONCERNING OPERATIONS AND TECHNIQUES

A. GENERAL: The following text describes the methods to be used, general principles of techniques, description of specific techniques, and a brief description of typical operations:

OVERVIEW OF METHOD

For hail suppression, aircraft patrolling based upon forecasts and hourly weather reports will be used to initiate seeding as soon as appropriate conditions develop. Storms will be seeded if they have radar reflectivities of approximately 35 dBZ at heights above the -5°C temperature level, and are considered to be a potential hail threat to an urban or populated area. When large hail is forecast, seeding will commence when radar reflectivities reach approximately 20 dBZ in order to start the microphysical suppression process as early as possible within the potential hailstorms. Storms will be seeded by aircraft using either droppable AgI pyrotechnics and/or wing mounted AgI pyrotechnics or AgI-solution burners.

Subsequent to an independent (2018) review of the project science, limited seeding of a few less-intense storms with both glaciogenic and hygroscopic seeding agents will be conducted to assess the theorized positive effect of such treatment. The hygroscopic material used will be in the form of 1-kilogram calcium carbonate (CaCl) pyrotechnics, a salt.

The amount of seeding material used will depend upon the lifetime and size of the cloud or storm and other meteorological conditions. The seeding rates are about double those used during the 1970's and 1980's in Alberta. Seeding will be focused on the feeder clouds of the storm's new growth zone and will be conducted at cloud top and cloud base. Further details of the seeding method are discussed below.

HAIL SUPPRESSION HYPOTHESIS

The cloud seeding hypothesis is based on the cloud microphysics concept of "beneficial competition". Beneficial competition assumes a lack of natural ice nuclei in the environment effective at temperatures warmer than -20°C and that the injection of AgI will result in the production of a significant number of "artificial" ice nuclei. The natural and artificial ice crystals "compete" for the available supercooled liquid cloud water within the storm. Hence, the hailstones that are formed within the seeded cloud volumes will be smaller and produce less damage if they should survive the fall to the surface. If enough nuclei are introduced into the new growth region of the storm, then it is possible that the hailstones will be small enough to melt completely before reaching the ground.

Cloud seeding operations are intended to alter the cloud microphysics of the treated clouds, assuming that the present precipitation process is inefficient due to a lack of natural ice nuclei. The seeding is based on a conceptual model of Alberta hailstorms that evolved from the studies of Chisholm (1970), Chisholm and Renick (1972), Barge and Bergwall (1976), Krauss and Marwitz (1984), English and Krauss (1986) and English (1986).

It is assumed that hail embryos grow within the time evolving "main" updraft of single cell storms and within the updrafts of developing "feeder clouds" or cumulus towers that flank mature "multi-cell" and "super-cell" storms (see e.g. Foote 1984). The growth to large hail is hypothesized to occur along the edges of the main storm updraft where the merging feeder clouds interact with the main storm updraft.

For hail suppression, seeding with a large amount of glaciogenic seeding agent will dramatically increase the ice crystal concentration in thunderstorm clouds and compete for the available supercooled cloud water to prevent the growth of large, damaging, ice particles. Based on WMI's experience, the cloud seeding will be targeted on the feeder cloud updraft regions associated with the production of hail and will leave unseeded those regions of the storm associated with the production of rain only. This will make efficient use of the seeding material and will reduce the possibility of overseeding.

To test the effects of seeding with both glaciogenic and hygroscopic seeding agents, a limited number of storms may be seeded with glaciogenic material at cloud top, and glaciogenic and hygroscopic agents in updrafts at cloud base. Hygroscopic agents (salts) are designed to encourage the formation of cloud droplets, which when frozen as a result of the simultaneous glaciogenic seeding, result in additional precipitation embryos, which then (as stated above) compete for the available supercooled liquid water.

CLOUD SEEDING METHODOLOGY - SEEDING TECHNIQUES

Convective cells (defined by radar) with maximum reflectivity approximately >35 dBZ within the cloud layer above the -5°C level, located within the project areas or within a 20 min travel time "buffer zone" upwind of the project area, will be seeded if they pose a potential threat of damaging hail for an urban or populated area. Radar observers/controllers will be responsible for making the "seed" decision and directing the cloud seeding missions.

Patrol flights will be launched before clouds within the target area meet the radar reflectivity seeding criteria. These patrol flights are meant to provide immediate response to developing cells. In general, a patrol is launched in the event of visual reports of vigorous towering cumulus clouds near Calgary or Red Deer, or when radar cells exceed 25 kft height over the higher terrain along the western border and begin moving towards the urban areas.

Launches of more than one aircraft are determined by the number of storms in each area, the lead time required for a seeder aircraft to reach the proper location and altitude, and projected overlap of coverage and on-station time for multiple aircraft missions. In general, only one aircraft can work safely at cloud top and one aircraft at cloud base for a single storm. The operation of three aircraft is recommended to provide uninterrupted seeding coverage at either cloud-base or cloud-top and to seed three storms simultaneously if required.

The program is designed to seed convective clouds, before they achieve radar reflectivities associated with hail, and deliver seeding material to regions of updraft and supercooled liquid water i.e. the primary conditions responsible for the growth of hailstones.

Factors that determine cloud top or cloud base seeding are: storm structure, visibility, cloud base height, or time available to reach seeding altitude. Cloud base seeding is conducted by flying at cloud base within the main inflow of single cell storms, or the inflow associated with the new growth zone (shelf cloud) located on the upshear side of multi-cell storms.

Cloud top seeding is conducted between typically between -5°C and -10°C. The pencil flares fall approximately 1.5 km (approximately 10°C) during their 35-40 second burn time. The seeding aircraft will penetrate the edges of single convective cells meeting the seed criteria. For multi-cell storms, or storms with feeder clouds, the seeding aircraft will penetrate the tops of the developing cumulus towers on the upshear sides of convective cells, as they grow up through the aircraft's altitude.

Occasionally, with embedded cells or convective complexes, there are no clearly defined feeder turrets visible to the flight crews or on radar. In these instances, at an altitude between -5°C and - 10°C, a seeding aircraft will penetrate the storm edge (region of tight radar reflectivity gradient) on the upshear

side and burn a burn-in-place flare and inject droppable pencil flares when updrafts are encountered.

Seeding is effective only within cloud updrafts and in the presence of supercooled cloud water, i.e. the developing, and mature stages in the evolution of the classic thunderstorm conceptual model. The dissipative stages of a storm would be seeded only if the maximum reflectivity is particularly severe and there is evidence (visual cloud growth, or tight reflectivity gradients) indicating the possible presence of embedded updrafts.

<u>SEEDING RATE</u>

A seeding rate of one 20 g flare every 5 s is typically used during cloud penetration. A slightly higher rate is used (e.g. 1 flare every 2 s) if updrafts are very strong (e.g. > 2000 ft/min) and the storm is particularly intense. Calculations show that this seeding rate will produce >1300 ice crystals per litre which is more than sufficient to deplete the liquid water content produced by updrafts of 10 m/s (2000 ft/min), thereby preventing the growth of hailstones within the seeded cloud volumes.

A cloud seeding pass is repeated immediately if there are visual signs of new cloud growth or radar reflectivity gradients remain tight (indicative of persistent updrafts). A 5 to 10 min waiting period may be used, to allow for the seeding material to take effect and the storm to dissipate, if visual signs of glaciation appear or radar reflectivity values decrease and gradients weaken. This waiting period precludes the waste of seeding material and ensures its optimum usage.

For cloud base seeding, a typical seeding rate of 1 burn-in-place flare (150 g each) is used. Cloud seeding runs are repeated until no further inflow is found. Wing-tip seeding solution burners will also be used to provide continuous silver iodide seeding if extensive regions of weak updraft are observed at cloud base and the shelf cloud region. Base seeding is not conducted if only downdrafts are encountered at cloud base, since this would waste seeding material.

If hygroscopic materials are used, one, burn-in-place 1-kg hygroscopic pyrotechnic will be burned at a time, simultaneously with one, burn-in-place glaciogenic pyrotechnic, so that the aerosols from the two flare types mix as they are ingested by the cloud.

The cloud seeding flares are glaciogenic pyrotechnics containing silver-iodide, with an ice nucleus effective yield of approximately 10^{14} nuclei per gram of pyrotechnic, active at -10°C, as determined by independent cloud chamber tests at Colorado State University.

Sufficient dispersion of the particles is required for glaciogenic plume overlap from consecutive flares by the time the cloud particles reach hail size for effective hail suppression. The work by Grandia et al. (1979) based on turbulence measurements within Alberta feeder clouds indicated that the time for the diameter of the diffusing line of seeding agent to reach the integral length scale (200 m) in the inertial subrange size scales of mixing, was 140 seconds. This is insufficient time for ice particles to grow to hail size. Therefore, dropping flares at 5 sec intervals should effectively deplete the supercooled liquid water and prevent the growth of hail particles. The use of the 20 gram flares and a frequent drop rate provides better seeding coverage than using larger flares with greater time/distance spacing between flare drops. In fact, the above calculations are conservative when one considers that the center of the ice crystal plume will have a higher concentration of crystals.

B. EQUIPMENT

Type:

- one C-band Doppler weather radar, 250 kw peak power, with 1.65 deg. beam width, located at the Olds-Didsbury airport, 15.3 m tower-mounted, including radome.
- Three Beechcraft C90 King-Air prop-jet aircraft (two in Springbank and one in Red Deer).
- Two Cessna 340 aircraft (one in Springbank and one in Red Deer).

C. MATERIALS TO BE EMITTED:

- Cloud top (ejectable) pyrotechnic flares are 20g mass of glaciogenic formulation, ICE-EJ®, manufactured by Ice Crystal Engineering (ICE) of Kindred, North Dakota, USA (www.iceflares.com)
- Cloud base (burn-in-place) flares are 150g glaciogenic formulation, ICE-EB®, manufactured by Ice Crystal Engineering (ICE) of Kindred, North Dakota, USA (www.iceflares.com)
- A solution of acetone, silver iodide, sodium perchlorate, paradichlorobenzene, and ammonium iodide will also be burned for continuous seeding at cloud base. The products of combustion yield silver iodide-silver chloride-salt (AgI-AgCl-NaCl) ice nuclei, carbon dioxide (CO_2), and water (H_2O).
- The hygroscopic flares to be used produce a hygroscopic (water-attracting) nuclei comprised of calcium chloride (CaCl), a common salt, but a salt lacking the adverse effects of sodium chloride (NaCl) on clay soils.

Activation tests performed at Colorado State University indicate greater than10^{14} ice crystals per gram of seeding agent burned, active at -10°C.

Total flight hours and quantities to be dispersed: We estimate the project may use 8,500 twenty-gram flares and 1,000 one hundred-fifty gram flares, plus approximately 250 gallons of the seeding solution (2% AgI by volume) will be burned. The hygroscopic CaCl flares are being used only in limited instances on a trial basis, it is likely between 100 and 200 might be burned. The number of operational days, flights, and amount of seeding material dispensed over the past 24 years is summarized in the attached table. No harmful effects from these materials is expected. This is based on years of studies (both in the USA and Canada) to detect silver in precipitation (above background levels) following cloud seeding. The amount of silver distributed by the cloud seeding is small compared to the output from industry. Silver amounts from cloud seeding are far, far less than the USA EPA guidelines.

PART 8. GENERAL INFORMATION CONCERNING USE OF AIRCRAFT.

- Three C90 King Air prop-jet aircraft, two in Springbank (N904DK and N518TS) and one based in Red Deer (N127ZW).
- Two Cessna 340 aircraft, one in Springbank (N457DM) and one in Red Deer (N37356).

PART 9. GENERAL INFORMATION CONCERNING USE OF GROUND VEHICLES.

No special project ground vehicles will be deployed for the project. (Only private vehicles for personal transportation will be used.)

PART 10. GENERAL INFORMATION CONCERNING ANY MEASUREMENTS OR OBSERVATION INSTRUMENTATION.

No special surface observations are planned for this project. The primary instrumentation is the weather radar and special aircraft instrumentation. Daily weather charts will be recorded for documentation and reporting purposes.

AIRCRAFT TRACKING GLOBAL POSITIONING SYSTEM (GPS): The WMI weather radar control and communications center will be equipped to receive and record data from the GPS aircraft tracking system. The GPS system displays the exact position of aircraft superimposed on the radar display to enable the controller to accurately direct the seeding aircraft to optimum seeding locations within the storm system. The color-coded aircraft position on the PPI will be marked with a small symbol. Electronic coding will enable radar controllers to discriminate between all project aircraft.

TEMPERATURE INSTRUMENTATION: Each of the cloud seeding aircraft will have a temperature sensor to ensure that the cloud penetration seeding runs are conducted at the proper temperature levels.

WEATHER RADAR: The C-band Doppler radar will be equipped with a computerized radar recording and display system. The radar recording system will be capable of providing numerous cell statistics and colour products including plots of radar PPI displays and maximum reflectivity maps. The sophisticated radar tracking software called TITAN (Thunderstorm Identification, Tracking, Analysis, and Nowcasting) has been used since 1997 and has proved to be very useful. TITAN is licensed from the U.S. National Center for Atmospheric Research (NCAR).

A limited number of upper air observations (weather balloons) perhaps one dozen or so, will be made during the project season. These instrumented balloons measure the vertical profiles of temperature, humidity, and winds.

PART 11. CERTIFICATION BY ORGANIZATION FOR WHOM ACTIVITY IS TO BE CONDUCTED:

State type of working agreement entered into with the weather modifier: Contract.

I HEREBY CERTIFY THAT ALL STATEMENTS MADE IN THIS NOTIFICATION OF INTENT TO ENGAGE IN WEATHER MODIFICATION ACTIVITIES ARE TRUE AND COMPLETE TO THE BEST OF MY KNOWLEDGE, AND REPRESENT IN SUBSTANCE AN ACCURATE DESCRIPTION OF A PROPOSAL TO UNDERTAKE WEATHER MODIFICATION ACTIVITIES ON BEHALF OF THE ORGANIZATION NAMED HEREIN.

Name of organization: Alberta Severe Weather Management Society

Full name of certifying officer and title:

Todd Klapak
President, Alberta Severe Weather Management Society
(403) 231-1357, Todd.Klapak@intact.net

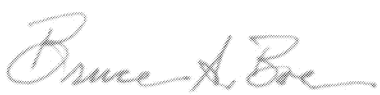
Signature: Date: May 4, 2020

PART 12. CERTIFICATION BY PERSON PROPOSING TO CONDUCT ACTIVITY.

I HEREBY CERTIFY THAT INFORMATION PROVIDED IN THIS NOTIFICATION OF INTENT TO ENGAGE IN WEATHER MODIFICATION ACTIVITIES IS A TRUE AND COMPLETE DESCRIPTION OF MY PROPOSED PLANS TO ENGAGE IN THE SPECIFIC WEATHER MODIFICATION ACTIVITIES HEREIN DESCRIBED.

Name of organization: Weather Modification International

Full name of certifying officer:
Bruce A. Boe
Vice President of Meteorology
(701) 235-5500



Signature: Date: May 4, 2020

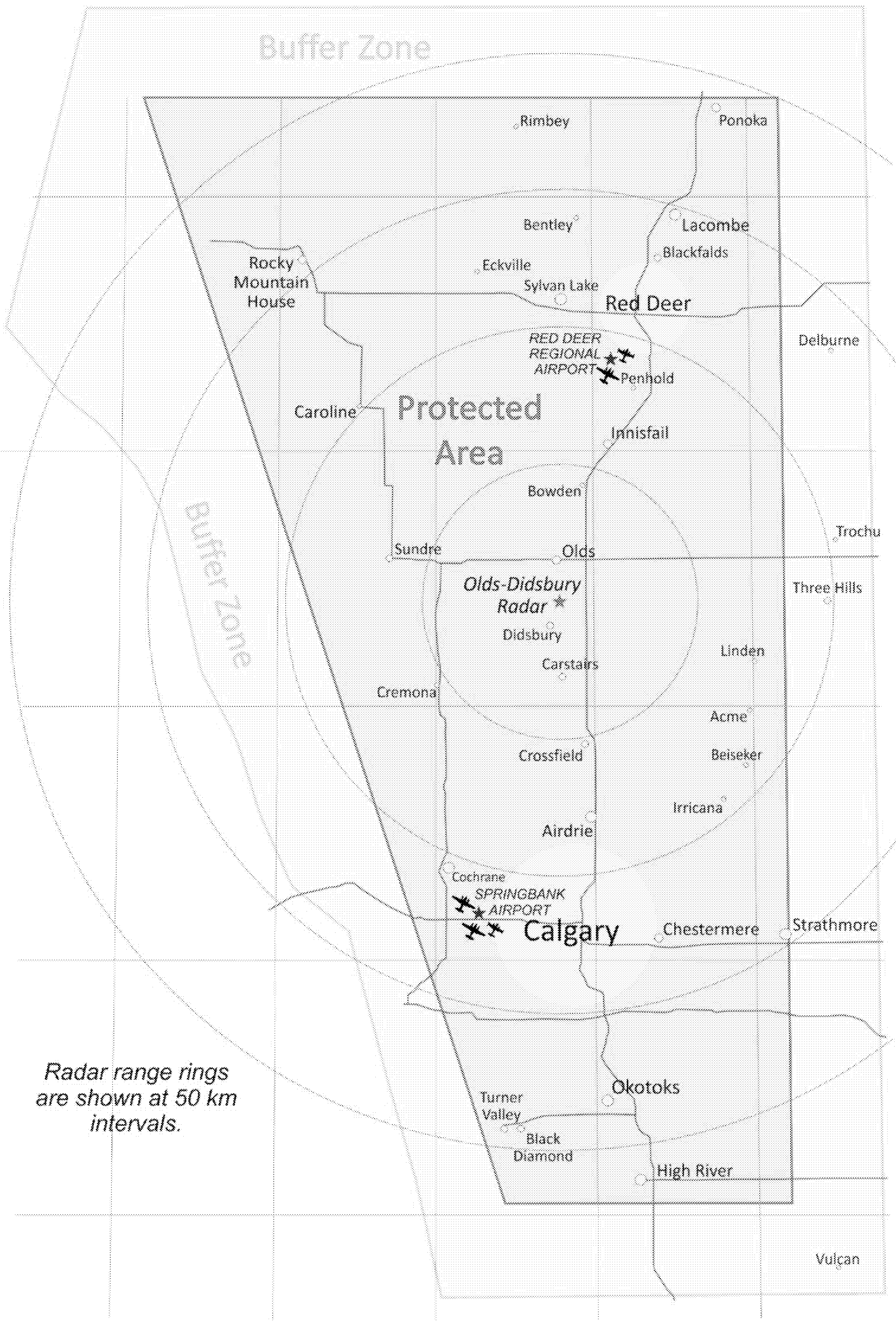


Figure 1: Map of south-central Alberta showing the project area, outlined in green, covered by the Hail Suppression activities.

Table 1. Seeding activity through 2019.

SEASON	Storm Days With Seeding	Aircraft Missions (Seeding & Patrol)	Total Flight Time (hours)	Number of Storms Seeded	Total Seeding Agent (kg)	Seeding Agent Per Day (kg)	Seeding Agent Per Hour (kg)	Seeding Agent Per Storm (kg)	Ejectable Flares	Burn-in-place Flares	Seeding Solution (gallons)	Season Activity Rank
2019	27	114	253.2	61	296.4	11.0	1.17	4.86	7520	912	150.5	10
MEAN	29	101	208.7	86	214.1	7.0	0.99	2.52	5148	670	159.1	
2018	26	127	262.5	77	248.0	9.5	0.94	3.22	4663	951	198.0	9
2017	25	107	224.5	64	255.4	10.2	1.14	3.99	5939	842	170.2	12
2016	35	139	277.1	96	294.9	8.4	1.06	3.07	6496	1000	246.9	6
2015	26	115	233.3	79	349.2	14.6	1.37	4.42	8127	1138	262.9	8
2014	32	128	259.5	101	382.5	12.0	1.47	3.79	10782	1020	228.6	3
2013	26	103	229.6	70	233.3	9.0	1.02	3.33	6311	636	131.7	15
2012	37	143	300.1	116	314.6	8.5	1.16	2.70	7717	914	260.3	2
2011	48	158	383.0	134	400.1	8.3	1.13	3.00	10779	1020	350.2	1
2010	42	115	271.8	118	263.8	6.3	1.10	2.20	5837	851	227.5	7
2009	20	38	109.3	30	48.4	2.4	0.84	1.60	451	237	56.5	24
2008	26	112	194.7	56	122.9	4.7	1.00	2.20	1648	548	113.5	19
2007	19	76	115.3	41	99.7	5.2	0.90	2.40	1622	413	77	23
2006	28	92	190.2	65	214	7.6	1.10	3.30	4929	703	145.4	16
2005	27	80	157.9	70	159.1	5.9	1.00	2.30	3770	515	94.2	21
2004	29	105	227.5	90	270.9	9.3	1.20	3.00	6513	877	132.7	11
2003	26	92	163.6	79	173.4	6.7	1.10	2.20	4465	518	92.6	18
2002	27	92	157.4	54	124.2	4.6	0.80	2.30	3108	377	80.3	22
2001	36	109	208.3	98	195	5.4	0.90	2.00	5225	533	140.8	13
2000	33	130	265.2	136	343.8	10.4	1.30	2.50	9653	940	141.3	4
1999	39	118	251.3	162	212.7	5.5	0.80	1.30	4439	690	297.5	5
1998	31	96	189.9	153	111.1	3.6	0.60	0.70	2023	496	193.8	14
1997*	38	92	188.1	108	110.8	2.9	0.60	1.00	2376	356	144.3	17
1996*	29	71	159.1	75	163.3	5.6	1.00	2.20	3817	542	80.5	20

**The 1996 and 1997 seasons began on June 15, not June 1, which has been the norm ever since.*

NOTICE OF INTENT TO ENGAGE IN WEATHER MODIFICATION ACTIVITIES
PURSUANT TO THE WEATHER MODIFICATION INFORMATION ACT AND REGULATIONS
SCHEDULE I

PART 1. GENERAL IDENTIFICATION OF ACTIVITY

Date of notice: May 28, 2021
Proposed starting date: June 1, 2021
Expected duration: September 15, 2021

Province and area to be affected: Central Alberta, covering the Red Deer to Calgary regions (see attached map showing project area which has remained essentially the same since 1996).

Weather elements to be modified: Thunderstorms
Modification expected: Hail Suppression
Class of operation: Operational
Operating method: airborne
Class of economy to benefit: insurance industry: private and public property primary, agriculture secondary.

PART 2. GENERAL INFORMATION CONCERNING WEATHER MODIFIER

Organization name: Weather Modification International (WMI)
http://www.weathermodification.com/
Parent Organization: Weather Modification LLC
3802 20th Street North
Fargo, ND USA 58102
Chief Officer: Mr. Patrick Sweeney, President Tel: (701) 235-5500
pat@weathermod.com
Local Organization: Weather Modification International Tel. (403) 335-8359
Olds-Didsbury Airport, Highway 2A
Olds, AB T4H 1A1

Name and relevant qualifications of officer(s) designated in charge of project:

Chief Officer: Mr. Daniel Gilbert, Chief Meteorologist
B.S., 18 years' experience
WMA Certified Weather Modification Operator #78
Office Tel: (403) 335-8359
(see Part 5 for details of qualifications and experience)

Vice President - Meteorology Mr. Bruce Boe
Project Manager/Meteorology, 47 years' experience
Tel: (701) 235-5500

Primary activities of organization (see web page at www.weathermodification.com):
- cloud seeding
- atmospheric research
- air pollution monitoring
- meteorological radar monitoring
- equipment design and fabrication
- aircraft modifications

Amount of public liability insurance carried applicable to activity: CAD$50 million by the Alberta Severe Weather Management Society and USD$25 million by Weather Modification LLC.

List of similar weather modification activities previously undertaken:

a. Canada: The Alberta Hail Project has been operating in its present form since 1996. The contractor (operator) for this entire period has been WMI.

b. Elsewhere:
- WMI has conducted the hail suppression cloud seeding in North Dakota for more than 50 years. This is an ongoing project.
- WMI conducted hail suppression in Mendoza, Argentina using 3 to 4 Cheyenne II aircraft and a Lear Jet 1998-2004.
- WMI conducted operational cloud seeding in Oklahoma for Rain Enhancement and Hail Suppression 1997-2001.
- WMI has conducted operational cloud seeding in Alberta, Burkina Faso, California, Colorado, Idaho, UAE, India, Mali, Nevada, North Dakota, Saudi Arabia, Senegal, and Wyoming within the last 10 years.

4. References:

1. Dr. Terry Krauss
Krauss Weather Services
79 Irving Crescent
Red Deer, AB T4R 3S3 Tel. 403-318-0400
2. Mr. Darin Langerud, Director
State of North Dakota Atmospheric Resource Board
900 E. Boulevard Ave.
Bismarck, ND 58505 Tel. 701-328-2788
3. Dr. Ronald E. Rinehart
3629 W. Gordon Drive
Jefferson City, MO 65109 Tel. 816-344-0846
4. Dr. Andrew Detwiler
South Dakota School of Mines & Technology
501 E. St. Joseph Street
Rapid City, SD 57701-3995 Tel. 605-394-2291

List of subcontractors: WMI owns and operates its own fleet of aircraft and weather radars. No major sub-contractors are being used on the Alberta Hail project for aircraft or radar services. Solution Blend Services, Calgary, Alberta (403) 207-9840 will be handling and mixing seeding solutions for the project.

PART 3. GENERAL INFORMATION CONCERNING ORGANIZATION FOR WHOM ACTIVITY IS TO BE CONDUCTED.

Name of organization: Alberta Severe Weather Management Society (ASWMS)

Chief officers: Mr. Todd Klapak, President
todd.klapak@intact.net
Ms. Lisa Thomson, Secretary-Treasurer

Nature of organization: A not-for-profit society of the property and casualty insurers and brokers operating in Alberta. The society was formed for the purpose of collecting funds from its members to operate a hail suppression program to help reduce insurance payout due to hail and stabilize insurance rates throughout the province.

PART 4. GENERAL INFORMATION CONCERNING FIELD BASES OF ACTIVITY

Address and location of project primary field base:
Olds-Didsbury Airport, Alberta. tel. 403-335-8359
Address(es) and locations(s) of project secondary field base(s):
- Springbank Airport tel. 403-247-0001
- Red Deer Regional Airport tel. 403-886-7857

PART 5. GENERAL INFORMATION CONCERNING OPERATING FIELD PERSONNEL

Name and title of field officer in charge: Mr. Daniel Gilbert, Chief Meteorologist
Old-Didsbury Airport, Highway 2A
Olds, AB T4H 1A1

tel. & fax. 403-335-8359,
e-mail: dgilbert@weathermodifcation.com
home page: http://www.weathermodification.com/

Qualifications of field officer in charge (Gilbert):

Education
Bachelor of Science, Meteorology and Environmental Studies (double major) May 2004, Iowa State University, Ames, IA
Associate of Arts, Liberal Arts, May 2000, Iowa Central Community College, Fort Dodge, IA

Weather Modification Experience
Chief Meteorologist, Weather Modification International (Wyoming and Alberta) - November 2009 to present
    Forecaster, radar operator, rawinsondes, direction of seeding aircraft. Case declarations, wintertime (Wyoming) research program.
Meteorologist, RHS Consulting (Fresno, CA) – November 2008-February 2009
    Directed airborne and ground based cloud seeding operations over portions of the central and southern Sierra Nevada Mountains. Set up and performed routine maintenance of ground based ice nucleus generators. Provided daily forecasts for clients and project personnel.
Meteorologist, Independent Contractor, (Boise, ID) – October 2007 to April 2008
    Provided meteorological services to support Idaho Power Company's winter cloud seeding project in West Central Idaho, directed airborne and ground seeding operations, directed rawinsonde releases, provided short-term operational forecasts and nowcasts for pilots, communicated with aircraft via two-way radio
Field Meteorologist, North Dakota Cloud Modification Project, (Stanley or Bowman, ND) – Summers, 2003-2009
    Operated 5 cm weather radar equipped with TITAN software package, launched and directed seeding aircraft using two-way radio and GPS tracking, performed data recording and documentation of cloud seeding operations, prepared silver iodide seeding solution, assisted with radar calibrations, prepared forecasts and briefed pilots daily, supervised intern meteorologists, presented case studies for ground school, operated cloud condensation nuclei counter for joint research with South Dakota School of Mines
Forecaster, Atmospherics Incorporated, (Fresno, CA) - October 2006 - May 2007
Field Meteorologist, Atmospherics, Inc. (Modesto, CA) - November 2005 - April 2006
Field Meteorologist, Atmospherics, Inc. (Paso Robles, CA) - December 2004 - February 2005
    Provided daily forecasts for seeding operations and/or clients, operated 5cm weather radar, directed winter cloud seeding operations over the Sierra Nevada utilizing both glaciogenic and hygroscopic seeding agents, traced radar overlays, performed data recording of operations, wrote monthly and annual reports

Memberships and Honors

- Meteorologist Distinguished Service Award, 2013, Weather Modification Association
- Member, Weather Modification Association (certified operator #78)
- Member, American Meteorological Society
- Iowa Central Community College Honor Society, inducted April 27, 2000
- Wilbur E Brewer Professionalism Award, 2007 North Dakota Cloud Modification Project

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Field Address: Olds-Didsbury Airport, Highway 2A, Olds, AB
Field Telephone no. 403-335-8359
Field personnel: full time = 4
part time = 14

Daily records of activities: Custodian = Ms. Erin Fischer
WMI Project Operations Centre
Olds-Didsbury Airport, Highway 2A, AB T4H 1A1

All records are maintained June 1st -Sept. 15th annually.

- daily weather synopsis and forecast report
- radar echo storm data report and maps
- daily operations summary report
- chemical inventory report
- equipment status report
- aircraft flight track maps
- flight log report
- project aircraft maintenance report

PART 6. GENERAL INFORMATION CONCERNING PROPOSED ACTIVITY

Reasons for organization seeking modified weather: The hailstorm on Sept. 7, 1991 caused >$400 million damage in the City of Calgary alone. Hailstorms in the City of Calgary caused >$500 Million in 2010 and again in 2012. In addition, hailstorms have caused >$100 Million damage to crops annually since 2007 and the damage to crops was >$400 Million in 2012. A hailstorm in Calgary in 2020 resulted in just over $1.3 billion in damage. The 20 largest insurance companies and their affiliates have banded together to conduct hail suppression operations in the "hail alley" of central Alberta to combat urban hail damage in the Calgary to Red Deer area. The current program has conducted cloud-seeding operations in central Alberta each summer since 1996.

Specific modification sought: Diminish hail damage to property in central Alberta with special priority given to the urban areas of Calgary and Red Deer.

Quantitative estimate of modification expected: Even very small positive results (+1%) will be economically beneficial, however, it is hoped that reductions in damage on the order of 25% or greater will be realized. The insurance industry has been encouraged by the results, estimating a savings of several hundred-million dollars to the industry, paying out approximately 50% of what they expected.

Secondary effects anticipated: Some reductions in crop damage due to hail should also be realized. Seeding may also provide a slight increase in precipitation according to recent analyses of radar data. The crop hail insurance data for the first 10 years of the project indicated a reduction in the loss-to-risk values compared with the historical 58 year average for the province as a whole. However, a recent analysis shows increased variability and an increasing trend in hail damage over the last 10 years both inside and outside the project area which is likely due to climate change. The effect of the seeding on crop damage is inconclusive at this time.

Geographic area affected (see attached map): The main project area is from Calgary to Red Deer, Alberta and west to the foothills of the Rocky Mountains.

Estimate of adjoining geographic area possibly affected: Areas downwind (east) of highway no. 2 to highway no. 21 may also benefit from the seeded storms.

Approximate total cost: approx. $5.0 million per year.

Funds to be expended in Canada: est. $1,000,000 per year.

General period of operation: June 1st - Sept. 15th annually.

PART 7. GENERAL INFORMATION CONCERNING OPERATIONS AND TECHNIQUES

A. GENERAL: The following text describes the methods to be used, general principles of techniques, description of specific techniques, and a brief description of typical operations:

OVERVIEW OF METHOD

For hail suppression, aircraft patrolling based upon forecasts and hourly weather reports will be used to initiate seeding as soon as appropriate conditions develop. Storms will be seeded if they have radar reflectivities of approximately 35 dBZ at heights above the -5°C temperature level, and are considered to be a potential hail threat to an urban or populated area. When large hail is forecast, seeding will commence when radar reflectivities reach approximately 20 dBZ in order to start the microphysical suppression process as early as possible within the potential hailstorms. Storms will be seeded by aircraft using either droppable AgI pyrotechnics and/or wing mounted AgI pyrotechnics or AgI-solution burners.

Subsequent to an independent (2018) review of the project science, limited seeding of a few less-intense storms with both glaciogenic and hygroscopic seeding agents will be conducted to assess the theorized positive effect of such treatment. The hygroscopic material used will be in the form of 1-kilogram calcium carbonate (CaCl) pyrotechnics, a salt.

The amount of seeding material used will depend upon the lifetime and size of the cloud or storm and other meteorological conditions. The seeding rates are about double those used during the 1970's and 1980's in Alberta. Seeding will be focused on the feeder clouds of the storm's new growth zone and will be conducted at cloud top and cloud base. Further details of the seeding method are discussed below.

HAIL SUPPRESSION HYPOTHESIS

The cloud seeding hypothesis is based on the cloud microphysics concept of "beneficial competition". Beneficial competition assumes a lack of natural ice nuclei in the environment effective at temperatures warmer than -20°C and that the injection of AgI will result in the production of a significant number of "artificial" ice nuclei. The natural and artificial ice crystals "compete" for the available supercooled liquid cloud water within the storm. Hence, the hailstones that are formed within the seeded cloud volumes will be smaller and produce less damage if they should survive the fall to the surface. If enough nuclei are introduced into the new growth region of the storm, then it is possible that the hailstones will be small enough to melt completely before reaching the ground.

Cloud seeding operations are intended to alter the cloud microphysics of the treated clouds, assuming that the present precipitation process is inefficient due to a lack of natural ice nuclei. The seeding is based on a conceptual model of Alberta hailstorms that evolved from the studies of Chisholm (1970), Chisholm and Renick (1972), Barge and Bergwall (1976), Krauss and Marwitz (1984), English and Krauss (1986) and English (1986).

It is assumed that hail embryos grow within the time evolving "main" updraft of single cell storms and within the updrafts of developing "feeder clouds" or cumulus towers that flank mature "multi-cell" and "super-cell" storms (see e.g. Foote 1984). The growth to large hail is hypothesized to occur along the edges of the main storm updraft where the merging feeder clouds interact with the main storm updraft.

For hail suppression, seeding with a large amount of glaciogenic seeding agent will dramatically increase the ice crystal concentration in thunderstorm clouds and compete for the available supercooled cloud water to prevent the growth of large, damaging, ice particles. Based on WMI's experience, the cloud seeding will be targeted on the feeder cloud updraft regions associated with the production of hail and will leave unseeded those regions of the storm associated with the production of rain only. This will make efficient use of the seeding material and will reduce the possibility of overseeding.

To test the effects of seeding with both glaciogenic and hygroscopic seeding agents, a limited number of storms may be seeded with glaciogenic material at cloud top, and glaciogenic and hygroscopic agents in updrafts at cloud base. Hygroscopic agents (salts) are designed to encourage the formation of cloud droplets, which when frozen as a result of the simultaneous glaciogenic seeding, result in additional precipitation embryos, which then (as stated above) compete for the available supercooled liquid water.

CLOUD SEEDING METHODOLOGY - SEEDING TECHNIQUES

Convective cells (defined by radar) with maximum reflectivity approximately >35 dBZ within the cloud layer above the -5°C level, located within the project areas or within a 20 min travel time "buffer zone" upwind of the project area, will be seeded if they pose a potential threat of damaging hail for an urban or populated area. Radar observers/controllers will be responsible for making the "seed" decision and directing the cloud seeding missions.

Patrol flights will be launched before clouds within the target area meet the radar reflectivity seeding criteria. These patrol flights are meant to provide immediate response to developing cells. In general, a patrol is launched in the event of visual reports of vigorous towering cumulus clouds near Calgary or Red Deer, or when radar cells exceed 25 kft height over the higher terrain along the western border and begin moving towards the urban areas.

Launches of more than one aircraft are determined by the number of storms in each area, the lead time required for a seeder aircraft to reach the proper location and altitude, and projected overlap of coverage and on-station time for multiple aircraft missions. In general, only one aircraft can work safely at cloud top and one aircraft at cloud base for a single storm. The operation of three aircraft is recommended to provide uninterrupted seeding coverage at either cloud-base or cloud-top and to seed three storms simultaneously if required.

The program is designed to seed convective clouds, before they achieve radar reflectivities associated with hail, and deliver seeding material to regions of updraft and supercooled liquid water i.e. the primary conditions responsible for the growth of hailstones.

Factors that determine cloud top or cloud base seeding are: storm structure, visibility, cloud base height, or time available to reach seeding altitude. Cloud base seeding is conducted by flying at cloud base within the main inflow of single cell storms, or the inflow associated with the new growth zone (shelf cloud) located on the upshear side of multi-cell storms.

Cloud top seeding is conducted between typically between -5°C and -10°C. The ejectable flares fall approximately 1.5 km (approximately 10°C) during their 35-40 second burn time. The seeding aircraft will penetrate the edges of single convective cells meeting the seed criteria. For multi-cell storms, or storms with feeder clouds, the seeding aircraft will penetrate the tops of the developing cumulus towers on the upshear sides of convective cells, as they grow up through the aircraft's altitude.

Occasionally, with embedded cells or convective complexes, there are no clearly defined feeder turrets visible to the flight crews or on radar. In these instances, at an altitude between -5°C and - 10°C, a seeding aircraft will penetrate the storm edge (region of tight radar reflectivity gradient) on the upshear

side and burn a burn-in-place flare and inject droppable pencil flares when updrafts are encountered.

Seeding is effective only within cloud updrafts and in the presence of supercooled cloud water, i.e. the developing, and mature stages in the evolution of the classic thunderstorm conceptual model. The dissipative stages of a storm would be seeded only if the maximum reflectivity is particularly severe and there is evidence (visual cloud growth, or tight reflectivity gradients) indicating the possible presence of embedded updrafts.

SEEDING RATE

A seeding rate of one 20 g flare every 5 s is typically used during cloud penetration. A slightly higher rate is used (e.g. 1 flare every 2 s) if updrafts are very strong (e.g. > 2000 ft/min) and the storm is particularly intense. Calculations show that this seeding rate will produce >1300 ice crystals per litre which is more than sufficient to deplete the liquid water content produced by updrafts of 10 m/s (2000 ft/min), thereby preventing the growth of hailstones within the seeded cloud volumes.

A cloud seeding pass is repeated immediately if there are visual signs of new cloud growth or radar reflectivity gradients remain tight (indicative of persistent updrafts). A 5 to 10 min waiting period may be used, to allow for the seeding material to take effect and the storm to dissipate, if visual signs of glaciation appear or radar reflectivity values decrease and gradients weaken. This waiting period precludes the waste of seeding material and ensures its optimum usage.

For cloud base seeding, a typical seeding rate of 1 burn-in-place flare (150 g each) is used. Cloud seeding runs are repeated until no further inflow is found. Base seeding is not conducted if only downdrafts are encountered at cloud base, since this would waste seeding material.

If hygroscopic materials are used, one, burn-in-place 1-kg hygroscopic pyrotechnic will be burned at a time, simultaneously with one, burn-in-place glaciogenic pyrotechnic, so that the aerosols from the two flare types mix as they are ingested by the cloud.

The cloud seeding flares are glaciogenic pyrotechnics containing silver-iodide, with an ice nucleus effective yield of approximately 10^{14} nuclei per gram of pyrotechnic, active at -10°C, as determined by independent cloud chamber tests at Colorado State University.

Sufficient dispersion of the particles is required for glaciogenic plume overlap from consecutive flares by the time the cloud particles reach hail size for effective hail suppression. The work by Grandia et al. (1979) based on turbulence measurements within Alberta feeder clouds indicated that the time for the diameter of the diffusing line of seeding agent to reach the integral length scale (200 m) in the inertial subrange size scales of mixing, was 140 seconds. This is insufficient time for ice particles to grow to hail size. Therefore, dropping flares at 5 sec intervals should effectively deplete the supercooled liquid water and prevent the growth of hail particles. The use of the 20 gram flares and a frequent drop rate provides better seeding coverage than using larger flares with greater time/distance spacing between flare drops. In fact, the above calculations are conservative when one considers that the center of the ice crystal plume will have a higher concentration of crystals.

B. EQUIPMENT

Type:

- one C-band Doppler weather radar, 250 kw peak power, with 1.65 deg. beam width, located at the Olds-Didsbury airport, 15.3 m tower-mounted, including radome.
- Five Beechcraft C90 King-Air prop-jet aircraft (three in Springbank and two in Red Deer).

C. MATERIALS TO BE EMITTED:

- Cloud top (ejectable) pyrotechnic flares are 20g mass of glaciogenic formulation, ICE-EJ®, manufactured by Ice Crystal Engineering (ICE) of Kindred, North Dakota, USA (www.iceflares.com)
- Cloud base (burn-in-place) flares are 150g glaciogenic formulation, ICE-EB®, manufactured by Ice Crystal Engineering (ICE) of Kindred, North Dakota, USA (www.iceflares.com)
- The hygroscopic flares to be used produce a hygroscopic (water-attracting) nuclei comprised of calcium chloride (CaCl), a common salt, but a salt lacking the adverse effects of sodium chloride (NaCl) on clay soils.

Activation tests performed at Colorado State University indicate greater than10^{14} ice crystals per gram of seeding agent burned, active at -10°C.

Total flight hours and quantities to be dispersed: We estimate the project may use 8,500 twenty-gram flares and 1,000 one-hundred-fifty gram flares. The hygroscopic CaCl flares are being used only in limited instances on a trial basis; it is likely between 100 and 200 might be burned. The number of operational days, flights, and amount of seeding material dispensed over the past 25 seasons is summarized in the attached table. No harmful effects from these materials is expected. This is based on years of studies (both in the USA and Canada) to detect silver in precipitation (above background levels) following cloud seeding. The amount of silver distributed by the cloud seeding is small compared to the output from industry. Silver amounts from cloud seeding are far, far less than the USA EPA guidelines.

PART 8. GENERAL INFORMATION CONCERNING USE OF AIRCRAFT.

- Five C90 King Air prop-jet aircraft, three in Springbank (N904DK, N6111V, and N518TS) and two based in Red Deer (N127ZW and N522JP).

PART 9. GENERAL INFORMATION CONCERNING USE OF GROUND VEHICLES.

No special project ground vehicles will be deployed for the project. (Only private vehicles for personal transportation will be used.)

PART 10. GENERAL INFORMATION CONCERNING ANY MEASUREMENTS OR OBSERVATION INSTRUMENTATION.

No special surface observations are planned for this project. The primary instrumentation is the weather radar and special aircraft instrumentation. Daily weather charts will be recorded for documentation and reporting purposes.

AIRCRAFT TRACKING GLOBAL POSITIONING SYSTEM (GPS): The WMI weather radar control and communications center will be equipped to receive and record data from the GPS aircraft tracking system. The GPS system displays the exact position of aircraft superimposed on the radar display to enable the controller to accurately direct the seeding aircraft to optimum seeding locations within the storm system. The color-coded aircraft position on the PPI will be marked with a small symbol. Electronic coding will enable radar controllers to discriminate between all project aircraft.

TEMPERATURE INSTRUMENTATION: Each of the cloud seeding aircraft will have a temperature sensor to ensure that the cloud penetration seeding runs are conducted at the proper temperature levels.

WEATHER RADAR: The C-band Doppler radar will be equipped with a computerized radar recording and display system. The radar recording system will be capable of providing numerous cell statistics and colour products including plots of radar PPI displays and maximum reflectivity maps. The sophisticated radar tracking software called TITAN (Thunderstorm Identification, Tracking, Analysis, and Nowcasting) has been used since 1997 and has proved to be very useful. TITAN is licensed from the U.S. National

Center for Atmospheric Research (NCAR).

A limited number of upper air observations (weather balloons) perhaps one dozen or so, will be made during the project season. These instrumented balloons measure the vertical profiles of temperature, humidity, and winds.

PART 11. CERTIFICATION BY ORGANIZATION FOR WHOM ACTIVITY IS TO BE CONDUCTED:

State type of working agreement entered into with the weather modifier: Contract.

I HEREBY CERTIFY THAT ALL STATEMENTS MADE IN THIS NOTIFICATION OF INTENT TO ENGAGE IN WEATHER MODIFICATION ACTIVITIES ARE TRUE AND COMPLETE TO THE BEST OF MY KNOWLEDGE, AND REPRESENT IN SUBSTANCE AN ACCURATE DESCRIPTION OF A PROPOSAL TO UNDERTAKE WEATHER MODIFICATION ACTIVITIES ON BEHALF OF THE ORGANIZATION NAMED HEREIN.

Name of organization: Alberta Severe Weather Management Society

Full name of certifying officer and title:

Todd Klapak
President, Alberta Severe Weather Management Society
(403) 231-1357, Todd.Klapak@intact.net

Signature: Date: May 28, 2021

Todd Klapak

PART 12. CERTIFICATION BY PERSON PROPOSING TO CONDUCT ACTIVITY.

I HEREBY CERTIFY THAT INFORMATION PROVIDED IN THIS NOTIFICATION OF INTENT TO ENGAGE IN WEATHER MODIFICATION ACTIVITIES IS A TRUE AND COMPLETE DESCRIPTION OF MY PROPOSED PLANS TO ENGAGE IN THE SPECIFIC WEATHER MODIFICATION ACTIVITIES HEREIN DESCRIBED.

Name of organization: Weather Modification International

Full name of certifying officer:
Bruce A. Boe
Vice President of Meteorology
(701) 235-5500

Signature: Date: May 28, 2021

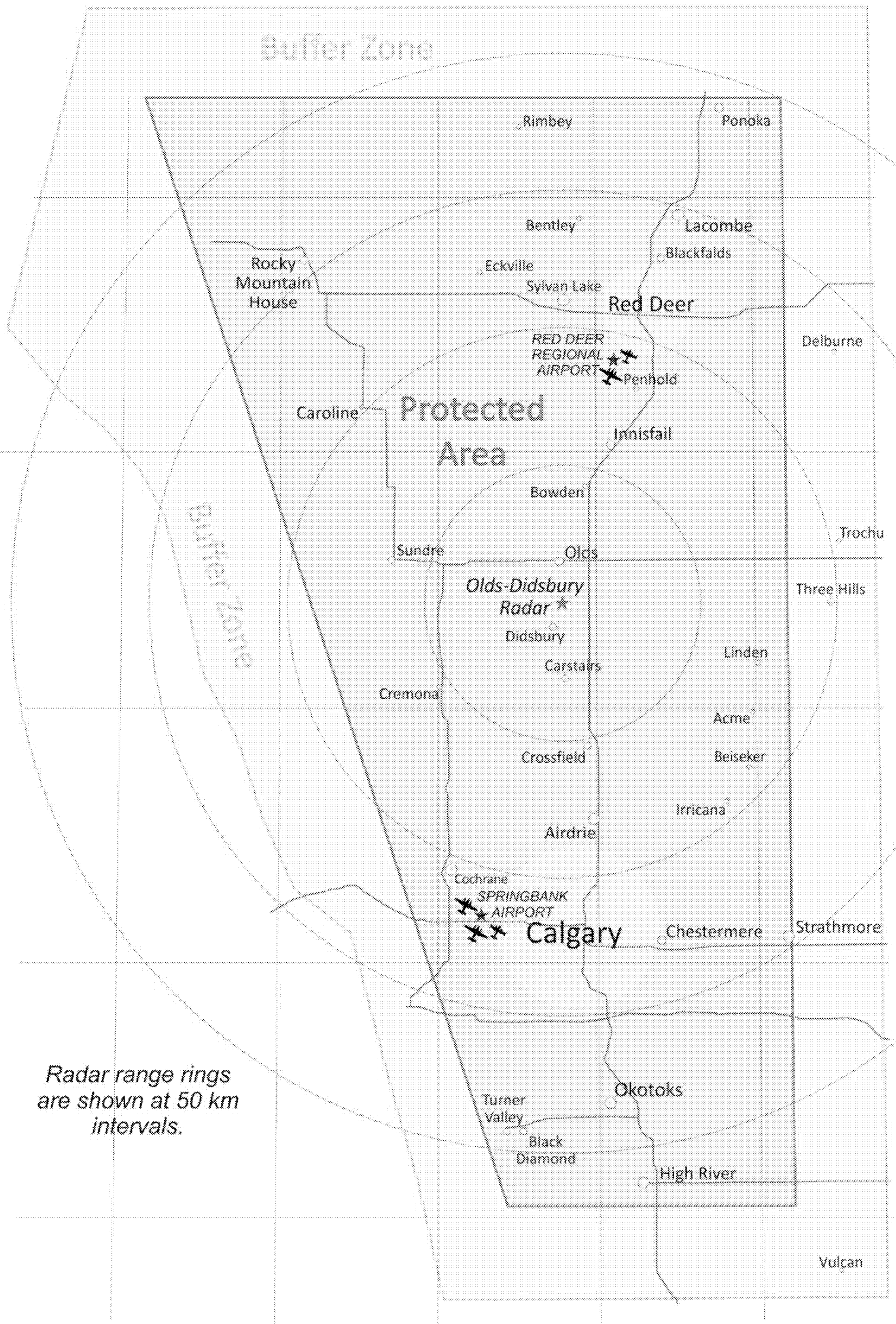


Figure 1: Map of south-central Alberta showing the project area, outlined in green, covered by the Hail Suppression activities.

Table 1. Seeding activity through 2019.

Season	*Storm Days With Seeding*	*Aircraft Missions (Seeding & Patrol)*	*Total Flight Time (hours)*	*Number of Storms Seeded*	*Total Seeding Agent (kg)*	*Seeding Agent Per Day (kg)*	*Seeding Agent Per Hour (kg)*	*Seeding Agent Per Storm (kg)*	*Ejectable Flares*	*Burn-in-place Flares*	*Seeding Solution (gallons)*	*Season Activity Rank*
2020	23	111	256.2	71	305.1	16.4	1.41	4.30	6722	1066	177.4	9
Mean	**30**	**107**	**220.8**	**88**	**227.7**	**7.7**	**1.04**	**2.72**	**5397**	**724**	**167.8**	
2019	27	114	243.9	61	296.4	11.0	1.22	4.86	7520	912	150.5	11
2018	26	127	262.5	77	248.0	9.5	0.94	3.22	4663	951	198.0	10
2017	25	107	224.5	64	255.4	10.2	1.14	3.99	5939	842	170.2	13
2016	35	139	277.1	96	294.9	8.4	1.06	3.07	6496	1000	246.9	6
2015	26	115	233.3	79	349.2	14.6	1.37	4.42	8127	1138	262.9	8
2014	32	128	259.5	101	382.5	12.0	1.47	3.79	10782	1020	228.6	3
2013	26	103	229.6	70	233.3	9.0	1.02	3.33	6311	636	131.7	16
2012	37	143	300.1	116	314.6	8.5	1.16	2.70	7717	914	260.3	2
2011	48	158	383.0	134	400.1	8.3	1.13	3.00	10779	1020	350.2	1
2010	42	115	271.8	118	263.8	6.3	1.10	2.20	5837	851	227.5	7
2009	20	38	109.3	30	48.4	2.4	0.84	1.60	451	237	56.5	25
2008	26	112	194.7	56	122.9	4.7	1.00	2.20	1648	548	113.5	20
2007	19	76	115.3	41	99.7	5.2	0.90	2.40	1622	413	77	24
2006	28	92	190.2	65	214	7.6	1.10	3.30	4929	703	145.4	17
2005	27	80	157.9	70	159.1	5.9	1.00	2.30	3770	515	94.2	22
2004	29	105	227.5	90	270.9	9.3	1.20	3.00	6513	877	132.7	12
2003	26	92	163.6	79	173.4	6.7	1.10	2.20	4465	518	92.6	19
2002	27	92	157.4	54	124.2	4.6	0.80	2.30	3108	377	80.3	23
2001	36	109	208.3	98	195	5.4	0.90	2.00	5225	533	140.8	14
2000	33	130	265.2	136	343.8	10.4	1.30	2.50	9653	940	141.3	4
1999	39	118	251.3	162	212.7	5.5	0.80	1.30	4439	690	297.5	5
1998	31	96	189.9	153	111.1	3.6	0.60	0.70	2023	496	193.8	15
1997*	38	92	188.1	108	110.8	2.9	0.60	1.00	2376	356	144.3	18
1996*	29	71	159.1	75	163.3	5.6	1.00	2.20	3817	542	80.5	21

**The 1996 and 1997 seasons began on June 15, not June 1, which has been the norm ever since.*

NOTICE OF INTENT TO ENGAGE IN WEATHER MODIFICATION ACTIVITIES
PURSUANT TO THE WEATHER MODIFICATION INFORMATION ACT AND REGULATIONS
SCHEDULE I

PART 1. GENERAL IDENTIFICATION OF ACTIVITY

Date of notice: May 10, 2022
Proposed starting date: June 1, 2022
Expected duration: September 15, 2022

Province and area to be affected: Central Alberta, covering the Red Deer to Calgary regions (see attached map showing project area which has remained essentially the same since 1996).

Weather elements to be modified: Thunderstorms
Modification expected: Hail Suppression
Class of operation: Operational
Operating method: airborne
Class of economy to benefit: insurance industry: private and public property primary, agriculture secondary.

PART 2. GENERAL INFORMATION CONCERNING WEATHER MODIFIER

Organization name: Weather Modification International (WMI)
http://www.weathermodification.com/
Parent Organization: Weather Modification LLC
3802 20th Street North
Fargo, ND USA 58102
Chief Officer: Mr. Patrick Sweeney, President Tel: (701) 235-5500
pat@weathermod.com
Local Organization: Weather Modification International Tel. (403) 335-8359
Olds-Didsbury Airport, Highway 2A
Olds, AB T4H 1A1

Name and relevant qualifications of officer(s) designated in charge of project:

Chief Officer: Mr. Adam Brainard, Meteorological Systems Lead
M.Sc., 9 years' field experience with hail suppression and convective storms, 8 years' Alberta project experience
WMA Certified Weather Modification Operator #98
Office Tel: (403) 335-8359
(see Part 5 for details of qualifications and experience)

Vice President - Meteorology Mr. Bruce Boe
Project Manager/Meteorology, 48 years' experience
Tel: (701) 235-5500

Primary activities of organization (see web page at www.weathermodification.com):
- cloud seeding
- atmospheric research
- air pollution monitoring
- meteorological radar monitoring
- equipment design and fabrication
- aircraft modifications

Amount of public liability insurance carried applicable to activity: CAD$50 million by the Alberta Severe Weather Management Society and USD$25 million by Weather Modification LLC.

List of similar weather modification activities previously undertaken:

a. Canada: The Alberta Hail Project has been operating in its present form since 1996. The contractor (operator) for this entire period has been WMI.

b. Elsewhere:
- WMI has conducted the hail suppression cloud seeding in North Dakota for more than 50 years. This is an ongoing project.
- WMI conducted hail suppression in Mendoza, Argentina using 3 to 4 Cheyenne II aircraft and a Lear Jet 1998-2004.
- WMI conducted operational cloud seeding in Oklahoma for Rain Enhancement and Hail Suppression 1997-2001.
- WMI has conducted operational cloud seeding in Alberta, Burkina Faso, California, Colorado, Idaho, UAE, India, Mali, Nevada, North Dakota, Saudi Arabia, Senegal, and Wyoming within the last 10 years.

4. References:

1. Dr. Terry Krauss
Krauss Weather Services
79 Irving Crescent
Red Deer, AB T4R 3S3 Tel. 403-318-0400
2. Mr. Darin Langerud, Director
State of North Dakota Atmospheric Resource Board
900 E. Boulevard Ave.
Bismarck, ND 58505 Tel. 701-328-2788
3. Dr. Ronald E. Rinehart
3629 W. Gordon Drive
Jefferson City, MO 65109 Tel. 816-344-0846
4. Dr. Andrew Detwiler
University of North Dakota, Atmospheric Sciences
4149 University Ave
Grand Forks, ND 58202 Tel. 605-431-7120

List of subcontractors: WMI owns and operates its own fleet of aircraft and weather radars. No major sub-contractors are being used on the Alberta Hail project for aircraft or radar services. Solution Blend Services, Calgary, Alberta (403) 207-9840 will be handling and mixing seeding solutions for the project.

PART 3. GENERAL INFORMATION CONCERNING ORGANIZATION FOR WHOM ACTIVITY IS TO BE CONDUCTED.

Name of organization: Alberta Severe Weather Management Society (ASWMS)

Chief officers: Mr. Todd Klapak, President
todd.klapak@intact.net

Nature of organization: A not-for-profit society of the property and casualty insurers and brokers operating in Alberta. The society was formed for the purpose of collecting funds from its members to operate a hail suppression program to help reduce insurance payout due to hail and stabilize insurance rates throughout the province.

PART 4. GENERAL INFORMATION CONCERNING FIELD BASES OF ACTIVITY

Address and location of project primary field base:
Olds-Didsbury Airport, Alberta. tel. 403-335-8359
Address(es) and locations(s) of project secondary field base(s):

- Springbank Airport tel. 403-247-0001
- Red Deer Regional Airport tel. 403-886-7857

PART 5. GENERAL INFORMATION CONCERNING OPERATING FIELD PERSONNEL

Name and title of field officer in charge: Mr. Adam Brainard, Meteorology Systems Lead
Olds-Didsbury Airport, Highway 2A
Olds, AB T4H 1A1
tel. & fax. 403-335-8359,
e-mail: abrainard@weathermodifcation.com
home page: http://www.weathermodification.com/

Qualifications of field officer in charge (Adam Brainard):

Education
Bachelor of Science, Meteorology – Valparaiso University 2014
Master of Science, Atmospheric Science – Texas A&M University 2016

Weather Modification Experience
Meteorological Systems Lead, Weather Modification International - December 2009 to present
Forecaster, radar operator, operations director, numerical weather prediction, software engineering, web services, rawinsondes, direction of seeding aircraft. Forecasting and seeding operations initiation, wintertime (State of Wyoming, Northern California Power Association, Modesto and Turlock Irrigation Districts, Kingdom of Saudi Arabia), summertime (Alberta, North Dakota).

Memberships

- Member, Weather Modification Association (certified operator #98)
- Member, American Meteorological Society

Field Address: Olds-Didsbury Airport, Highway 2A, Olds, AB
Field Telephone no. 403-335-8359
Field personnel: full time = 14
part time = 2

Daily records of activities: Custodian = Ms. Erin Fischer
WMI Project Operations Centre
Olds-Didsbury Airport, Highway 2A, AB T4H 1A1

All records are maintained June 1st -Sept. 15th annually.

- daily weather synopsis and forecast report
- radar echo storm data report and maps
- daily operations summary report
- chemical inventory report
- equipment status report
- aircraft flight track maps
- flight log report
- project aircraft maintenance report

PART 6. GENERAL INFORMATION CONCERNING PROPOSED ACTIVITY

Reasons for organization seeking modified weather: The hailstorm on Sept. 7, 1991 caused >$400 million damage in the City of Calgary alone. Hailstorms in the City of Calgary caused >$500 Million in 2010 and again in 2012. In addition, hailstorms have caused >$100 Million damage to crops annually since 2007 and the damage to crops was >$400 Million in 2012. A hailstorm in Calgary in 2020 resulted in just over $1.3 billion in damage. The 20 largest insurance companies and their affiliates have banded together to conduct hail suppression operations in the "hail alley" of central Alberta to combat urban hail damage in the Calgary to Red Deer area. The current program has conducted cloud-seeding operations in central Alberta each summer since 1996.

Specific modification sought: Diminish hail damage to property in central Alberta with special priority given to the urban areas of Calgary and Red Deer.

Quantitative estimate of modification expected: Even very small positive results (+1%) will be economically beneficial, however, it is hoped that reductions in damage on the order of 25% or greater will be realized. The insurance industry has been encouraged by the results, estimating a savings of several hundred-million dollars to the industry, paying out approximately 50% of what they expected.

Secondary effects anticipated: Some reductions in crop damage due to hail should also be realized. Seeding may also provide a slight increase in precipitation according to recent analyses of radar data. The crop hail insurance data for the first 10 years of the project indicated a reduction in the loss-to-risk values compared with the historical 58 year average for the province as a whole. However, a recent analysis shows increased variability and an increasing trend in hail damage over the last 10 years both inside and outside the project area which is likely due to climate change. The effect of the seeding on crop damage is inconclusive at this time.

Geographic area affected (see attached map): The main project area is from Calgary to Red Deer, Alberta and west to the foothills of the Rocky Mountains.

Estimate of adjoining geographic area possibly affected: Areas downwind (east) of highway no. 2 to highway no. 21 may also benefit from the seeded storms.

Approximate total cost: approx. $5.0 million per year.

Funds to be expended in Canada: est. $1,000,000 per year.

General period of operation: June 1st - Sept. 15th annually.

PART 7. GENERAL INFORMATION CONCERNING OPERATIONS AND TECHNIQUES

A. GENERAL: The following text describes the methods to be used, general principles of techniques, description of specific techniques, and a brief description of typical operations:

<u>OVERVIEW OF METHOD</u>
For hail suppression, aircraft patrolling based upon forecasts and hourly weather reports will be used to initiate seeding as soon as appropriate conditions develop. Storms will be seeded if they have radar reflectivities of approximately 35 dBZ at heights above the -5°C temperature level, and are considered to be a potential hail threat to an urban or populated area. When large hail is forecast, seeding will commence when radar reflectivities reach approximately 20 dBZ in order to start the microphysical suppression process as early as possible within the potential hailstorms. Storms will be seeded by aircraft using either droppable AgI pyrotechnics and/or wing mounted AgI pyrotechnics or AgI-solution burners.

The amount of seeding material used will depend upon the lifetime and size of the cloud or storm and other meteorological conditions. The seeding rates are about double those used during the 1970's and 1980's in Alberta. Seeding will be focused on the feeder clouds of the storm's new growth zone and will be conducted at cloud top and cloud base. Further details of the seeding method are discussed below.

HAIL SUPPRESSION HYPOTHESIS

The cloud seeding hypothesis is based on the cloud microphysics concept of "beneficial competition". Beneficial competition assumes a lack of natural ice nuclei in the environment effective at temperatures warmer than -20°C and that the injection of AgI will result in the production of a significant number of "artificial" ice nuclei. The natural and artificial ice crystals "compete" for the available supercooled liquid cloud water within the storm. Hence, the hailstones that are formed within the seeded cloud volumes will be smaller and produce less damage if they should survive the fall to the surface. If enough nuclei are introduced into the new growth region of the storm, then it is possible that the hailstones will be small enough to melt completely before reaching the ground.

Cloud seeding operations are intended to alter the cloud microphysics of the treated clouds, assuming that the present precipitation process is inefficient due to a lack of natural ice nuclei. The seeding is based on a conceptual model of Alberta hailstorms that evolved from the studies of Chisholm (1970), Chisholm and Renick (1972), Barge and Bergwall (1976), Krauss and Marwitz (1984), English and Krauss (1986) and English (1986).

It is assumed that hail embryos grow within the time evolving "main" updraft of single cell storms and within the updrafts of developing "feeder clouds" or cumulus towers that flank mature "multi-cell" and "super-cell" storms (see e.g. Foote 1984). The growth to large hail is hypothesized to occur along the edges of the main storm updraft where the merging feeder clouds interact with the main storm updraft.

For hail suppression, seeding with a large amount of glaciogenic seeding agent will dramatically increase the ice crystal concentration in thunderstorm clouds and compete for the available supercooled cloud water to prevent the growth of large, damaging, ice particles. Based on WMI's experience, the cloud seeding will be targeted on the feeder cloud updraft regions associated with the production of hail and will leave unseeded those regions of the storm associated with the production of rain only. This will make efficient use of the seeding material and will reduce the possibility of overseeding.

To test the effects of seeding with both glaciogenic and hygroscopic seeding agents, a limited number of storms may be seeded with glaciogenic material at cloud top, and glaciogenic and hygroscopic agents in updrafts at cloud base. Hygroscopic agents (salts) are designed to encourage the formation of cloud droplets, which when frozen as a result of the simultaneous glaciogenic seeding, result in additional precipitation embryos, which then (as stated above) compete for the available supercooled liquid water.

CLOUD SEEDING METHODOLOGY - SEEDING TECHNIQUES

Convective cells (defined by radar) with maximum reflectivity approximately >35 dBZ within the cloud layer above the -5°C level, located within the project areas or within a 20 min travel time "buffer zone" upwind of the project area, will be seeded if they pose a potential threat of damaging hail for an urban or populated area. Radar observers/controllers will be responsible for making the "seed" decision and directing the cloud seeding missions.

Patrol flights will be launched before clouds within the target area meet the radar reflectivity seeding criteria. These patrol flights are meant to provide immediate response to developing cells. In general, a patrol is launched in the event of visual reports of vigorous towering cumulus clouds near Calgary or Red Deer, or when radar cells exceed 25 kft height over the higher terrain along the western border and begin moving towards the urban areas.
Launches of more than one aircraft are determined by the number of storms in each area, the lead time required for a seeder aircraft to reach the proper location and altitude, and projected overlap of coverage and on-station time for multiple aircraft missions. In general, only one aircraft can work safely at cloud top and one aircraft at cloud base for a single storm. The operation of three aircraft is recommended to provide uninterrupted seeding coverage at either cloud-base or cloud-top and to seed three storms

simultaneously if required.
The program is designed to seed convective clouds, before they achieve radar reflectivities associated with hail, and deliver seeding material to regions of updraft and supercooled liquid water i.e. the primary conditions responsible for the growth of hailstones.

Factors that determine cloud top or cloud base seeding are: storm structure, visibility, cloud base height, or time available to reach seeding altitude. Cloud base seeding is conducted by flying at cloud base within the main inflow of single cell storms, or the inflow associated with the new growth zone (shelf cloud) located on the upshear side of multi-cell storms.

Cloud top seeding is conducted between typically between -5°C and -10°C. The ejectable flares fall approximately 1.5 km (approximately 10°C) during their 35-40 second burn time. The seeding aircraft will penetrate the edges of single convective cells meeting the seed criteria. For multi-cell storms, or storms with feeder clouds, the seeding aircraft will penetrate the tops of the developing cumulus towers on the upshear sides of convective cells, as they grow up through the aircraft's altitude.

Occasionally, with embedded cells or convective complexes, there are no clearly defined feeder turrets visible to the flight crews or on radar. In these instances, at an altitude between -5°C and - 10°C, a seeding aircraft will penetrate the storm edge (region of tight radar reflectivity gradient) on the upshear side and burn a burn-in-place flare and inject droppable pencil flares when updrafts are encountered.

Seeding is effective only within cloud updrafts and in the presence of supercooled cloud water, i.e. the developing, and mature stages in the evolution of the classic thunderstorm conceptual model. The dissipative stages of a storm would be seeded only if the maximum reflectivity is particularly severe and there is evidence (visual cloud growth, or tight reflectivity gradients) indicating the possible presence of embedded updrafts.

SEEDING RATE
A seeding rate of one 20 g flare every 5 s is typically used during cloud penetration. A slightly higher rate is used (e.g. 1 flare every 2 s) if updrafts are very strong (e.g. > 2000 ft/min) and the storm is particularly intense. Calculations show that this seeding rate will produce >1300 ice crystals per litre which is more than sufficient to deplete the liquid water content produced by updrafts of 10 m/s (2000 ft/min), thereby preventing the growth of hailstones within the seeded cloud volumes.

A cloud seeding pass is repeated immediately if there are visual signs of new cloud growth or radar reflectivity gradients remain tight (indicative of persistent updrafts). A 5 to 10 min waiting period may be used, to allow for the seeding material to take effect and the storm to dissipate, if visual signs of glaciation appear or radar reflectivity values decrease and gradients weaken. This waiting period precludes the waste of seeding material and ensures its optimum usage.

For cloud base seeding, a typical seeding rate of 1 burn-in-place flare (150 g each) is used. Cloud seeding runs are repeated until no further inflow is found. Base seeding is not conducted if only downdrafts are encountered at cloud base, since this would waste seeding material.

The cloud seeding flares are glaciogenic pyrotechnics containing silver-iodide, with an ice nucleus effective yield of approximately 10^{14} nuclei per gram of pyrotechnic, active at -10°C, as determined by independent cloud chamber tests at Colorado State University.

Sufficient dispersion of the particles is required for glaciogenic plume overlap from consecutive flares by the time the cloud particles reach hail size for effective hail suppression. The work by Grandia et al. (1979) based on turbulence measurements within Alberta feeder clouds indicated that the time for the diameter of the diffusing line of seeding agent to reach the integral length scale (200 m) in the inertial subrange size scales of mixing, was 140 seconds. This is insufficient time for ice particles to grow to hail size. Therefore, dropping flares at 5 sec intervals should effectively deplete the supercooled liquid water and prevent the growth of hail particles.

The use of the 20 gram flares and a frequent drop rate provides better seeding coverage than using larger flares with greater time/distance spacing between flare drops. In fact, the above calculations are conservative when one considers that the center of the ice crystal plume will have a higher concentration of crystals.

B. EQUIPMENT

Type:

- one C-band Doppler weather radar, 250 kw peak power, with 1.65 deg. beam width, located at the Olds-Didsbury airport, 15.3 m tower-mounted, including radome.
- Five Beechcraft C90 King-Air prop-jet aircraft (three in Springbank and two in Red Deer).

C. MATERIALS TO BE EMITTED:

- Cloud top (ejectable) pyrotechnic flares are 20g mass of glaciogenic formulation, ICE-EJ®, manufactured by Ice Crystal Engineering (ICE) of Kindred, North Dakota, USA (www.iceflares.com)
- Cloud base (burn-in-place) flares are 150g glaciogenic formulation, ICE-EB®, manufactured by Ice Crystal Engineering (ICE) of Kindred, North Dakota, USA (www.iceflares.com)
- The hygroscopic flares to be used produce a hygroscopic (water-attracting) nuclei comprised of calcium chloride (CaCl), a common salt, but a salt lacking the adverse effects of sodium chloride (NaCl) on clay soils.

Activation tests performed at Colorado State University indicate greater than10^{14} ice crystals per gram of seeding agent burned, active at -10°C.

Total flight hours and quantities to be dispersed: We estimate the project may use 8,500 twenty-gram flares and 1,000 one-hundred-fifty gram flares. The hygroscopic CaCl flares are being used only in limited instances on a trial basis; it is likely between 100 and 200 might be burned. The number of operational days, flights, and amount of seeding material dispensed over the past 25 seasons is summarized in the attached table. No harmful effects from these materials is expected. This is based on years of studies (both in the USA and Canada) to detect silver in precipitation (above background levels) following cloud seeding. The amount of silver distributed by the cloud seeding is small compared to the output from industry. Silver amounts from cloud seeding are far, far less than the USA EPA guidelines.

PART 8. GENERAL INFORMATION CONCERNING USE OF AIRCRAFT.

- Five C90 King Air prop-jet aircraft, three in Springbank (N904DK, N6111V, and N518TS) and two based in Red Deer (N127ZW and N522JP).

PART 9. GENERAL INFORMATION CONCERNING USE OF GROUND VEHICLES.

No special project ground vehicles will be deployed for the project. (Only private vehicles for personal transportation will be used.)

PART 10. GENERAL INFORMATION CONCERNING ANY MEASUREMENTS OR OBSERVATION INSTRUMENTATION.

No special surface observations are planned for this project. The primary instrumentation is the weather radar and special aircraft instrumentation. Daily weather charts will be recorded for documentation and reporting purposes.

AIRCRAFT TRACKING GLOBAL POSITIONING SYSTEM (GPS): The WMI weather radar control and communications center will be equipped to receive and record data from the GPS aircraft tracking system. The GPS system displays the exact position of aircraft superimposed on the radar display to enable the controller to accurately direct the seeding aircraft to optimum seeding locations within the storm system. The color-coded aircraft position on the PPI will be marked with a small symbol. Electronic coding will enable radar controllers to discriminate between all project aircraft.

TEMPERATURE INSTRUMENTATION: Each of the cloud seeding aircraft will have a temperature sensor to ensure that the cloud penetration seeding runs are conducted at the proper temperature levels.

WEATHER RADAR: The C-band Doppler radar will be equipped with a computerized radar recording and display system. The radar recording system will be capable of providing numerous cell statistics and colour products including plots of radar PPI displays and maximum reflectivity maps. The sophisticated radar tracking software called TITAN (Thunderstorm Identification, Tracking, Analysis, and Nowcasting) has been used since 1997 and has proved to be very useful. TITAN is licensed from the U.S. National Center for Atmospheric Research (NCAR).

PART 11. CERTIFICATION BY ORGANIZATION FOR WHOM ACTIVITY IS TO BE CONDUCTED:

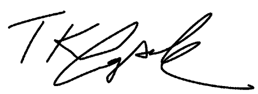
State type of working agreement entered into with the weather modifier: Contract.

I HEREBY CERTIFY THAT ALL STATEMENTS MADE IN THIS NOTIFICATION OF INTENT TO ENGAGE IN WEATHER MODIFICATION ACTIVITIES ARE TRUE AND COMPLETE TO THE BEST OF MY KNOWLEDGE, AND REPRESENT IN SUBSTANCE AN ACCURATE DESCRIPTION OF A PROPOSAL TO UNDERTAKE WEATHER MODIFICATION ACTIVITIES ON BEHALF OF THE ORGANIZATION NAMED HEREIN.

Name of organization: Alberta Severe Weather Management Society

Full name of certifying officer and title:

Todd Klapak
President, Alberta Severe Weather Management Society
(403) 231-1357, Todd.Klapak@intact.net



Signature: Todd Klapak Date: May 13, 2022

PART 12. CERTIFICATION BY PERSON PROPOSING TO CONDUCT ACTIVITY.

I HEREBY CERTIFY THAT INFORMATION PROVIDED IN THIS NOTIFICATION OF INTENT TO ENGAGE IN WEATHER MODIFICATION ACTIVITIES IS A TRUE AND COMPLETE DESCRIPTION OF MY PROPOSED PLANS TO ENGAGE IN THE SPECIFIC WEATHER MODIFICATION ACTIVITIES HEREIN DESCRIBED.

Name of organization: Weather Modification International

Full name of certifying officer:
Bruce A. Boe
Vice President of Meteorology
(701) 235-5500

Signature: Bruce A. Boe Date: May 13, 2022

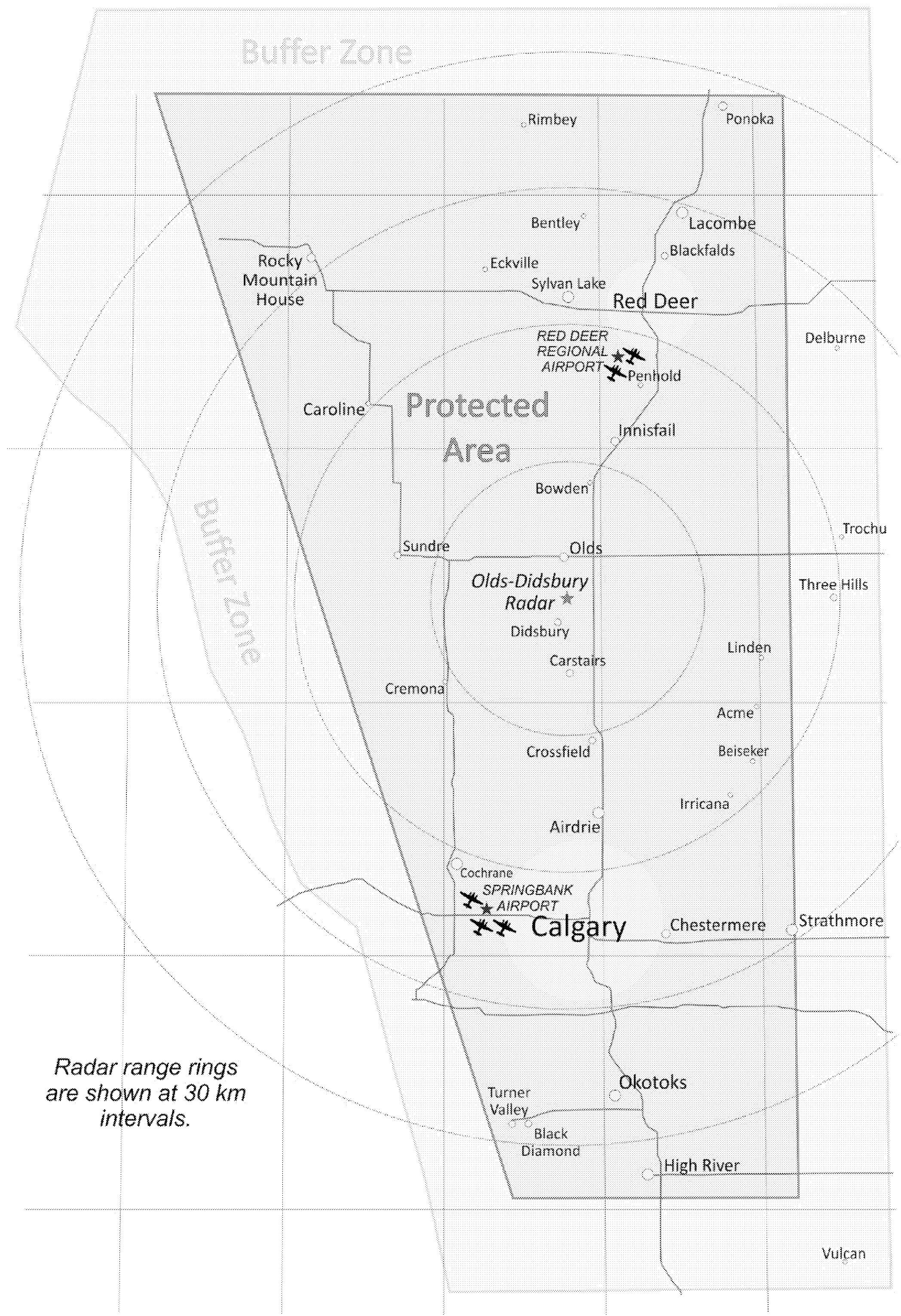


Figure 1: Map of south-central Alberta showing the project area, outlined in green, covered by the Hail Suppression activities.

Table 1. Seeding activity through 2021.

Season	Storm Days With Seeding	Aircraft Missions (Seeding & Patrol)	Total Flight Time (hours)	Number of Storms Seeded	Total Seeding Agent (kg)	Seeding Agent Per Day (kg)	Seeding Agent Per Hour (kg)	Seeding Agent Per Storm (kg)	Ejectable Flares	Burn-in-place Flares	Seeding Solution (gallons)**	Season Activity Rank
2021	15	57	159.9	35	213.6	15.3	1.34	6.10	3391	972	0.0	24
Mean	**30**	**105**	**218.4**	**86**	**227.2**	**7.9**	**1.05**	**2.85**	**5320**	**733**	**167.8**	
2020	23	111	256.2	71	305.1	13.3	1.19	4.30	6722	1066	177.4	9
2019	27	114	243.9	61	296.4	11.0	1.22	4.86	7520	912	150.5	11
2018	26	127	262.5	77	248.0	9.5	0.94	3.22	4663	951	198.0	10
2017	25	107	224.5	64	255.4	10.2	1.14	3.99	5939	842	170.2	13
2016	35	139	277.1	96	294.9	8.4	1.06	3.07	6496	1000	246.9	6
2015	26	115	233.3	79	349.2	14.6	1.37	4.42	8127	1138	262.9	8
2014	32	128	259.5	101	382.5	12.0	1.47	3.79	10782	1020	228.6	3
2013	26	103	229.6	70	233.3	9.0	1.02	3.33	6311	636	131.7	16
2012	37	143	300.1	116	314.6	8.5	1.16	2.70	7717	914	260.3	2
2011	48	158	383.0	134	400.1	8.3	1.13	3.00	10779	1020	350.2	1
2010	42	115	271.8	118	263.8	6.3	1.10	2.20	5837	851	227.5	7
2009	20	38	109.3	30	48.4	2.4	0.84	1.60	451	237	56.5	26
2008	26	112	194.7	56	122.9	4.7	1.00	2.20	1648	548	113.5	20
2007	19	76	115.3	41	99.7	5.2	0.90	2.40	1622	413	77	25
2006	28	92	190.2	65	214.0	7.6	1.10	3.30	4929	703	145.4	17
2005	27	80	157.9	70	159.1	5.9	1.00	2.30	3770	515	94.2	22
2004	29	105	227.5	90	270.9	9.3	1.20	3.00	6513	877	132.7	12
2003	26	92	163.6	79	173.4	6.7	1.10	2.20	4465	518	92.6	19
2002	27	92	157.4	54	124.2	4.6	0.80	2.30	3108	377	80.3	23
2001	36	109	208.3	98	195	5.4	0.90	2.00	5225	533	140.8	14
2000	33	130	265.2	136	343.8	10.4	1.30	2.50	9653	940	141.3	4
1999	39	118	251.3	162	212.7	5.5	0.80	1.30	4439	690	297.5	5
1998	31	96	189.9	153	111.1	3.6	0.60	0.70	2023	496	193.8	15
1997*	38	92	188.1	108	110.8	2.9	0.60	1.00	2376	356	144.3	18
1996*	29	71	159.1	75	163.3	5.6	1.00	2.20	3817	542	80.5	21

**The 1996 and 1997 seasons began on June 15, not June 1, which has been the norm ever since.*

***Use of seeding solution was discontinued beginning in 2021. The mean shown reflects previous seasons only.*