Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

MARINE INVESTIGATION REPORT
M01C0033

TAKING ON WATER AND SINKING

AMPHIBIOUS VEHICLE *LADY DUCK*
OTTAWA RIVER
30 JUNE 2001

Canada

Marine Investigation Report

Taking on Water and Sinking

Amphibious Vehicle *Lady Duck*
Ottawa River
30 June 2001

Report Number M01C0033

Summary

At about 1030 on 30 June 2001, the amphibious vehicle *Lady Duck* took on water while on the Ottawa River during a combined land and waterborne sightseeing tour of the National Capital Region. All eight passengers and the tour guide donned personal flotation devices and were safely transferred to a private craft and a Royal Canadian Mounted Police patrol boat that responded to an emergency message broadcast by the driver of the vehicle. The *Lady Duck* capsized and sank about 30 minutes later as tour company personnel attempted to drive it out of the water. No injuries or environmental damage were reported as a result of the occurrence.

Ce rapport est également disponible en français.

Other Factual Information

Particulars of the Vehicle

	Lady Duck
Port of Registry	Exempted from registry (amphibious vehicle)
Flag	Not applicable
Registry/Licence Number	BP2 110 (road licence)
Type	Amphibious passenger vehicle
Gross Tonnage[1]	less than 5.0
Length	8.38 m
Draught	0.84 m
Built	2001
Propulsion	Mercruiser inboard/outboard drive
Number of Crew	2
Number of Passengers	8
Registered Owner	Amphibus Lady Dive Inc., St. Isidore, Ontario

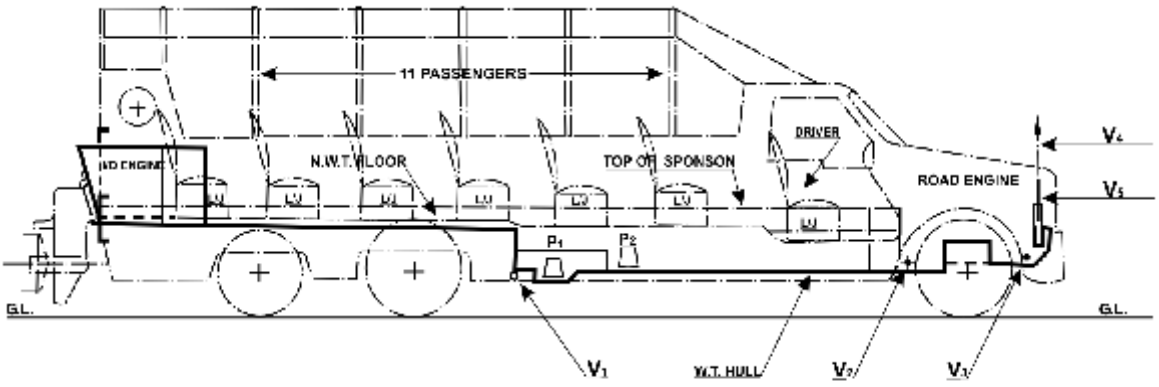
Description of the Vehicle

The *Lady Duck* is an amphibious vehicle arranged to carry up to 11 passengers on combined road and waterborne tours in the National Capital Region (NCR) and on the Ottawa River. The vehicle was developed and built by the owner and entered commercial service at the start of the tourist season in June 2001 (Photograph 1).

Photograph 1. *Lady Duck* entering the water at Hull Marina.

The vehicle is based on the conversion of a Ford F-350 truck chassis. The original gasoline engine is used for on-road operation; a gasoline-powered Mercruiser inboard/outboard engine at the rear is used for waterborne propulsion. Figure 1 shows the basic layout of the vehicle.

[1] Units of measurement in this report conform to International Maritime Organization standards or, where there is no such standard, are expressed in the International System of Units.



G.L.	GROUND LEVEL	V_1	2 BILGE DRAIN VALVES (19 mm dia)
I./O.	INBOARD/OUTBOARD	V_2	2 BILGE DRAIN VALVES (19 mm dia)
L/J	LIFE JACKET	V_3	1 BILGE DRAIN VALVE (12 mm dia)
W.T.	WATERTIGHT	V_4	VISOR TELL-TALE INDICATOR
N.W.T.	NON-WATERTIGHT	V_5	VERTICAL SLIDING W.T. VISOR
P_1	2 BILGE PUMPS IN WELLS	P_2	2 BILGE PUMPS IN HULL

Figure 1. Construction Profile Outline

The bottom of the chassis is enclosed with welded and bolted steel plating, and the sides are extended upward to enclose a buoyant structure. The original truck wheels and the suspension are outside the watertight hull. The effective breadth of the chassis is increased by the addition of extensions (sponsons) on each side. These sponsons are partially filled with rigid foam plastic to enhance transverse stability and reserve buoyancy and to ensure appropriate forward and aft trim when waterborne.

A passenger boarding ramp, located at the rear left corner of the vehicle, hinges up to a steel sill and a flexible gasket to ensure the watertight boundary of the passenger deck. Single seats are arranged along each side of the open passenger deck, and a canvas awning provides some protection from inclement weather. Approved lifejackets were stowed in lockers under each of the passenger seats. Twelve additional approved personal flotation devices were located adjacent to the seats in the passenger area, readily available and without restraints.

A vertical sliding steel visor plate (visor) is fitted at the front of the vehicle. This visor may be raised to prevent water from entering the hull when the vehicle is waterborne and lowered to allow cooling air to flow to the radiator of the forward (road) engine when operating on land. The visor is raised by a compressed air cylinder operated from the driver's cab. A latch and cam-like wedges that engage in slots in the fixed guide frame set the visor firmly onto a flexible gasket seal and keep the visor in place. When the visor locking wedges engage in the fully raised position, they give off a clear and distinctive click. A "telltale" metal rod that is attached to the visor extends some 260 mm above the closed hood when the visor is fully raised. This rod provides further indication to the driver that the visor is raised.

The vehicle is fitted with five bilge draining points to release any accumulation of water in the bilges due to shipped spray, rain water, or hull, stern-tube, or through-hull fittings seepage, etc. This arrangement was adopted in lieu of the accepted marine practice of screwed drain plugs so that the vehicle could be more conveniently drained of any bilge water when on land

and between scheduled tours.

The drainage points are each comprised of hand-operated ball check valves (seacocks) with a swing-check nonreturn valve immediately inboard, both mounted on a common pipe spigot. Four of the drainage points are 19 mm in diameter; the fifth is 12 mm in diameter. They are located as shown in Figure 1.

At the time of the occurrence, the vehicle was equipped with four electrically driven submersible bilge pumps. Two pumps are of 39.4 L/min (625 US G/h) rated capacity; each were located in drain wells extending below the hull bottom near the midlength of the vehicle. Two similar-type pumps of 47.4 L/min (750 US G/h) and 78.8 L/min (1250 US G/h) rated capacity, respectively, were located in the hull forward of the bilge wells, approximately 4 m from the front of the vehicle. The on/off operating switches for all of the pumps were at the driver's position, and no automatic bilge water-level alarms were fitted. The vehicle's equipment also included a VHF radio, a cell phone, and a depth recorder, all adjacent to the driving position.

Pre-voyage Vehicle Preparation

On Saturday, 30 June 2001 at approximately 0730,[2] the driver was the first to arrive at the tour company garage in Hull, Quebec. In accordance with his understanding of the driver's work roster, he began the routine walk-round inspection and other preparation procedures to ready the *Lady Duck* for operation. He was unable to open the hood to check the front engine oil and other fluid levels and proceeded to fill the gasoline fuel tank.

Shortly afterward, a second driver arrived and said the work roster indicated that he was the designated driver for the first tour of the day scheduled for the *Lady Duck*. Since roster changes were not unusual, he proceeded with the routine walk-round inspection and the refuelling of the *Lady Dive I* in anticipation of clarification of the roster when both vehicles reported at the company ticket kiosk in Ottawa.

The assistance of two other drivers was unsuccessful in opening the hood of the *Lady Duck*. At about 0755, the first driver sought further assistance from the operations and maintenance manager (OM). However, the hood front-release mechanism could not be activated from outside the vehicle, and they were unaware of a hood release—originally supplied with the chassis—in the driver's cab.

Because all engine systems had been satisfactory the previous evening, it was considered that topping up of the road engine and other fluids was not immediately necessary. The first driver was then instructed to take the vehicle to the company ticket kiosk in Ottawa without completing the routine fluid levels check, and he noted this omission in the vehicle logbook before departure from the garage yard.

On arrival at the ticket kiosk at approximately 0830, the driver parked the *Lady Duck* in the first passenger loading bay. He then went for a coffee break before starting his first tour with the *Lady Dive I*, which was scheduled for 0900. When he returned at approximately 0855, the dispatcher informed him that, due to a minor mishap during the refuelling of the *Lady Dive I*, the second driver would not arrive in time to take the scheduled first tour of the day in the

---

[2] All times are eastern daylight time (Coordinated Universal Time minus four hours).

Lady Duck and that he was to drive that vehicle in place of the second driver.

History of the Voyage

The *Lady Duck* started the combined on-road and waterborne tour of Ottawa-Hull and the Ottawa River at about 0900, with the driver, eight passengers, and a tour guide on board. Before departure, the driver raised and secured the passenger boarding ramp at the rear of the vehicle but omitted to check whether the five hand-operated seacocks were secured in the closed position.

The land part of the tour proceeded without incident. Just before the vehicle entered the Ottawa River from the ramp at the Hull Marina, the driver prepared the *Lady Duck* for waterborne operations.

While the tour guide briefed the passengers on safety features and the location of lifejackets, the driver carried out routine pre-launching checks, including the operation of lights and horn, and set the VHF radio to emergency channel 16. He raised the steel visor in front of the road engine radiator, ensured that the telltale antenna was above the hood, and heard the characteristic click when the visor became engaged in the closed position. He also noticed that the compressed air visor raising system showed the correct operating pressure.

At about 0950, the vehicle was driven down the ramp and entered the water. The front engine was kept running in neutral after the inboard/outboard motor at the rear was started, and the waterborne part of the tour began. The weather was fine and clear with little wind, and the water was calm. The vehicle was steered to the Ottawa side of the river at the normal speed of approximately 10 km/h and then at slower speeds to the various points of interest so that passengers could take photographs.

After approximately 30 minutes, when the vehicle was in midstream and approaching the Rideau Falls, the driver switched on two bilge pumps as a routine measure to pump out any accumulation of bilge water and observed some water flowing from the discharge pipes on each side of the vehicle. The vehicle's speed was gradually reduced until it was stopped opposite the Rideau Falls while passengers took more photographs. Shortly thereafter, the vehicle was turned upstream to return to the ramp at the Hull Marina. The driver suddenly noticed that the vehicle was floating deeper than usual and that the tops of the sponsons were nearly submerged.

The driver switched on all four bilge pumps and turned the vehicle toward the Ottawa shore, which was closer and out of the main downstream current. He also told the tour guide to instruct the passengers to don lifejackets. As the vehicle approached the river bank, he noticed that the sponsons were more clear of the water. Shortly thereafter, however, he also noticed water approximately 50 mm deep near his feet. He called the dispatcher at the ticket kiosk by cell phone to inform the company of the situation and was advised to call the OM for advice.

The driver then broadcast a message on emergency channel 16 stating that the *Lady Duck*, with eight passengers on board, was just below the MacDonald-Cartier Bridge on the Ottawa side of the river and required immediate assistance because it was taking on water.

A response was promptly received from the pleasure craft *Scotch Mist*, which was about to leave the Hull Marina and would be on scene within two to three minutes. The emergency

message broadcast was also received by a Royal Canadian Mounted Police (RCMP) patrol craft and a Canadian Coast Guard (CCG) boat (rigid hull inflatable, 17-foot Zodiac Hurricane, GCU-480) that were in the area monitoring a waterborne racing event.

When the *Scotch Mist* arrived on scene at about 1030, the *Lady Duck* was approximately 6 m from the river bank and some 300 m east of the MacDonald-Cartier Bridge. As the *Scotch Mist* approached the *Lady Duck*, the vehicle was seen to be upright (without visible heel) but floating much deeper in the water at the driver's end (forward end).

At the request of the driver, four passengers were transferred to the *Scotch Mist*. Shortly afterward, the remaining four passengers and the tour guide were taken on board the RCMP patrol craft when it arrived on scene. The driver remained on board the *Lady Duck* while all of the passengers were transported to the Hull Marina, where they boarded another tour bus and returned to Ottawa.

The tour company president, having been alerted while he was in the company garage in Hull, drove to the Hull Marina and was transported to the scene by the RCMP patrol craft as it returned to render further assistance. The OM drove a company truck from Hull to Ottawa and arrived on scene at approximately 1040 to find the *Lady Duck* some 300 m east of MacDonald-Cartier Bridge. The vehicle was near the river bank and was facing downstream with the right- hand wheels touching bottom. The bilge pumps were seen to be discharging water on both sides of the partially flooded vehicle.

The company president and the OM joined the driver on board. When the source of the ingress of water could not be found, it was decided to take the vehicle as quickly as possible to a disused ramp near the Ottawa Rowing Club, where the vehicle could be driven out of the water (Appendix A). While the vehicle was manoeuvring near the river bank and turning to head upstream toward the ramp, the steering linkage of the inboard/outboard motor was damaged, and both it and the front wheels became jammed in the full left turn position.

The driver was then instructed to go ashore and drive the OM's truck to the company garage in Hull and return with ropes and other gear that might be needed in the recovery of the vehicle at the disused ramp. The OM took over the controls and continued to manoeuvre slowly upstream while keeping the vehicle close to the river bank.

When GCU-480 arrived on scene, it was positioned on the left-hand side, between the *Lady Duck* and the river bank. At about 1055, it began pushing the partially flooded vehicle upstream. As it approached the ramp, the *Lady Duck* was floating deeper in the water due to the further accumulation of water in the forward end of the hull. The company president boarded GCU-480 while the OM remained at the controls.

When close to the ramp, GCU-480 was disengaged to enable the *Lady Duck* to make the left turn necessary to align the vehicle with the centreline of the ramp. However, because the damaged steering controls and the marked forward trim made manoeuvring difficult, the final approach was not directly in line with the ramp's central axis. The front right wheel became grounded on the left edge of the ramp, with the vehicle aligned some 45° to the left of the ramp axis.

The grounding effect at the front wheel slightly raised the right side of the vehicle, and floodwater in the hull surged and gravitated to the left. This transfer of weight caused the

vehicle to suddenly heel to the left and ship water over that side. The OM quickly abandoned the vehicle before it downflooded, capsized, and sank alongside the ramp in 5.5 m of water. The vehicle finally came to rest on the river bottom at approximately 1110, lying on its right side, with the front end nearest the shore.

The driver returned to the scene shortly afterward and was informed that the vehicle had sunk while attempting to mount the ramp. He was advised to seek dry clothes and to go off duty because his services would not be required during the recovery operation.

At the scene, GCU-480 reported the sinking incident to the CCG's Marine Rescue Sub-Centre (MRSC) Québec, which in turn informed the CCG's Marine Communications and Traffic Services (MCTS) Québec. MCTS Québec then relayed the incident report to Environment Canada (EC) in Montréal. EC personnel traced the identity of the owner through motor vehicle licensing and registration records and contacted the owner. After further confirmation, EC personnel arrived on site at about 1825 to ensure that appropriate pollution control measures were taken throughout the recovery operation.

The vehicle was hauled upright on the river bottom before being pulled out of the river by a towtruck at about 2310. Minor quantities of gasoline fuel and engine lubricants escaped from the submerged vehicle; reportedly, the environmental pollution was insignificant. The vehicle was hauled ashore and drained of floodwater before being towed from the scene shortly before 2400, arriving at the owner's premises in St. Isidore, Ontario, at about 0230 on 01 July 2001.

Injuries to Persons

No injuries were reported by passengers, crew, or other company personnel.

Driver Certification

The driver in charge of the vehicle at the time of the occurrence held a passenger vehicle road licence and a marine Masters Limited Certificate (up to 60 in gross tonnage [GT]), a Restricted Engineer Certificate, and a Restricted Radio Operators Certificate, all of which were valid at the time of the occurrence.

Driver Training

Before entering the tour service, drivers receive a total of some 25 or 30 hours of on-the-water instruction on board this and two larger amphibious passenger vehicles operated by the company. The training on board the *Lady Duck* includes familiarization with various vehicle controls and operational procedures when raising and lowering the watertight visor at the front of the vehicle. Drivers practise and become familiar with the manoeuvring characteristics of the vehicles, with particular attention to entering and leaving the water by way of the ramp at the Hull Marina. The training addresses the location and operation of road and marine operating signal lights, horn, public address system, VHF radio, bilge pumps, fire extinguishers, and the stowage of lifejackets, etc.

Training for routine preparation of the *Lady Duck* calls for drivers to check that the forward and after engine fuel and other fluids are at operating levels and that all other systems are operational before beginning passenger service. All instruction is given verbally; particular

attention is paid to ensuring that the vehicle is kept free of any significant accumulation of bilge water. The instructions call for all bilge drain valves to be fully opened when the vehicle is returned to the company garage in Hull at the end of each day's operations and for these valves to be closed before the vehicle is returned to passenger-carrying service the following day.

Training for routine in-service operation also calls for drivers to check the operation of the bilge pumps while afloat, as well as the operation and securing of the bilge drain valves when the vehicle is ashore and parked between road tours.

Vehicle Licensing and Inspection

As an amphibious vehicle of less than 5 in GT carrying not more than 12 passengers, the *Lady Duck* is not subject to compliance with the *Hull Construction Regulations* or the *Hull Inspection Regulations* made pursuant to the *Canada Shipping Act*.

The *Lady Duck* is an amphibious passenger vehicle with a valid provincial automobile licence for highway operation and is explicitly excluded from the marine licensing requirements of Part I of the *Small Vessel Regulations* (SVR). However, the vehicle is required to comply with the life-saving, safety, and navigation equipment requirements of Part IV of the SVR. Such compliance is the responsibility of the owner; when waterborne, the vehicle is subject to random inspection.

The Interim Passenger Vessel Compliance Program came into effect in June 1999. The related *Ship Safety Bulletin* (SSB), 11/99, announced that the inspection threshold for vessels carrying not more than 12 passengers would be raised in October 1999 from 5 in GT to 15 in GT. In April 2001, SSB 04/2001 re-introduced the Interim Small Passenger Vessel Compliance Program (ISPVCP) and extended its expiry date to 31 December 2002. As a waterborne passenger vehicle of less than 15 in GT carrying not more than 12 passengers and completed in the spring of 2001, the *Lady Duck* is subject to the safety requirements of the ISPVCP in accordance with SSB 04/2001. Under the related Small Vessel Monitoring and Inspection Program (SVMIP), the vehicle is required

1. to have a First Inspection and receive a "Notice of Survey";
2. to have an "Annual Seaworthiness Information Report" completed annually by the owner;
3. to be subject to random inspection and compliance monitoring by a Marine Safety Inspector, whereby a "Letter of Compliance" will be issued; and
4. to be approved by Transport Canada Marine Safety (TCMS) and subject to inspection during construction.

The owner had limited knowledge of marine regulatory requirements, standards, and inspection procedures. He did not forward details of the vehicle to TCMS seeking a First Inspection in accordance with the ISPVCP, nor did he request a voluntary safety audit. Consequently, the vehicle was not inspected by TCMS before entering passenger-carrying service.

After the occurrence, TCMS issued a Detention Order on 03 July 2001, curtailing operation of the vehicle until applicable safety requirements and standards were met.

Under the aegis of the ISPVCP, TCMS began a First Inspection in accordance with the SVMIP on 03 July 2001. A copy of the related SSB, 04/2001, was also passed to the owner at this time. This SSB included details of applicable standards, safety requirements, and inspection compliance regimes.

First Inspection safety equipment requirements, including trim and stability assessments, were completed by and to the satisfaction of TCMS. The Detention Order was rescinded 20 July 2001, and the *Lady Duck* resumed passenger-carrying operations shortly thereafter.

Life-saving and Safety Equipment Requirements

Part IV of the SVR calls for vessels more than 8 m long to be equipped with the following:

1. one approved lifejacket for each person on board;
2. one approved 762-mm diameter lifebuoy with not less than 9 m of rope attached;
3. one bailer and one manual handpump;
4. 12 approved pyrotechnic distress signals;
5. one anchor with not less than 15 m of cable, rope, or chain; and
6. one Class B II fire extinguisher.

The vessel must also be fitted with navigation lights and sound signalling appliances in compliance with the *Regulations for the Prevention of Collisions* (COLREGS).

At the time of the occurrence, the *Lady Duck* complied with items 1, 4, and 6 and with the requirements of the COLREGS. The vehicle was also equipped with four electrically powered bilge pumps and 12 additional approved personal flotation devices.

After the occurrence and during the SVMIP First Inspection, TCMS called for the provision of equipment to comply with items 2, 3, and 5 and for electrically powered pumps in the engine compartments at either end of the vehicle.

On completion of the First Inspection on 20 July 2001, the augmented outfit of safety equipment on board the vehicle was in compliance with SVR requirements and was to the satisfaction of TCMS.

Incident Reporting and Response

Once the flooding of the hull was noticed, the driver broadcast the emergency situation on VHF emergency channel 16. The prompt response of the *Scotch Mist* and an RCMP patrol boat ensured that the passengers were safely evacuated within six minutes of the emergency broadcast, before efforts to drive the partially flooded vehicle ashore.

The emergency broadcast on channel 16 was received by the RCMP patrol craft and by GCU-480, both of which were in the area monitoring a marine racing event being held that day in the NCR. Both craft responded and rendered assistance in the evacuation of passengers and in the attempted recovery of the partially flooded vehicle. No CCG shore radio station monitored the transmission on channel 16.

At the scene, GCU-480 reported the sinking incident to MRSC, which in turn informed MCTS. MCTS Québec, then relayed the incident report to EC in Montréal and to the TSB office in Sainte-Foy, Quebec.

The owner did not report the occurrence and sinking to any marine regulatory, emergency response, or highway licensing authority.

Flooding and Sinking Sequence

After being stopped for several minutes while the passengers took photographs, the *Lady Duck* was again under way when the driver noticed that the sponsons were lower in the water than usual. The driver switched on all four bilge pumps, and shortly afterwards, as the vehicle approached the shore, the sponsons were seen to have risen clearer of the surface.

When heading toward the river bank, the forward trim did not change perceptively; however, it was noted that the front end of the vehicle was floating lower than normal. While the *Lady Duck* was stopped to evacuate the passengers, the vehicle once again began to settle deeper in the water.

When the vehicle was stopped or moving slowly ahead, there was a loss or reduction of the venturi suction effect of the water flowing by the ends of the open bilge drain valves. This resulted in an increased rate of flooding as more water entered the open seacocks and flowed past the secondary (but ineffective) swing-check valves.

The bilge pumps stemmed the inflow and reduced the total accumulation of floodwater while the vehicle was under way. However, the bilge pumps—located near the vehicle's midlength—could not discharge the floodwater that accumulated in the forward end of the trimmed vehicle because this water was below the level of the pumps' suctions (Figure 2). While stationary or being slowly manoeuvred along the river bank toward the disused ramp, the vehicle continued to trim more by the front and to settle deeper in the water.

As attempts were being made to drive the *Lady Duck* out of the water, the front right wheel of the partially flooded vehicle grounded on the left edge of the ramp. The forward momentum and the grounding effect slightly raised the front right side of the vehicle, and the floodwater in the hull surged to the left side. This transfer of weight caused the vehicle to heel to the left and ship more water over that side. The additional shipped water downflooded into the hull and caused the *Lady Duck* to suddenly capsize and sink.

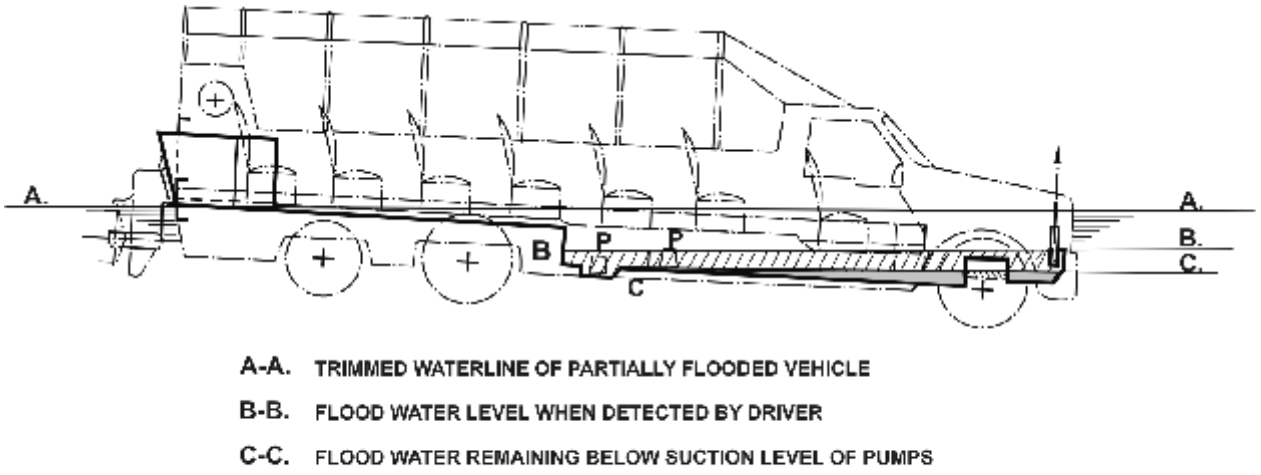


Figure 2. Trim of Partially Flooded Vehicle

Vehicle Condition on Recovery

When the vehicle was recovered from the river bottom, the front radiator visor was in the raised position with its telltale rod fully exposed above the closed hood.

After the vehicle was hauled completely ashore, floodwater flowed freely from the five bilge drainage valves, all of which were found in the fully open position.

A welded through-hull connection in the front engine exhaust system was fractured, allowing minor seepage of water into the hull.

The front engine was running when the vehicle sank and incurred extensive mechanical and electrical damage due to water ingestion.

The passenger boarding ramp at the rear of the vehicle was in the raised position and fully seated in the watertight gasket surrounding the access opening to the passenger deck.

The inboard/outboard drive unit and the front wheels were jammed in the full left turn position due to damage to the linkage of their combined steering system.

The hooked inner end of the hood front-release cable was bent open and was detached from the hood release lever. The loose release cable and its pull button were inaccessible from outside the vehicle because they had been lifted above the top of the front grill by the raised visor. The hood was subsequently opened from inside the driver's cab by means of the hood release mechanism originally supplied with the basic chassis.

The front right and left side panels of the vehicle were buckled, and a front headlight was broken due to bottom impact or damage incurred during recovery operations.

Several miscellaneous loose items of equipment, including the vehicle logbook, reportedly floated free while the *Lady Duck* was submerged and were not recovered.

Watertight Integrity Assessment

Post-occurrence inspections and tests to assess the watertight integrity of the hull were carried out by the TSB and TCMS. Related trim and intact transverse stability assessments of the vehicle were conducted by TCMS under the aegis of the ISPVCP and witnessed by the TSB.

Before conducting flotation tests, the bilge drainage seacocks and the swing-check valves were inspected and found to be correctly aligned and free of any mechanical damage or excessive wear. When the vehicle was returned to land after being afloat for 45 minutes with all the seacocks closed, the lowest seacock was opened and some 24 L of water were drained from the hull.

Tests with the seacocks left open (as at the time of the occurrence) showed that water flowed freely past the swing-check valves installed inboard of the seacocks. These valves were especially installed as a precautionary measure in case of seacock failure. However, the tests showed that they reduced but did not prevent the ingress of water while the vehicle was under way. Furthermore, the inflow of water into the hull was virtually unimpeded when the vehicle was stationary. This latter part of the test was curtailed after approximately six minutes. When the vehicle was driven ashore, the accumulated floodwater in the hull was seen to drain freely from all five seacocks for approximately seven minutes.

With the vehicle on land, the swing-check valves were tested to a pressure head of 1.67 m, which was three times greater than that experienced when afloat in normal service. However, water flowed freely past the valves at this higher pressure head, further confirming that their installation was ineffective in preventing water from entering the hull in the event of the nonclosure or failure of the seacocks.

To further ensure the watertight integrity of the hull during the TCMS assessment of the vehicle's trim and intact transverse stability characteristics, all five seacocks were secured and their outboard ends closed with screwed metal plugs. Removal of the screwed plugs and opening of the seacocks on completion of the tests showed that no water had entered the hull during the one and a half hours the vehicle was afloat. Consequently, the owner adopted the installation of screwed plugs in the outboard ends of all seacocks as future routine operating practice.

Before the vehicle returned to service, the owner established a formal vehicle preparation and handover system. Under this system, all drivers must complete a document to record vehicle status, the number of passengers on board, and the closure of all seacocks.

To prevent water from entering the hull due to inadvertent operation or malfunction of the visor, the visor's operating mechanism was disconnected and the visor bolted in the raised position. Combustion and cooling air supply requirements of the newly installed replacement engine now allow routine tour operation of the vehicle on land and when afloat with the visor in the fully raised position. Consequently, the unbolting and the lowering of the visor is required only when the vehicle is to be driven for long distances and not while engaged in routine tourist operation.

Trim and Stability Assessment

Assessment of the trim and intact transverse stability characteristics of the vehicle was carried out afloat with four test personnel, one driver, and 25 bags of road salt on board. The total test weight was similar to the total weight of a full in-service load of passengers and crew and was arranged symmetrically in the passenger seats on either side of the vehicle.

In the simulated static loading condition, the vehicle was virtually upright, trimmed 250 mm by the after end, and had a mean draught to the bottom of the road drive wheels of approximately 0.84 m. The effective freeboard at the after end was 0.6 m, approximately 0.52 m abreast the window at the driver's position, and 0.48 m to the top of the raised visor at the front of the vehicle. The tops of the sponsons at the after end of the vehicle were just clear of the water.

While under way at near service speed, the vehicle settled deeper in the water and trimmed slightly more by the after end, such that the rear 2.25 m of the sponsons became immersed. At this speed, a bow wave some 150 mm high was created in front of the raised visor, and the vehicle heeled approximately 1.5° when turning sharply to the left or right.

When all of the salt bags and test personnel were positioned as far to each side of the passenger deck as was possible, the vehicle heeled 3.5°, the after 2.75 m of the sponsons on the lower sides were immersed, and the effective freeboards on those sides were reduced by some 70 mm.

No accumulation of bilge water was found in the hull when the screw plugs were removed and the seacocks opened after the vehicle was driven out of the water.

On completion of the inspections and the tests, TCMS considered the watertight integrity, effective freeboards, trim, and statical intact transverse stability characteristics to be satisfactory in meeting SVMIP First Inspection requirements and in addressing these subjects as noted in the Detention Order of 03 July 2001.

Analysis

Operating Practices

Company operating practices were such that various drivers were assigned to a vehicle, and the daily preparation and in-service handover procedures were not formally monitored or recorded. The vehicle service personnel would verbally accept completion of these routine safety-related functions and did not have a documented checklist.

Training and instruction in vehicle in-service operation was hands-on and verbal. Standard operating instructions or emergency procedures were neither documented and maintained ashore, nor provided on the vehicles to guide the drivers.

The vehicle's design necessitated closure of the seacocks for safe waterborne passenger service. However, their routine operation and closure solely depended on the drivers' diligence and was not formally monitored or recorded at the start of daily operation or while the vehicle was parked between tours. Had a documented in-service checking system been in place, the main

safety defence against accidental or inadvertent ingress of water would not have been lost.

Relying solely on the verbal sharing of essential safety-related operating information among the Hull garage, the driver, and the company kiosk in Ottawa contributed to the vehicle beginning passenger-carrying service with all seacocks open.

Emergency Response

Because there was no formal emergency preparedness or response plan, the driver was unsure of the company department that should be informed first of the emergency situation. Company operational personnel in the Hull garage were contacted only after the initial cell phone call to the ticket kiosk in Ottawa. They subsequently arrived on scene after the safe evacuation of the passengers and in time to conduct the attempted recovery of the partially flooded vehicle.

The fire departments of Ottawa, Hull, and Gatineau are equipped for marine emergency response duties when alerted via a 911 telephone call; however, the tour company and the driver were unaware of this marine-related service.

The CCG is responsible for providing marine search-and-rescue (SAR) services, as shown in a diagram in the *National SAR Manual*. In considering the need for SAR resources in the Ottawa River, CCG assessed in its SAR planning exercise that there was no demonstrable evidence that dedicated government SAR resources should be established in the area. However, the CCG has historically provided SAR services up to the Portage Bridge (at Ottawa/Hull) by coordinating the provision of CCG auxiliary resources.

These auxiliary craft only monitor emergency VHF channel 16 intermittently. In accordance with the SAR plan, directional VHF antenna coverage of MCTS in Prescott, Ontario, and in Montréal does not extend to the NCR. Hence, a vessel issuing a distress Mayday on channel 16 must rely on local private, commercial, or auxiliary vessels that may or may not be monitoring the frequency, rather than having the call monitored directly by the MCTS, which has a direct line to the Rescue Coordination Centre, which can quickly dispatch necessary resources.

In this occurrence, the emergency response from a private vessel and an RCMP craft was prompt, as was the assistance and the subsequent reporting of the sinking by GCU-480. However, of the numerous private and commercial craft in the area, only one responded to the emergency. Furthermore, the presence of the RCMP boat and GCU-480 was fortuitous: they were on temporary assignment to the NCR, monitoring a marine racing event scheduled that day.

Vehicle Inspection

The owner/builder has previously constructed and now operates two other amphibious passenger vehicles that, because of their larger size and greater passenger-carrying capacity, were inspected and accepted by TCMS. During the building and inspection of these vehicles, the owner gained some limited knowledge and experience of marine regulatory requirements and procedures.

The owner/builder did not notify TCMS of the start of construction of the *Lady Duck*. Throughout the construction period and until after the vehicle sank, the owner was unaware

that TCMS published SSBs addressing standards, safety requirements, and inspection and compliance programs applicable to small passenger vessels. Consequently, the owner/builder did not request copies of the applicable SSBs or seek inclusion in the TCMS mailing list for the routine distribution of such publications.

Because TCMS was not notified of the start of construction, and no requests were received for SSBs or inclusion in the SSB distribution list, copies of these documents were not forwarded to the owner/builder. Consequently, a First Inspection was not carried out before the amphibious vehicle entered passenger-carrying service.

Safe operation, seaworthiness, and compliance with applicable regulatory requirements and appropriate standards are the responsibility of every vessel owner/operator. Consequently, while the *Lady Duck* may not be described as a "vessel", it is a commercially operated passenger-carrying waterborne craft and, as such, passenger safety requirements of vessel-related regulations and programs are appropriate.

Had a First Inspection been carried out by TCMS before the *Lady Duck* entered service, shortcomings in the outfit of safety equipment, pumping, and firefighting arrangements found after the sinking and noted in the Detention Order would have been identified. In particular, routine hose pressure head tests of the bilge drainage valve system would have shown how ineffective the swing-check valves were in preventing the entry of water in the event of nonclosure or failure of the seacocks. The tests would have dispelled any reliance on this system as a secondary precautionary measure to ensure the watertight integrity of the vehicle. They would also have highlighted the necessity for increased emphasis on the monitoring of seacock operating procedures.

Findings as to Causes and Contributing Factors

1. The initial ingress of water was due to the open bilge drainage seacocks and the failure of the swing-check nonreturn valves to function as a back-up.

2. The bilge pumps' location near the midlength of the vehicle precluded the discharge of floodwater that accumulated at the forward end of the trimmed vehicle.

3. When the vehicle proceeded at slower speeds or was stopped, the rate of flooding increased due to the reduction or loss of venturi suction effect at the ends of the open seacocks.

4. As the vehicle was being driven ashore, grounding effects raised the right side of the partially flooded hull and caused floodwater to gravitate to the left and increase the angle of heel. More water was shipped over the left side, downflooded into the hull, and caused the vehicle to suddenly capsize and sink.

5. There was no formal system to monitor and record the closure of seacocks before the vehicle began its first scheduled tour of the day.

Findings as to Risk

1. The builder did not forward notice of the start or completion of the vehicle's construction to Transport Canada Marine Safety (TCMS) to seek a First Inspection in accordance with *Ship Safety Bulletin* 04/2001. The vehicle was not inspected by TCMS before it entered passenger-carrying operation.

2. The builder did not request copies of ship safety bulletins addressing regulatory and safety requirements, standards, and inspection programs for small passenger vessels. Neither did he seek inclusion on the list maintained by TCMS for the routine distribution of such publications.

3. There was no formal system to check and record the completion of routine vehicle preparation procedures before starting or during daily operation.

4. Consistent with the Canadian Coast Guard's (CCG) Search and Rescue (SAR) plan, directional VHF antenna coverage of Marine Communications and Traffic Services in Prescott and in Montréal does not extend to the National Capital Region. SAR response is limited to two CCG auxiliary craft— and any other private or commercial craft in the area—that only monitor emergency channel 16 intermittently.

Other Findings

1. The owner did not report the occurrence to any regulatory, licensing, or emergency response authority.

2. The incorporation of externally mounted, hand-operated seacocks in lieu of conventional screwed drainage plugs was for operational convenience.

3. Because the vehicle is less than 5 in gross tonnage and carries not more than 12 passengers, it was not subject to the requirements of the *Hull Construction Regulations* and the *Hull Inspection Regulations.*

4. The vehicle was required to comply with the applicable sections of the *Small Vessel Regulations* and the Interim Small Passenger Vessel Compliance Program.

5. The presence of the Royal Canadian Mounted Police boat and GCU-480 at the time of the occurrence was fortuitous.

6. The company had no formal emergency contingency plan, nor was the vehicle driver aware of the marine emergency response available by contacting local fire departments through 911.

Safety Action

Action Taken

Transport Canada

- Transport Canada Marine Safety (TCMS) began a First Inspection in accordance with the Small Vessel Monitoring and Inspection Program on 03 July 2001. After the safety equipment deficiencies were satisfactorily addressed, TCMS rescinded the previously issued detention order on 20 July 2001.

- A copy of *Ship Safety Bulletin* 04/2001 was given to the owner of the *Lady Duck*. This bulletin included details of applicable standards, safety requirements, and inspection compliance requirements.

- The installation of screwed plugs in the outboard ends of all seacocks, fitted during the TCMS assessment of the vehicle's trim and intact transverse stability characteristics, was adopted by the owner as a future operating practice.

- Electrically driven pumps were installed in engine compartments at either end of the vehicle.

- The *Ship Station (Radio) Regulations, 1999*, is in the amendment process. These regulations prescribe the radio equipment to be carried by commercial vessels for distress, urgent, safety, and general communications. Passenger ships engaged on a voyage, any part of which is outside a VHF coverage area, will be required to be equipped with radio equipment capable of establishing continuous two-way communications with a Marine Communications and Traffic Services (MCTS) centre or a person ashore. The targeted date for pre-publishing in *Canada Gazette*, Part I, is autumn 2002.

Vehicle Owner

- The owner of the *Lady Duck* has amended company operating practices by mandating the completion of a safety checklist before each departure of the vehicle. Accordingly, the driver must verify the status of the seacocks, sign the safety checklist, and have it countersigned by the guide or the kiosk attendant for retention ashore. The list also includes the number of passengers on board.

- To prevent water from entering the front of the hull through inadvertent operation or malfunction of the vertical sliding visor, the visor is now bolted in the raised position when the vehicle is engaged in routine tourist operation.

Safety Concerns

SAR/MCTS Coverage

The CCG's Search and Rescue (SAR) organization has overall responsibility for administering the national marine SAR program, including the provision of marine emergency channel 16 VHF radio coverage. According to a diagram in the *National SAR Manual*, the National Capital Region (NCR) stretch of the Ottawa River is within the SAR organization's area of responsibility, yet no government SAR resources are located in the NCR or the adjacent area. Vessels in this area rely on two auxiliary units and on local fire and police services.

The NCR is outside the VHF monitoring range of MCTS Prescott and MCTS Montréal. Thus, the local VHF radio monitoring and response services are only provided intermittently by CCG auxiliary craft and by private and other commercial craft in the area. Other services—such as 911 in Ottawa and Hull, cell phones, and other radio frequencies, ex. CBs—are used to report distress. Therefore, there is no official coordination of distress communications.

Tourism is a growing industry in the NCR. In addition to numerous pleasure craft, some 19 tourist vessels, including 4 amphibious vehicles, are currently in operation, representing a significant number of waterborne passengers. With such a number of private vessels, commercial passenger vessels, and amphibious vehicles in the Ottawa/Hull area, it is essential that effective marine SAR monitoring and response resources be available in the event of a marine emergency.

In this occurrence, the presence of the Royal Canadian Mounted Police boat and GCU-480 was fortuitous. While the response of the private vessel was prompt, it was the only one of the numerous private vessels in the area to respond.

The TSB report (M00L0043) of an occurrence in May 2000 involving the loss overboard of a passenger from the *Miss Gatineau* noted that, while local marine rescue services responded quickly, subsequent SAR activities were not well coordinated. The report also found that the lack of access to the CCG SAR marine emergency radio system reduces the probability of an effective and coordinated SAR response in the event of a distress situation.

In May 1999, the Ottawa and Hull 911 services, police departments, and fire departments, along with the Canadian Coast Guard Auxiliary and the CCG, reportedly held a joint meeting. It was suggested, inter alia, that all marine units be equipped with VHF radios to ensure effective communication. The 911 service in Hull also proposed the incorporation of a marine VHF station in their system, but no further action was taken.

The Board is concerned with the effectiveness of current SAR and MCTS coverage within the NCR because MCTS stations do not monitor marine emergency channel 16 VHF radio communications in the NCR stretch of the Ottawa River, and the timely deployment of vessels cannot be coordinated according to the expectation of the CCG SAR plan. The Board encourages the CCG SAR organization to reassess the area plan.

Amphibious Vehicles

As a vessel (amphibious vehicle) under 5 in gross tonnage (GT) carrying fewer than 12 passengers, the *Lady Duck* is not subject to compliance with the *Hull Construction Regulations*, the *Hull Inspection Regulations*, or the *Standards for the Construction and Inspection of Small Passenger Vessels* (TP11717). The *Small Vessel Regulations* define the life-saving appliances required on such small passenger-carrying vessels but do not address buoyancy or stability requirements. TCMS is revising the *Construction Standards for Small Vessels* (TP1332) that are applicable to pleasure craft up to 6 m long and non-pleasure craft up to 15 in GT. The standards incorporate criteria for inherent buoyancy and stability for pleasure craft but not for non-pleasure craft. The Interim Small Passenger Vessel Compliance Program, re-introduced by TCMS in April 2001, addresses the inspection of conventional monohull-type vessels, with safety requirements in accordance with the *Consolidated Regulations* of the *Canada Shipping Act* and the above standards.

Just before the publication of this report, TCMS indicated that owners of these vessels may not be legally required to comply with Transport Canada's Interim Small Passenger Vessel Compliance Program (ISPVCP). It should be noted, however, that the *Lady Duck* was subjected to the ISPVCP at the start of the 2002 season and was issued a Notice of Inspection and Compliance Monitoring for vessels not more than 15 in GT and carrying not more than 12 passengers under the Small Vessel Monitoring and Inspection Program.

In May 1999, 13 of the 20 passengers on board an amphibious vehicle died when it sank in Lake Hamilton, Arkansas. The vehicle was a DUKW-type craft originally built for the transport of military personnel and supplies during World War II and subsequently converted for passenger excursion operation, in accordance with the then-current US Coast Guard (USCG) requirements. As a result of its investigation into the sinking, the National Transportation Safety Board (NTSB) identified several safety issues, including

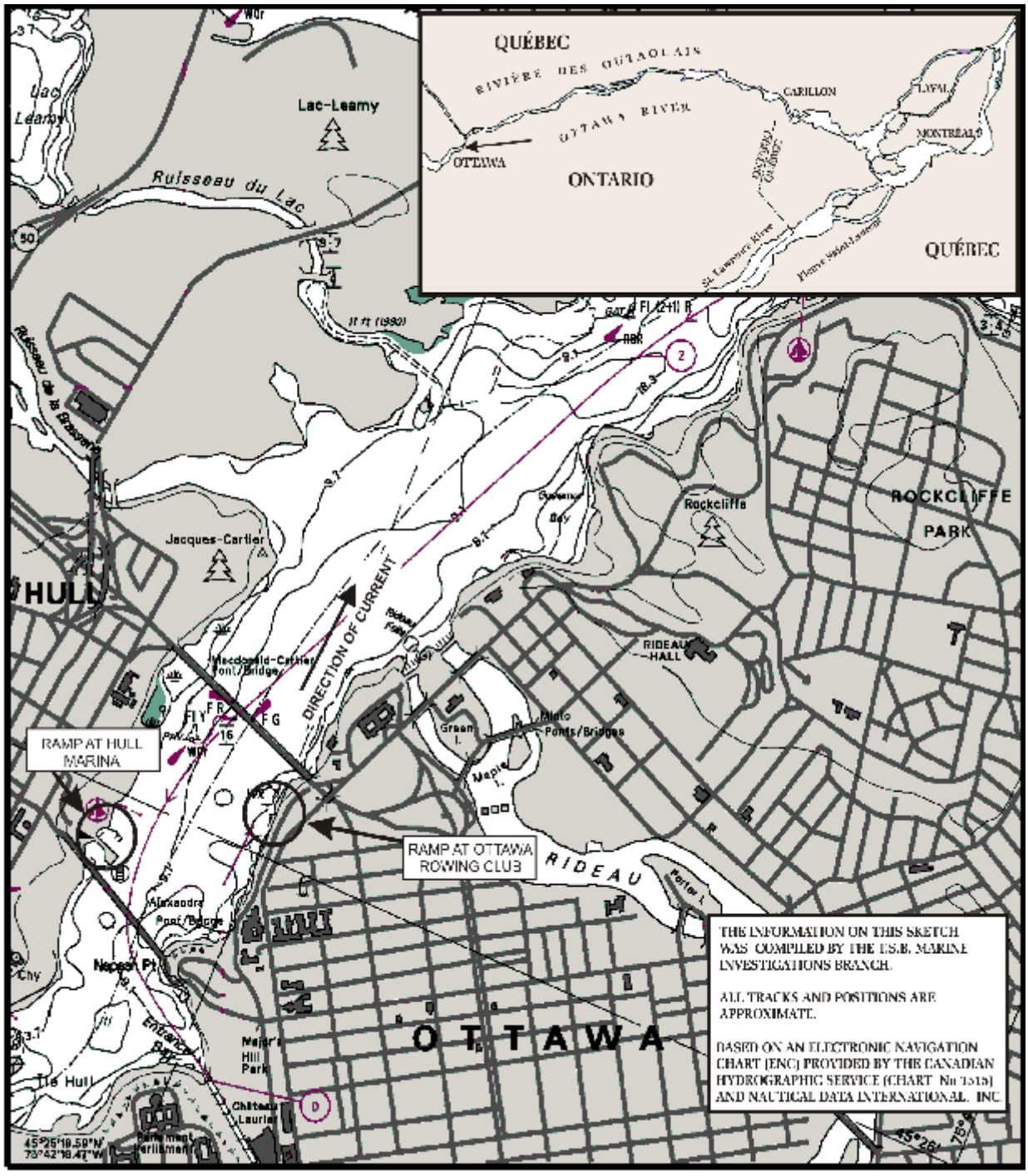
- vehicle maintenance
- USCG inspection standards
- guidance to inspectors and owner-operators
- reserve buoyancy
- vehicle survivability

The NTSB also made a number of safety recommendations to the USCG. Recommendation M-02-01 called for the provision of sufficient reserve buoyancy through passive means, such as built-in flotation, to ensure that the amphibious vehicles remain afloat and upright in the event of flooding. Recommendation M-02-03 required that, until such time as sufficient reserve buoyancy is provided, operators are to ensure that canopies (awnings) do not restrict horizontal or vertical escape by passengers in the event of sinking and that passengers don lifejackets before the vehicle becomes waterborne. USCG *Guidelines for the Certification of DUKW Amphibious Vehicles* (NVIC 1-01) was also issued to disseminate information on good marine practice in the inspection, operation, and repair of these amphibious vehicles to USCG marine inspectors, vehicle owners, operators, and repair facilities.

The Board (TSB) is concerned that the safety of Canadian waterborne passengers is also at risk because current regulatory requirements (*Canada Shipping Act* and regulations), standards, and guidelines for ship inspectors and owners are complex and not fully compatible with each other and do not specifically address the unique operating characteristics of amphibious vehicles.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 08 July 2002.

Appendix A: Sketch of Occurrence Area



Appendix B: Glossary

CCG	Canadian Coast Guard
COLREGS	*Regulations for the Prevention of Collisions*
EC	Environment Canada
G/h	gallons per hour
GT	gross tonnage
ISPVCP	Interim Small Passenger Vessel Compliance Program
km/h	kilometres per hour
L	litres
L/min	litres per minute
m	metres
mm	millimetres
MRSC	Marine Rescue Sub-Centre
MCTS	Marine Communications and Traffic Services
NCR	National Capital Region
NTSB	(US) National Transportation Safety Board
OM	operations and maintenance manager
RCMP	Royal Canadian Mounted Police
SAR	search and rescue
SSB	*Ship Safety Bulletin*
SVMIP	Small Vessel Monitoring and Inspection Program
SVR	*Small Vessel Regulations*
TCMS	Transport Canada Marine Safety
TSB	Transportation Safety Board of Canada
USCG	United States Coast Guard
VHF	very high frequency
°	degrees