Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

AVIATION INVESTIGATION REPORT
A10Q0087

COLLISION WITH WATER
LAKE BUCCANEER LA-4-200 (PRIVATE), C-GGFK
LAC BERTÉ, QUEBEC
03 JUNE 2010

Canada

Aviation Investigation Report

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Lac Berté, Quebec
03 June 2010

Report Number A10Q0087

Synopsis

At approximately 1900 Eastern Daylight Time on 03 June 2010, a privately operated Lake Buccaneer LA-4-200 amphibious aircraft (registration C-GGFK, serial number 1082), with the pilot and a passenger on board departed on a visual flight rules flight from Lac de la Marmotte II to Baie Comeau, Quebec. The 98 nautical mile flight was to take approximately 1.3 hours. When the aircraft did not arrive at destination by the end of day on 04 June 2010, a search was started on the morning of 05 June 2010. Using sonar, the aircraft was located on 26 June 2010 by the Sûreté du Québec police dive team at a depth of 230 feet in Lac Berté, 5 nautical miles south of Lac de la Marmotte II. The aircraft and occupants were recovered on 02 and 03 July 2010 with the assistance of a remotely operated vehicle with underwater camera. The aircraft sustained substantial damage on impact with the surface of the water. The pilot and passenger were seriously injured and drowned. No emergency locator transmitter signal was detected by the search and rescue system.

Ce rapport est également disponible en français.

Factual Information

History of the Flight

The pilot and passenger departed from the Baie Comeau (Manic 1) airstrip (CSL9) located 6 nautical miles (nm) northwest of the Baie Comeau airport (CYBC) at approximately 1030 [1] on 01 June 2010 for a visual flight rules (VFR) flight to the pilot's cottage located on Lac de la Marmotte II [2], Quebec, 98 nm to the northeast. The flight was uneventful; having arrived, the pilot reported no technical difficulties with the aircraft.

At 1806 on 03 June, a message was left on the pilot's home voicemail indicating that they would be returning to Baie Comeau. However, there was no mention if the intent was to return on 03 June or 04 June. No other information was provided in the message. It was not the pilot's habit to depart after supper time; family members believed the departure would take place sometime on 04 June.

When the aircraft did not arrive by end of day on 04 June 2010, family members initiated a search on 05 June 2010. [3] A search by private helicopter was conducted in the vicinity of the pilot's cottage and other known frequented fishing locations; the aircraft was not located. Search and Rescue Halifax were advised of the missing aircraft and deployed to the area. On 05 June 2010, debris from the right wing auxiliary fuel tank (sponson) was located on the shore of a bay on the northeast side of Lac Berté, 5 nm south of Lac de la Marmotte II (Appendix A). An underwater sonar search was initiated by the Sûreté du Québec (SQ) police dive team as well as a shoreline land search by family members. The SQ dive team located the aircraft at a depth of 230 feet at the bottom of Lac Berté on 26 June 2010 in the area south of the initial search area. A remotely operated vehicle (ROV), equipped with an underwater camera and robot claw, was used to recover the aircraft occupants and to secure the aircraft to raise it to the surface. The aircraft and the pilot were recovered on 02 July 2010. The passenger was recovered on 03 July 2010, 80 feet from the aircraft location. The aircraft was examined before transporting the engine and propeller to the TSB Laboratory in Ottawa for further examination.

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1 All times Eastern Daylight Time (Coordinated Universal Time minus 4 hours).

2 The lake on which the pilot's cabin is located carries no official name. The pilot held a land lease lot #142540812, since 1991. Locally the lake is known as Lac de la Marmotte II and will be referred to as such in this report.

3 The occurrence took place in Class G airspace which is all uncontrolled domestic airspace where no air traffic control services are provided. Flight information and alerting services are, however, provided. The pilot filed a flight itinerary with a responsible person who initiated search and rescue efforts.

Retrieved Photos

The passenger's camera was found in the wreckage. Photos extracted from the camera were taken over a 3-day period coinciding with the 3 days the pilot and passenger spent at the pilot's cottage. The last group of photos shows the aircraft on take-off, heading south from Lac de la Marmotte II towards Lac Berté, and in cruise flight over the tip of the northeast bay of Lac Berté heading south. It was determined that the pictures were taken in the evening because photos show the sun setting to the right, while the aircraft is flying in a southerly direction. This information helped confirm that the occurrence flight took place on the evening of 03 June 2010. The aircraft's altitude as shown on the last photo (Appendix B) was estimated to be approximately 876 feet above the surface of the lake (2073 feet above sea level). The exact time of the occurrence is unknown.

Weather

The retrieved photos also helped determine the weather conditions at the approximate time of the occurrence flight. The reflection of the sky and clouds on the surface of Lac Berté, revealed that weather was conducive to VFR flight; it was sunny with scattered clouds, winds were light to nil giving glassy water conditions for the lake surface; no thunderstorm activity or precipitation was visible in the area at the time the photos were taken.

A weather study completed by Environment Canada confirms the weather picture depicted in the photos. The study for the Lac Berté area on the evening of 03 June 2010 concludes that the Manicouagan reservoir region weather was appropriate for VFR flight; the sky was generally clear and winds were nil to light at less than 5 knots from the east. These weather conditions remained until the morning of 04 June 2010 and were not considered a contributing factor in this occurrence. Weather was forecast to deteriorate late on the morning of 04 June 2010 due to an approaching low pressure system.

The pilot's satellite phone indicated several calls were placed on 01 June, 02 June and one on 03 June 2010. No calls were placed to the Flight Information Centre telephone number to obtain aviation weather information. The pilot may have obtained forecasted weather from an alternate source such as AM/FM or HF radio which was available at his cottage. It could not be confirmed if the pilot decided to leave on 03 June 2010 because the weather was forecast to deteriorate late morning on 04 June 2010.

The Pilot

The pilot held a valid private pilot licence since 1975 and a seaplane endorsement since 1976. The pilot had previously owned 2 other Lake Buccaneer aircraft before purchasing C-GGFK in 1983 and had approximately 2930 hours total flying time; all but 90 hours, were completed on Lake aircraft. Over the past several years, the pilot flew occasionally during the months of April through October, flying approximately 45 hours per year. The pilot had met all Transport Canada currency training requirements. [4]

[4] *Canadian Aviation Regulations* CAR 401.05(1)*(a)*, Standard 421.05 and CAR 401.05(2).

The Aircraft

The aircraft, a single engine Lake LA-4-200 EPR amphibious aircraft, was manufactured in the United States by Consolidated Aeronautics Inc. in 1983. The engine is mounted on the top of the rear cabin area in a pusher type configuration. The pilot purchased the aircraft new in May 1983. Records indicate that the aircraft was certified, equipped, and maintained in accordance with existing regulations and approved procedures. The last annual / 100-hour maintenance inspection was completed on 03 August 2009.

It is estimated that had the aircraft taken off from Lac de la Marmotte II with slightly over a half fuel load, 2 people on board (actual weights used) and approximately 100 pounds of baggage, the weight and centre of gravity would have been within the prescribed limits during the occurrence flight.

The aircraft was not equipped with a flight data recorder or a cockpit voice recorder, nor was either required by regulation.

The global positioning system (GPS) on board the aircraft was a panel mounted Trimble TNL 1000 GPS and did not allow downloading of any flight data information which would have been available to the investigation.

The Wreckage

Examination of the wreckage did not reveal any pre-existing aircraft structural deficiencies. All flight control surfaces were recovered. Continuity of primary pitch, roll and yaw controls was confirmed with no sign of any pre-impact anomaly. Flaps were found in the up position, the normal position for cruise flight. The landing gear was found in the up and locked position, the normal position for cruise, take-off or landing on water. The elevator trim is hydraulically operated and was found in the cruise position. However, since many hydraulic lines were severed, the trim position may have been modified during the impact with the water.

Photo 1. Lake Buccaneer C-GGFK

The aircraft collided with the water at an approximate 20° nose-down attitude, right lateral movement and right wing low attitude. The right wing tip collided with the water first, tearing away the right wing sponson and the outboard portion of the right wing leading edge and wing tip cover (Photo 1). The nose section, from the instrument panel to the nose cone of the aircraft, was torn open from right to left. It remained attached to the rest of the fuselage by the front left side skin, electrical wires and hydraulic lines. The cabin floor was torn apart as the nose section separated from the rest of the aircraft. The seat rails failed in overload as the floor was torn open allowing the seats to come free of the aircraft. The left wing outboard leading edge was flattened as it whipped around to hit the surface of the water after the right wing and nose struck the water. The tail section and top vertical fin of the aircraft also showed kinks in the aircraft skin indicating the aircraft struck the water while rotating around the right wing. The aircraft was found upside down, resting on the top of the engine, at the bottom of the lake. There were no signs of pre-impact fire or bird strike.

The Lycoming engine [5] was removed from the aircraft and transported to the TSB Laboratory in Ottawa for teardown. As it was installed on a pylon aft of the cabin and faced rearward, it was protected during the frontal impact of the aircraft with the lake surface and sustained no visible damage. Examination of the engine and accessories did not identify any anomalies that would have prevented normal operation.

The Hartzell propeller [6] was examined. The blades were in a low pitch position at the time of impact. However, an estimate of power output could not be determined. No anomalies were noted with the propeller that would have prevented normal operation.

The Directional Gyroscope [7] was examined and showed no evidence of impact damage. The gyroscopic rotor mass and mass housing revealed circumferential scrape marks in the base of the housing. The extent of the scrape marks indicate that the mass was spinning at high speed at impact with the water, indicating that the engine driven vacuum pump was functional at the time of the occurrence.

The electrically driven turn and bank coordinator [8] was examined. No witness marks were found on the dial face; however an examination of the gyroscopic mass revealed circumferential scrape marks made by contact between the spinning rotor and a protruding wire. For this to be the case, electrical power was likely available.

The dial face of the vertical speed indicator was examined and revealed a pointer edge scrape mark that showed a rate of descent of between 1000 to 1500 feet per minute at the time of impact.

The pilot fuelled the aircraft before departure from Manic 1 on 01 June 2010. The pilot was not in the habit of filling the 2 wing sponsons. When the main wing tanks are full, [9] endurance is approximately 4 hours of flight. Five-gallon jugs of aviation 100LL fuel were kept in a shed at the cottage. The aviation fuel jugs' handles were marked with blue spray paint in order to differentiate them from other stored unpainted 5-gallon jugs of gasoline used for other machinery such as all-terrain vehicles. The fuel stored at his cottage location and marked as aviation fuel was checked for its quality; no water or contaminants were found and the color of the fuel confirmed that it was the appropriate grade for the engine.

Because the aircraft sank in water, it was not possible to verify the integrity of the fuel on board nor was it possible to determine the exact amount of fuel on board at the time of the occurrence flight. Had automotive gasoline been mistakenly added to the aircraft main wing tanks and

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5 Engine Lycoming model IO-360-A1B6, serial number L-23075-51A

6 Propeller Hartzell model HC-E2YR-1BLF, serial number DK2071B

7 EDO-AIRE, part number 1U262-001-9, serial number A10955E

8 Aviation Instrument Mfg. Corp., part number 507-0020-901, serial number 1450

9 Capacity of 54 US gallons or 45 Imperial gallons

mixed with the aviation fuel already present in the wings, it would not have caused engine problems as many piston type aircraft operators using the same model of engine have a supplementary type certificate (STC) to use automobile type gasoline for their aircraft. The Aircraft Flight Manual recommends using 100LL, however the engine had been originally certified to fly with lower octane gasoline. The fuel valve selector was found in the ON position. Fuel filter bowl located on the engine pylon was found full of 100LL; the fact that fuel was present in the bowl would indicate that fuel was reaching the engine prior to impact with the water and engine stoppage.

Crashworthiness

It is estimated that impact forces with the surface of the water caused the nose section, including the instrument panel, control columns, rudder pedal areas and floor of the aircraft to tear away from the rest of the rear cabin area; consequently the 2 front seat attachment points failed. Both seats and floor tracks failed in overload. The applicable aircraft certification requirements at the time of manufacture of this Lake Buccaneer required that seats and their supporting structures be designed to sustain ultimate upward acceleration loads of 4.5 *g*,[10] forward acceleration loads of 9.0 *g* and sideward acceleration loads of 1.5 *g*.[11] The aircraft struck the water with both a forward and right sideward movement. When a seat does not remain securely attached to the floor, occupant injury protection offered either by the seat or by the safety belt and shoulder harness is considerably reduced.

The occurrence aircraft was equipped with safety belts and shoulder harnesses. The left portion of the pilot's safety belt attachment point attached to the left side wall had failed in overload indicating that it was worn at the time of impact. It was not the pilot's habit to wear the shoulder harness; the left side shoulder harness was found intact. The pilot was found in the aircraft. The passenger's safety belt and shoulder harness were found intact and unfastened; this does not necessarily indicate that the passenger was not wearing the belt because it may have come unfastened during the crash sequence. The passenger was found 80 feet from the aircraft. His seat was not retrieved. One inflatable life vest was found in the wreckage. Neither occupant was found wearing a life vest, nor is it required.

The Emergency Locator Transmitter

The emergency locator transmitter (ELT) on board C-GGFK was a KANNAD 406 AF-Compact ELT manufactured in France. It was programmed, installed and tested in April 2009. It was found in the ARM position when it was retrieved from the aircraft.

The TSB tested the ELT to verify its serviceability. The tests showed that the ELT still met the 121.5 MHz signal requirements. However it no longer met the 406 MHz signal requirements. The ELT would transmit an amplitude modulated sweeping audio signal on 121.5 MHz carrier frequency but would not transmit the data burst on a 406 MHz carrier frequency. The ELT's 15-

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10 4.5 times the normal load of acceleration due to gravity at the Earth's surface where 1 *g* is 9.80665 metres per second squared.

11 *Civil Air Regulations* (amendment May 15, 1956), Part 3-Airplane Airworthiness; Normal, Utility, and Acrobatic Categories, Section 3.386 Protection & 3.390 Seats and Berths.

digit hexadecimal identification is the data that is transmitted by the ELT on its 406 MHz carrier frequency. In addition it could no longer be armed or activated when impacted. The most probable cause for the ELT's failure to meet the 406 MHz signal and impact activation requirements is considered to be water and pressure damage by the immersion of the ELT to a depth of 230 feet.

At present, seaplanes only need to carry an ELT; no alternate means of emergency locating or tracking is required. Although seaplane occurrences can happen over land, many occur at low speeds during taxi maneuvres, landing and take-off on water. In these cases, the impact forces may not be strong enough or are not in the appropriate direction to activate the ELT inertia switch. In other cases, the ELT will become submerged partially or totally, rendering the unit unable to transmit its signal through water. If occupants are able to exit the aircraft, they find themselves unable to retrieve and activate the submerged ELT. If the aircraft becomes overdue and search is initiated, the aircraft and ELT may have sunk making it more difficult to locate. Survivability is dependent on rapid search and rescue, and medical response.

Recent technology offers an array of emergency signalling devices for water and land. Present regulation does not require seaplanes to carry a deployable, waterproof-type emergency position indicating radio beacon (EPIRB), even though many seaplane occurrences take place on water. Used on water-borne vessels, EPIRBs are similar to ELTs but are water-tight and are fixed to an area of the vessel where, in the event of capsizing, the EPIRB would float and emit a signal to initiate search and rescue efforts. Activation takes place on contact with the water. EPIRBs are used on commercial marine vessels but are not required for private pleasure craft. For aviation purposes there are ELTs that are standalone equipment capable of floating and intended to be removed from the aircraft. These ELTs are equipped with an auxiliary antenna and activated manually by survivors or automatically by a water switch sensor when in contact with water.

If occupants do egress from a seaplane, they are often injured and unable to reach the ELT. Many life preservers offer the personal locator beacon (PLB) option. Although present regulation requires that a life preserver be carried for each occupant of a seaplane, they do not have to be worn nor do they have to carry a PLB. [12]

In this case, the search for and recovery of the sunken aircraft and its occupants took close to a month and involved numerous resources. The expeditious location of underwater aircraft wreckage is essential for investigative purposes. An underwater location beacon (ULB), installed and operating, would likely have led to the wreckage being located more quickly. The ULB is designed to activate upon immersion and to transmit an acoustic signal at 37.5 kilohertz (kHz). [13] This signal propagates well in water and is normally easily detected using portable hydrophone detection equipment.
Transport Canada has been reassessing its policy on ELT requirements since 2007.

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12 CAR 602.62

13 Canadian Coast Guard (CCG) helicopters were equipped with ULBs following the TSB investigation A00A0076 and safety information letter to Transport Canada into the Department of Transport Aircraft Services. Also, the personal floatation devices on board CCG helicopters are now equipped with PLBs.

Glassy Water

Lac Berté is a large body of water with various inlets, bays and islands. An outfitter operates on the lake and cottages are sparsely dispersed along its shoreline. However, because of the outfitter's rights to the lake, no one, other than the outfitter's clients, is allowed to fish there. The pilot knew the area well and likely would not have intentionally landed on Lac Berté unless there had been an emergency situation.

The pilot was experienced in landing on water; however glassy water conditions are considered to be the most difficult conditions for landing a seaplane regardless of experience. The mirror effect created under glassy water conditions affects depth perception. If glassy water conditions exist, the following is recommended:

> Power assisted approaches and landings should be used although considerably more space will be required. The landing should be made as close to the shoreline as possible, and parallel to it, the height of the aircraft above the surface being judged from observation of the shoreline. Objects on the surface such as weeds and weed beds can be used for judging height. The recommended practice is to make an approach down to 200 feet (300 feet to 400 feet where visual aids for judgment of height are not available) and then place the aircraft in a slightly nose high attitude. Adjust power to maintain a minimum rate of descent, maintaining the recommended approach speed for the type until the aircraft is in contact with the surface. Do not "feel for the surface". At the point of contact, the throttle should be eased off gently while maintaining back pressure on the control column to hold a nose high attitude which will prevent the floats from digging in as the aircraft settles into the water. Care must be taken to trim the aircraft properly to ensure that there is no slip or skid at the point of contact. [14]

In the case of the Lake type aircraft, which are known to be more challenging to land when engine power is off or at idle, it is recommended that some engine power be maintained in order to properly control the rate of descent. It is also recommended to keep a speed of 65 mph until touchdown. If the height above the surface is not judged appropriately on approach and touchdown, it is likely that the aircraft will either hit the water hard because the pilot will not have levelled off in time for the aircraft to touchdown smoothly on the surface, or the pilot may level off too high, believing the aircraft is lower than it actually is. This can result in the aircraft stalling high above the water as the pilot reduces speed and pulls the nose up to land. It is possible that one wing stalls before the other, making the aircraft bank to the right or left, causing one wing to collide with the water.

The aircraft was found approximately 1476 feet laterally from the closest landmark. This distance would not have allowed the pilot to effectively judge the height of the aircraft above the water under glassy water conditions. The examination of the vertical speed indicator also showed a rate of descent between 1000 to 1500 feet per minute which would require a certain height above the water to attain.

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[14] Transport Canada Aeronautical Information Manual (TC AIM), Airmanship, 2.11.4 - Landing Seaplanes on Glassy Water."

The Pilot's Medical History

The 78-year-old pilot held a valid category 3 medical certificate. The pilot's last aviation medical examination took place on 23 July 2009. In 1987, it was found that the pilot had previously had a heart attack. A thorough cardiac investigation to assess the suitability for pilot medical recertification was conducted. Also in 1987, the pilot was found to have diabetes mellitus (Type 2 diabetes). Present regulations require that private pilots, 40 years and older, complete an aviation medical examination every 2 years. Because the occurrence pilot was diagnosed with several medical conditions, heart disease, hypertension, and diabetes, Transport Canada required that there be an annual follow-up. The pilot's family doctor was also aware of the pilot's health issues. The pilot was expected to complete and forward to Transport Canada, the results of various required medical tests relative to the diabetes and heart conditions, on an annual basis in order to maintain the category 3 medical certificate required for the private pilot licence. The pilot's next medical examination was due in July 2010.

The pilot had a fairly active lifestyle and anecdotal descriptions of the pilot's health and demeanour indicated that the pilot was feeling well and was disciplined in taking medications as prescribed.

The Passenger

The 69-year-old passenger had a heart condition. The passenger had a heart attack in 1990 followed by bypass surgery in 2000 and was taking medication for the heart, hypertension and hypercholesterolemia. The passenger was reported to be feeling well and had not mentioned any recent health concerns. The passenger was not a licensed pilot.

Post-Mortem Examination

Given their medical histories, autopsies were performed on both the pilot and passenger to help determine if either of them had suffered a medical event that could have led to incapacitation in flight. [15]

The autopsies performed did not determine that either occupant had an incapacitating medical event in flight. Heart attacks or angina attacks do not always leave markers evident in a post-mortem examination.

Neither occupant died of injuries incurred during the crash sequence. Both were seriously injured and died of drowning. The pilot had fractures to the upper maxilla (jaw bone), and both wrists. Fractures to the pilot's wrists (bracing maneuvre) would likely indicate that he was conscious and at the controls at the time of the impact with the water. The passenger also had fractures to the face and dislocation of the right ankle. There were no fractures to the passenger's hands or arms. It is likely that the serious injuries to the facial area rendered the occupants unconscious. The post-crash environment, i.e. the water, would have played a key role in their inability to survive.

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15 The definition of incapacitation is to deprive of power, strength, or capacity; disable. Collins English Dictionary – Complete and Unabridged. Harper Collins 2003

Toxicology results did not show the presence of illicit drugs or alcohol in either occupant. Test results did show the presence of the pilot's prescribed medications for treatment of high cholesterol and high blood pressure, although quantities could not be determined. The absence of high levels of lactic acid and glucose in the vitreous humor (liquid in the eye), would indicate that the pilot did not have a fatal hyperglycaemic event. The passenger was prescribed nitro-glycerine spray to relieve angina. Present analysis methods do not allow for valid testing for the presence of nitro-glycerine; therefore, it could not be determined if the passenger had used nitro-glycerine.

Review of Pilot's Aviation Medical Information

An expert medical opinion and review of the pilot's TC aviation medical records, family medical records and guidelines provided by the Handbook for Civil Aviation Medical Examiners was obtained. The following information was extracted from the medical expert's report:

- A review of the pilot's TC medical file showed that the pilot had appropriate and timely evaluations and treatment by clinical providers with respect to his diabetes and heart disease, and appropriate medical oversight by his Canadian Aviation Medical Examiner (CAME), and the TC Regional Aviation Medical Officers (RAMO). TC oversight was in accordance with the published guidelines for cardiovascular disease and diabetes.

- The guidance provided with respect to assessment and follow-up of cardiovascular disease and diabetes mellitus are contained in the relevant chapters of the Handbook for Civil Aviation Medical Examiners. [16] Both the guidelines have been updated in the past year and a half. The updated guidelines provide appropriate and current recommendations for assessment and follow-up relevant to this case.

- The pilot's diabetes was relatively mild and appeared to be controlled well and was very unlikely to contribute to performance impairment.

- The pilot had regular eye specialist evaluations with no evidence of diabetic retinopathy. However the pilot did have a venous occlusion in the right eye (1992) which resulted in some loss of visual acuity, which remained no better than 6/9 in the eye. It is possible that this (rather small) degree of anisometropia [17] could affect depth perception.

- It is unlikely that the accident was caused by an acute incapacitation in the pilot. Brace fractures to both wrists indicate that the pilot was likely conscious at the time of impact. The findings following the autopsy do not rule out the possibility

16 Transport Canada publication TP13312

17 Where there is an inequality in refractive power of the two eyes

of more subtle degrees of impairment related to the pilot's underlying medical conditions: diabetes, hypertension and heart disease.

- Review of family doctor records show that the pilot had been appropriately treated and followed for each of his medical conditions. With the pilot's history of past myocardial infarction, hypertension, diabetes and dyslipidemia, he was at increased risk for another cardiac event, but ongoing serial monitoring did not suggest this was imminent.

Safety Studies

In 1994 the TSB published a safety study of survivability in seaplane accidents. [18] The analysis covered a 15-year period, from 1976 to 1990. During that period, there were 1432 such accidents; of these accidents, 103 accidents terminated in water and resulted in 168 deaths. The study aimed to advance aviation safety by identifying factors affecting occupant survivability in seaplane accidents that terminate in the water. The causes of death for the 168 fatalities[19] from accidents which occurred on the water fell into 4 major categories as follows:

- 18 (11%) of the deaths occurred during impact;
- 17 (10%) of the occupants were incapacitated during the impact sequence from non-fatal impact forces and subsequently drowned;
- 113 (67%) died from drowning;
- and 3 (2%) died from exposure.

Crashworthiness studies conducted in the United States and Canada have consistently concluded that the probability of surviving impact forces is significantly enhanced if occupants of small, general aviation aircraft are protected by upper-torso restraints. [20] Occupants of a seaplane aircraft may drown in a sinking aircraft if they are unconscious; loss of consciousness is normally caused by a head trauma. If restrained and protected during the impact sequence, occupants may maintain consciousness and stand a better chance of successfully exiting a sinking aircraft. The use of a 3-point safety restraint (safety belt and shoulder harness) is known to reduce the severity of upper body and head injuries and more evenly distribute impact forces. [21]

Very little data regarding the availability of shoulder harnesses were available during the TSB 1994 seaplane study. However where information was recorded, 60% of the passengers did not have shoulder restraint available; of the remaining 40%, over half did not make use of the available shoulder restraint systems. Information concerning the use of shoulder restraints by

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18 The word ˝seaplane˝ is used by Transport Canada for licensing purposes and includes floatplanes, flying boats and amphibious aeroplanes.

19 In 17 cases (10%), no cause of death was recorded.

20 Small Aircraft Crashworthiness, Volume 1 TP 8655E, Prepared by Sypher: Mueller International Inc., July 1987, page 46. *Study of the Influence of Shoulder Harnesses in Aviation Safety*, Canadian Aviation Safety Board, 1987.

21 National Transportation Safety Board, Safety Report, NTSB/SR-83/01, General Aviation Crashworthiness Project, Phase Two – Impact severity and potential injury prevention in General Aviation accidents, March 15, 1985.

pilots was more complete. Sixty two percent (62%) of pilots were operating aircraft that had not been equipped with shoulder harnesses. Of the pilots that did have shoulder harnesses available, 68% were not using them at the time of the accident. Aircraft built before 1978 were not required to have shoulder harnesses available. [22] Many of these aircraft are still operational today. Aircraft manufactured after July 18, 1978 require the installation of shoulder harnesses for each front seat and their use during taxi, take-off and landing, and in flight if necessary for safety. [23]

Although regulation states that restraints must be used for movement on the ground (water), take-off and landing, or whenever it is deemed necessary for the safety of the occupants, it is not mandatory to wear the restraints for other than these specified phases of flight. It is likely that in the event of an emergency, restraints not worn in flight may be forgotten and not used during the emergency sequence and impact. [24] In this occurrence, it is not known if the passenger received a safety briefing, including the use of restraints and egress, prior to flight nor could it be determined if the safety belt and shoulder harness available had been used.

Safety Information and Statistics

The number of occurrences and fatalities in Canada over the past 20 years for both commercial and private operations has remained relatively the same for each of these operation types (Table 1). In an effort to increase seaplane safety, TC has recently published and distributed seaplane safety literature, *Seaplanes – A Passenger's Guide*, [25] throughout the aviation community.

Many occurrences involving floatplanes and seaplanes have been investigated by the TSB. Many of these occurrences have led to safety studies and safety communications in the effort to improve floatplane and seaplane safety. Such efforts have addressed piloting skills, abilities and knowledge of seaplane pilots including landing on glassy water and rough water, survivability in seaplane accidents, passenger briefing and safety features, fitting of emergency exits for rapid egress, donning of personal floatation devices. A list of these efforts was recently published as an appendix to the TSB aviation investigation report into the floatplane occurrence, A09P0397 – *Loss of Control – Collision with Water*.

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[22] CAR 605.24(1)

[23] CARs 605.24(1) and 605.25(1)

[24] A survivable accident is one in which the forces transmitted to the occupant through the seat and restraint system do not exceed the limits of human tolerance to abrupt accelerations and in which the structure in the occupant's immediate environment remains substantially intact to the extent that a livable volume is provided throughout the crash sequence. National Transportation Safety Board, Safety Report, NTSB/SR-83/01, General Aviation Crashworthiness Project, Phase One, June 27, 1983, page 3.

[25] TP12365

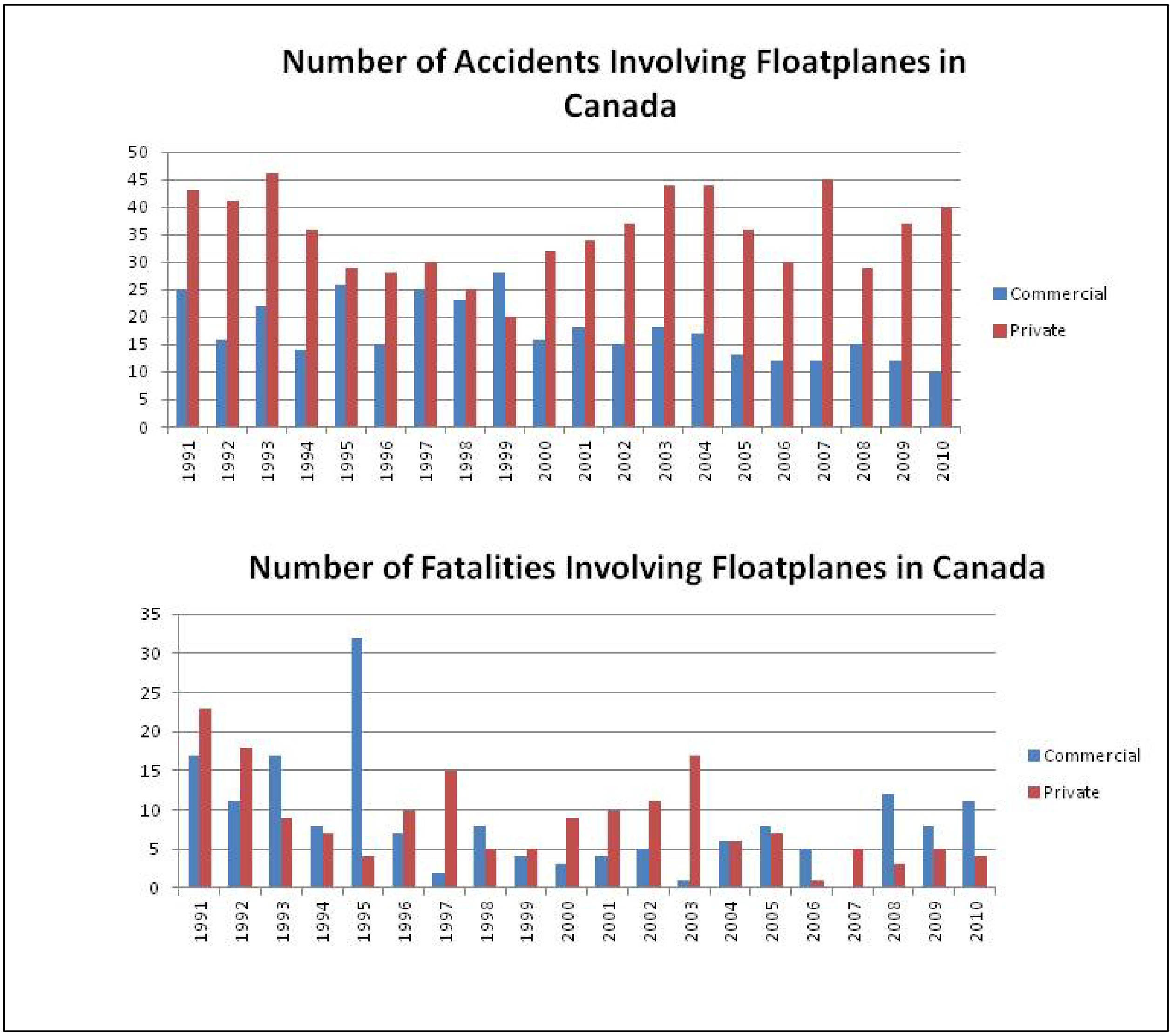


Table 1. Floatplane Statistics (includes seaplanes)

The following TSB Laboratory reports were completed:

LP 092/2010 Photo Analysis
LP 093/2010 Instrumentation & Document Analysis
LP 099/2010 Engine Examination
LP 046/2011 Conversion ROV footage

Analysis

The reason for departing Lac de la Marmotte II on the evening of 03 June 2010 is unknown. It is possible the pilot decided to depart late in the day, although it was not his habit to do so, because of approaching weather due in the area the following day.

Two possible scenarios resulting in the collision with water were considered: a missed precautionary or emergency landing due to aircraft operation difficulties and glassy water conditions, or a loss of control of the aircraft due to pilot or passenger impairment. Risk factors that may have increased the likelihood of sudden impairment were considered for both the pilot and the passenger; both were at risk of a sudden medical event.

The first possible scenario is that the aircraft had some system malfunction that was not determined during the post-accident examination. However, this scenario would not explain why the pilot, with much experience landing on water, and with ample space on Lac Berté to make a precautionary landing, was not able to land the aircraft safely on the water. The pilot's experience and skill level should have been sufficient to handle such an event. The last photo found in the passenger's camera shows the aircraft at 876 feet above the water, giving ample altitude to maneuvre following a technical problem. Winds were light to nil and would not have affected the direction of the landing or aircraft performance as would strong winds.

Given that the lake surface conditions were glassy, the pilot would likely have chosen to land closer to a shoreline or island in order to help judge the height above the water. The aircraft was found 1476 feet from any shoreline, which indicates that the pilot likely did not actively choose the area in which it struck the water, either because the pilot was unable to do so or the situation did not allow time to do so.

The second scenario is a sudden medical event resulting in pilot or passenger impairment while in flight over Lac Berté. The passenger took pictures during take-off, climb and cruise suggesting there was no apparent imminent danger or worry at that point during the flight.

Both the pilot and the passenger had pre-existing health risk factors making it possible that either one of them may have experienced a medical event resulting in some degree of impairment possibly leading to distraction and/or a loss of control of the aircraft. Fractures to the pilot's wrists would indicate that he was conscious and at the controls at the time of impact with the water. The pilot was monitored by his family doctor when necessary and by Transport Canada on an annual basis due to these increased health risk factors. Transport Canada assessed the pilot as fit. However, a medical event resulting in some level of impairment cannot be ruled out given the pilot's age and health risk factors. The rate of descent of 1000 to 1500 feet per minute shown on the vertical speed indicator would be considered high for a planned attempt at landing the aircraft in glassy water conditions and would therefore possibly indicate that for some unknown reason, the pilot may not have been able to control the aircraft fully.

Had the pilot experienced a sudden medical event in flight, the passenger, a non-pilot, would not have known how to land the aircraft safely on water and most likely would not have known how to maintain straight and level flight and radio call for help.

The passenger did not have any fractures to the wrists or arms. This would likely indicate that he was not at the controls at the time of impact with the water. Had the passenger experienced a sudden medical event in flight, the pilot's ability to control the aircraft may have been hindered.

The investigation could not determine if either the pilot or the passenger experienced an incapacitating medical event.

There was insufficient factual information to conclusively state why the aircraft descended and impacted the water.

Both occupants had severe facial injuries which would usually indicate that they were not wearing shoulder harnesses. However, as the seats were torn from the floor attachments and could no longer restrain the occupants, it was not possible to determine if shoulder harnesses would have been effective. The nose section was torn open from right to left. The cabin seats were consequently torn from their attachment points, no longer restraining the occupants in place. Impact forces were likely above the design limits. Seat support and attachment failures can subject occupants to unfavourable positions that greatly reduce tolerance to injury. The severity of the facial injuries would require a substantial impact. It is likely that the occupants were rendered unconscious and were therefore unable to exit the aircraft before it sank. Lack of consciousness in a post-crash water environment contributed to their deaths by drowning.

Studies have indicated that in the majority of small general aircraft accidents, the shoulder harnesses are not worn. Shoulder harnesses reduce the risk of serious injury to the head and upper torso. Most deaths in seaplane occurrences are caused by drowning, either because the occupants cannot exit the aircraft and drown or the severity of their injuries renders them unable to exit.

Given the alerting limitations of ELTs if submerged in water, alternate sources of alerting and tracking an aircraft are required. TC has not yet completed its review and updating of ELT regulatory requirements.

Findings as to Causes and Contributing Factors

1. It could not be determined why the aircraft descended and struck the surface of the water.

2. The pilot and passenger seats failed when the aircraft floor was torn open on impact. The lack of effective occupant restraint during the impact sequence likely contributed to the severity of their injuries, rendering them unconscious and unable to survive the post-crash water environment.

Findings as to Risk

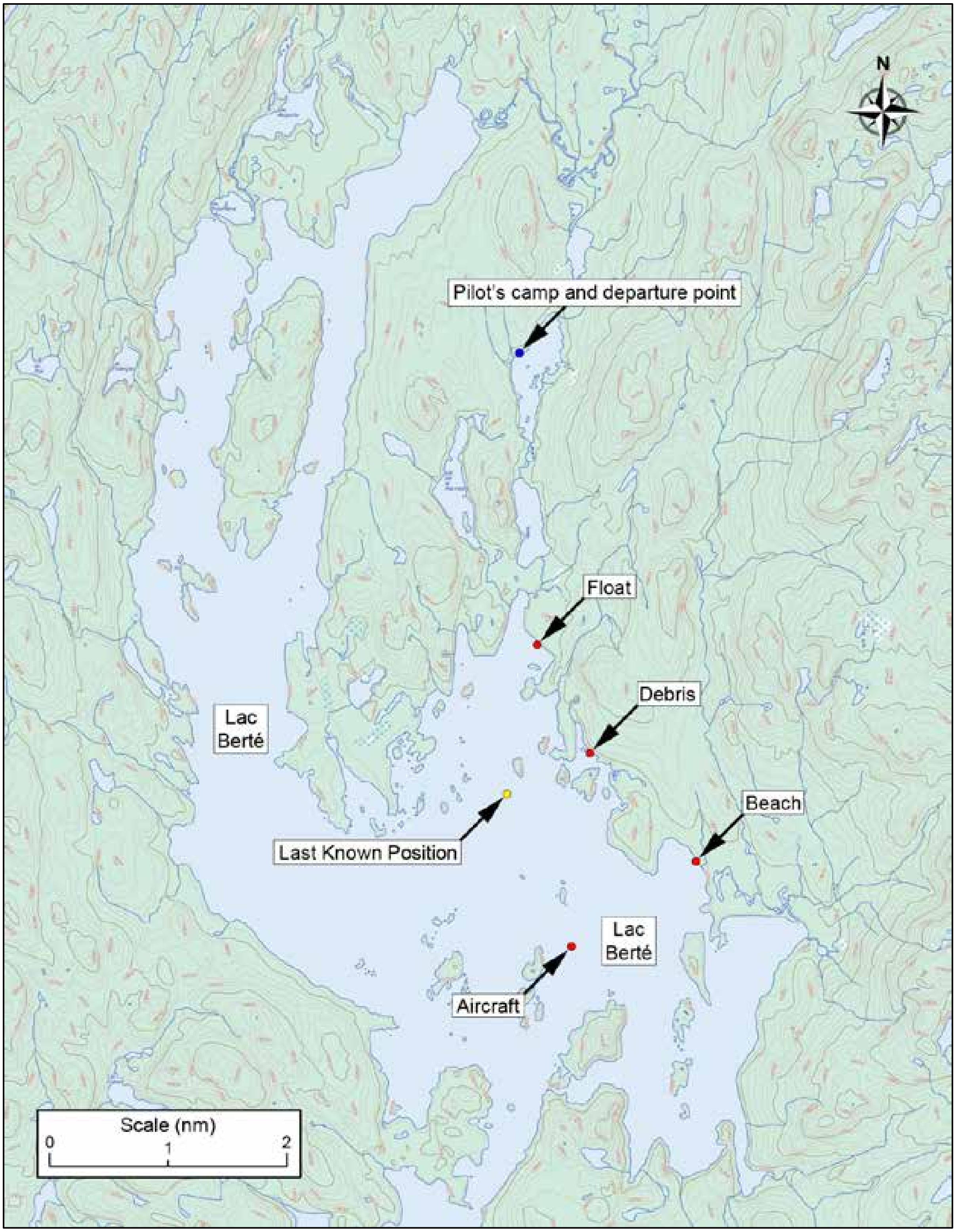
1. Once an ELT is submerged, a signal cannot be transmitted through water, delaying initiation of rescue efforts.

2. Not wearing shoulder harnesses increases the risk of serious injury to the head and upper torso in the event of an accident, which in turn may prevent a safe exit from the aircraft.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 30 May 2012. It was officially released on 03 July 2012.

Visit the Transportation Safety Board's website (www.bst-tsb.gc.ca) for information about the Transportation Safety Board and its products and services. There you will also find links to other safety organizations and related sites.

Appendix A – Area Map of Lac Berté and Location of Aircraft



Appendix B – Last photo taken with passenger's camera and its location relative to direction of flight

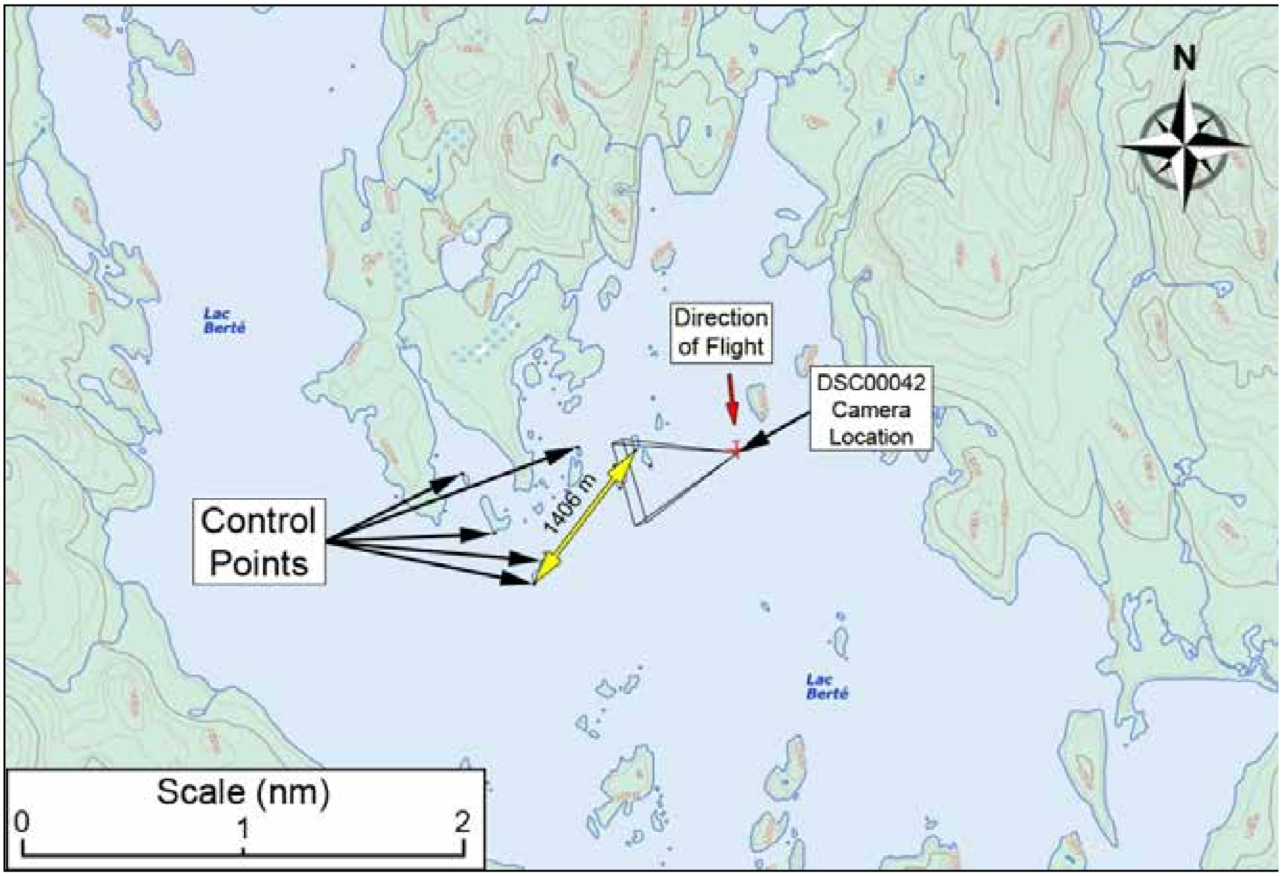


Figure 1. Camera location

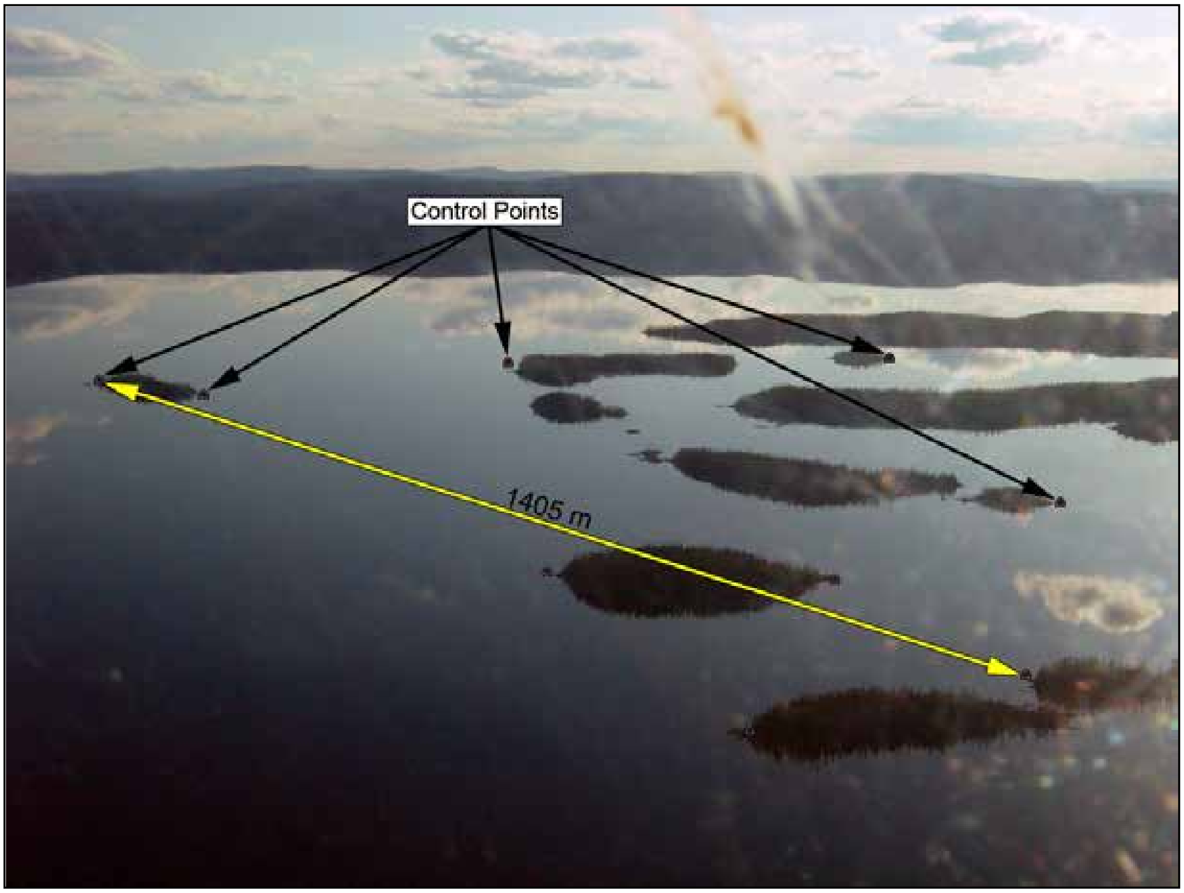


Photo 2. Last photo taken with passenger's camera