Report 08-209: Loss of the rigid inflatable boat Mugwop,
off the entrance to Lyttelton Harbour, 28 October 2008

Final Report

Marine Inquiry 08-209

Loss of the rigid inflatable boat Mugwop,
off the entrance to Lyttelton Harbour,
28 October 2008

Approved for publication: February 2011

Transport Accident Investigation Commission

About the Transport Accident Investigation Commission

The Transport Accident Investigation Commission (*Commission*) is an independent Crown entity responsible for inquiring into maritime, aviation and rail accidents and incidents for New Zealand, and co-ordinating and co-operating with other accident investigation organisations overseas. The principal purpose of its inquiries is to determine the circumstances and cause of occurrences with a view to avoiding similar occurrences in the future. Its purpose is not to ascribe blame to any person or agency or to pursue (or to assist an agency to pursue) criminal, civil or regulatory action against a person or agency. The Commission carries out its purpose by informing members of the transport sector, both domestically and internationally, of the lessons that can be learnt from transport accidents and incidents.

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Chief Commissioner	John Marshall, QC
Deputy Chief Commissioner	Pauline Winter, QSO
Commissioner	Captain Bryan Wyness

Key Commission personnel

Chief Executive	Lois Hutchinson
Chief Investigator of Accidents	Captain Tim Burfoot
Investigator in Charge	Paul Bird
General Counsel	Rama Rewi
Assessor	Keith Ingram

Email: inquiries@taic.org.nz

Web: www.taic.org.nz

Telephone: + 64 4 473 3112 (24 hrs) or 0800 188 926

Fax: + 64 4 499 1510

Address: Level 16, AXA Centre, 80 The Terrace, PO Box 10 323, Wellington 6143, New Zealand

Important notes

Nature of the final report

This final report has not been prepared for the purpose of supporting any criminal, civil or regulatory action against any person or agency. The Transport Accident Investigation Commission Act 1990 makes this final report inadmissible as evidence in any proceedings with the exception of a Coroner's inquest.

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Citations and referencing

Information derived from interviews during the Commission's inquiry into the occurrence is not cited in this final report. Documents that would normally be accessible to industry participants only and not discoverable under the Official Information Act 1980 have been referenced as footnotes only. Other documents referred to during the Commission's inquiry that are publicly available are cited.

Photographs, diagrams, pictures

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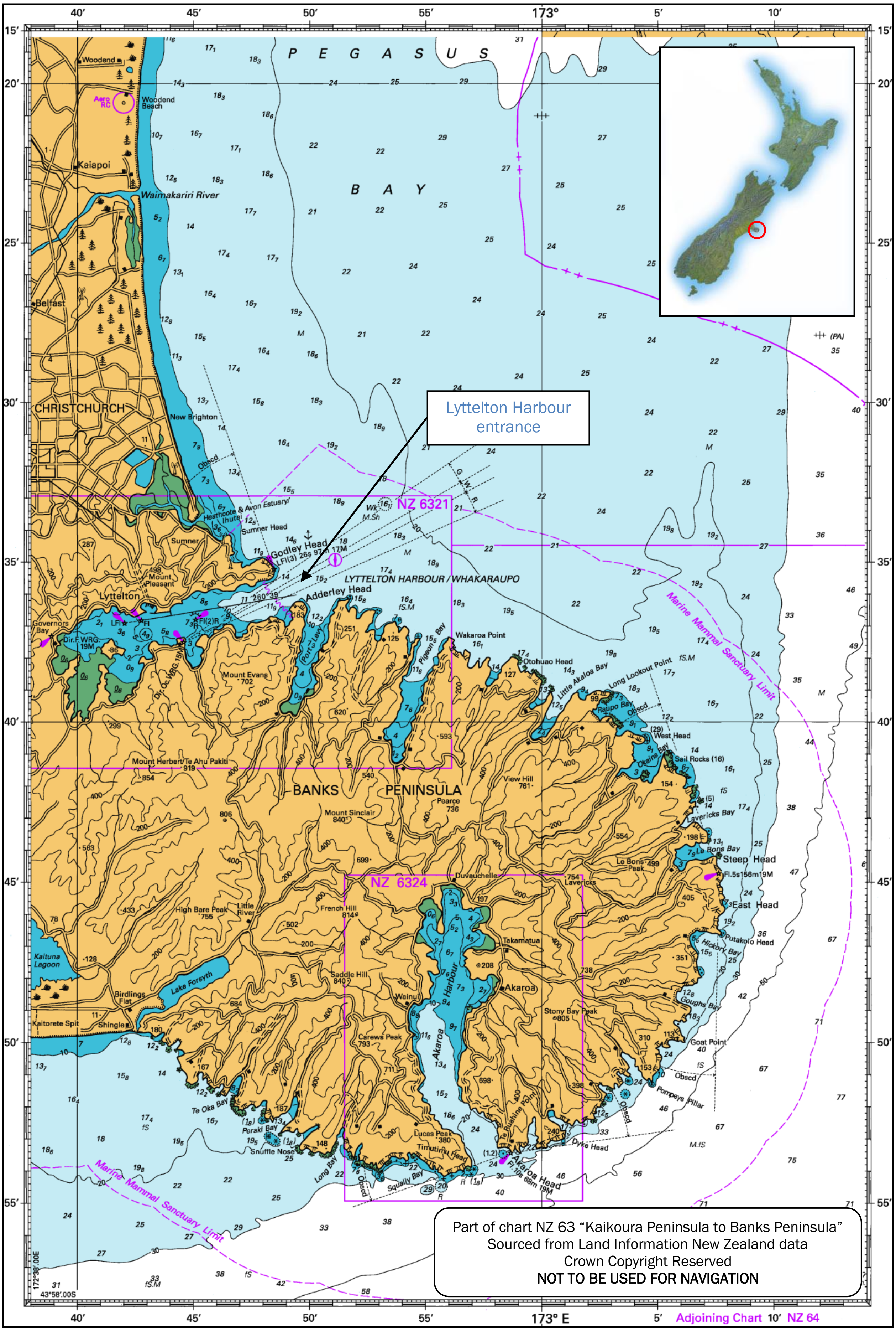
The *Mugwop*



Location of accident

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Abbreviations

Bay Underwater	Bay Underwater Services New Zealand Limited
Commission	Transport Accident Investigation Commission
EPIRB	emergency position Indicating radio beacon
Heron Construction	Heron Construction Company Limited
hp	horsepower
kW	kilowatt(s)
m	metres
mm	millimetres
RIB	rigid inflatable boat
SSM	safe ship management
Survey Nelson	Survey Nelson Limited
t	tonne(s)
UTC	universal co-ordinated time
VHF	very high frequency

Glossary

backhoe dredge	a mechanical apparatus moved on anchors or jack up legs and fitted with a hydraulic excavator
broaching	the unplanned and uncontrolled turning of a vessel so as to present the vessel's broadside to the wind and waves
dredging	the operation of removing material from under water, commonly the excavation is undertaken by specialist floating plant, known as a dredge.
spud	a large pole used to secure a vessel
tender	under Maritime Rule 21.9 (4), safe ship management systems (Government, 2010): a ship that is normally carried aboard a larger ship that operates within communication range of the larger ship— (a) may be considered to be part of the larger ship's equipment; and (b) may have its safe operation covered by the larger ship's documented operating procedures; and (c) need not otherwise comply with section 2.

Data summary

Vessel particulars:

Name:	*Mugwop*
Type:	rigid inflatable boat (RIB)
Class:	non-passenger
Limits:	inshore–restricted to within 5 nautical miles of the coastline.
Length:	5.8 metres (m)
Breadth:	2.2 m including the floatation tubes
Weight:	400 kilograms excluding motor
Built:	1996
Propulsion:	115 horse power (hp) 2-stroke outboard motor
Service speed:	estimated in excess of 70 kilometres per hour (38 knots)
Owner/operator:	Heron Construction Company Limited (Heron Construction)
Port of registry:	Auckland
Crew:	maximum 6
Date and time:	28 October 2008 at approximately 1830[1]
Location:	entrance to Lyttelton Harbour
Persons on board:	crew: 2
Injuries:	crew: 2 fatal
Damage:	boat lost

[1] Times in this report (08-209) are New Zealand Daylight Time (UTC + 13 hours) and are expressed in the 24-hour mode.

1. Executive Summary

1.1. The *Mugwop* was a 5.8 metre outboard-driven rigid inflatable boat (RIB), a tender for the dredge *Machiavelli,* which was working on the Christchurch ocean outfall project in Pegasus Bay off Christchurch. The *Mugwop* was being used to transfer crew twice daily between Christchurch and the various vessels involved in the project.

1.2. On 28 October 2008, the dredge and dive support barge were to seek shelter at the nearby port of Lyttelton from the forecast weather, which had already built up a one to 2 metre sea. The *Mugwop* would have normally been lifted on-board the *Machiavelli* for the trip, but the sea conditions made it too risky, so the *Mugwop* with a crew of 2 set off on the trip to Lyttelton on its own, but never arrived. The bodies of the 2 crew were recovered from the sea near the entrance to Lyttelton Harbour, one 7 hours after the event and the other about 15 days later; the *Mugwop* was never found. Post-mortem results determined that in the absence of any sign of traumatic injury the crew, who were both wearing life jackets, probably became hypothermic and drowned.

1.3. The *Mugwop* is believed to have suffered a rapid and catastrophic event that prevented the crew using any of the equipment on board to raise the alarm. The boat was likely travelling in the same direction as, and faster than, the waves, a circumstance that is known to cause failure of the inflatable pontoons at their weakest point, the bow on that type of craft.

1.4. The *Mugwop* was known to have 3 defects that could have put more pressure on the pontoons at the bow: the hull was leaking and almost certainly contained a significant quantity of water in its void space; the 115 hp outboard motor could not be trimmed to raise the bow; and the securing tag for the pontoons at the bow was not fastened to the hull.

1.5. Neither crew member was qualified to drive the *Mugwop*, nor had they been trained in driving techniques for rigid inflatable craft in heavy seas.

1.6. On 29 October 2008, the day after the accident, Survey Nelson Limited submitted an application to Maritime New Zealand for a safe ship management (SSM) certificate for the *Mugwop*. Included in the information provided was a Fit for Purpose Document for the *Mugwop* to ply as a non-passenger vessel to within 5 nautical miles of the coastline. The *Mugwop* was not fit for purpose because it did not comply with all of the requirements of the Maritime Rules with regard to stability, subdivision of the inflatable pontoons and having a water deflector forward.

1.7. The report discusses the general lack of maritime knowledge and awareness of safe ship management systems at the appropriate level of management with the principal contractors for the project, and how this probably contributed to a number of serious accidents and incidents, and non-compliances with Maritime Rules throughout the project.

1.8. Also discussed is the failure of the safe ship management system, and in particular the failure of the surveying company to ensure the *Mugwop* complied with all Maritime Rules, before being issued with a Fit for Purpose Document.

1.9. Arising out of previous reports, the Transport Accident Commission (Commission) has recommended that the safe ship management system for New Zealand domestic watercraft be reviewed. The Director of Maritime New Zealand has accepted the recommendation and the review has been completed. A draft Maritime Rule to introduce a new safety management system was under consultation at the time this report was published.

1.10. The report also discusses the issue of substance impairment and the need for legislation to regulate the maritime industry to prevent the abuse of substances that impair performance. A previous safety recommendation has already been made to the Secretary for Transport to address that issue.

1.11. New recommendations are made to educate drivers of rigid inflatable craft in driving techniques and limitations in what that type of craft can reasonably achieve in heavy weather operation.

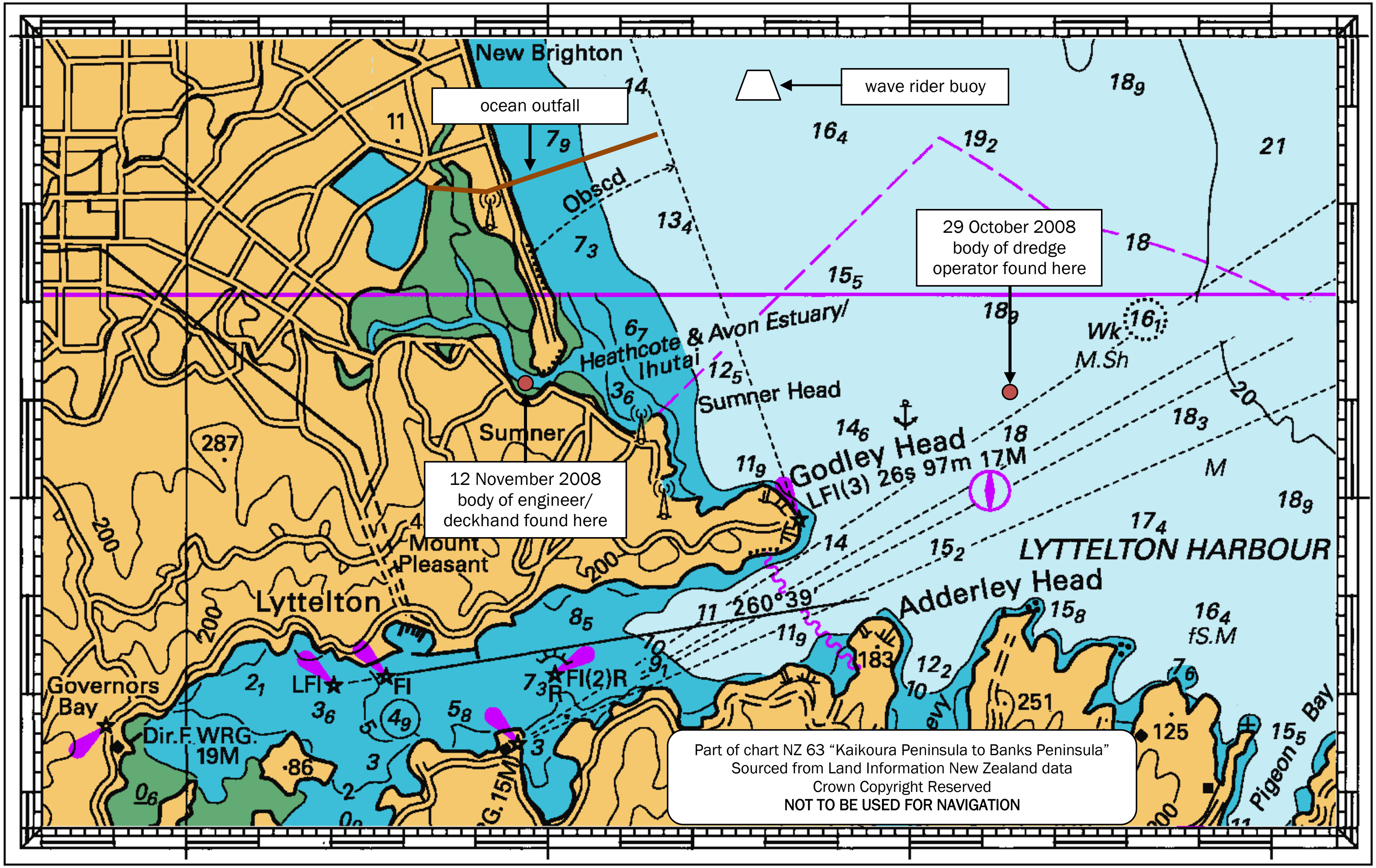

Figure 1
General area of accident

2. Conduct of inquiry

2.1. On 29 October 2008, Maritime New Zealand notified the Commission of the accident involving the RIB *Mugwop* engaged on a sewage ocean outfall project off the coast near Christchurch.

2.2. The circumstances reported were that the *Mugwop* had been returning to Lyttelton Harbour with 2 persons on board and never arrived at its destination. The body of one occupant had been recovered the previous night, but the other occupant and boat were still missing.

2.3. It was also reported that 2 other incidents had occurred the same day involving other vessels engaged on the same project. One involved a barge with 12 persons on board, which separated from its tug near the entrance to Lyttelton Harbour and the other involved the *Mugwop* earlier in the day, when the driver sustained a head injury when the boat dipped heavily into a wave.

2.4. The Commission launched an inquiry into the loss of the *Mugwop* encompassing the 2 other incidents as well.

2.5. On 29 October 2008, the Commission sent 2 investigators to Christchurch to begin the investigation. In the following weeks, the Commission interviewed personnel who had been involved in the events leading up to the *Mugwop* disappearing, as well as management for the various contractors involved in the project, including management for the Christchurch City Council.

2.6. The maintenance history of the *Mugwop* while it was under previous private ownership could not be traced, so the Commission only had access to information for the period since it had been purchased by the contractor who was operating the craft at the time it went missing.

2.7. As the *Mugwop* was a standard production craft, information was able to be sourced from the manufacturer. Surveyors and management from the safe ship management provider for the *Mugwop* were interviewed and the vessel file retrieved.

2.8. As well as conducting its own investigation, Maritime New Zealand conducted a series of audits of all vessels and contractors involved in the project. The results of those audits were provided to the Commission and formed part of the record of inquiry.

2.9. On 15 December 2010, the Commission approved draft final report 08-209 to be sent to 17 interested persons for comment.

2.10. The Commission received submissions from 5 interested parties in response to the draft final report. The submissions were considered and the report amended where necessary in response to the submissions received.

2.11. On 23 February 2011 the Commission approved final report 08-209 for release.

3. Factual information

3.1. Narrative

3.1.1. List and description of vessels and their operators involved in the occurrences of 28 October 2008.

Vessel	Description of vessel	Operator
Mugwop	5.8 m RIB, tender to the dredge *Machiavelli*	Heron Construction
Machiavelli	53 m backhoe dredge	Heron Construction
White Pointer	8.5 m aluminium jet propelled surveying vessel	Heron Construction
Kurutai	23.46 m ocean-going tug	Heron Construction
Waiomana	13.93 m tug/workboat	Bay Underwater Services New Zealand Limited
Flexifloat	Multi-segmented barge, used as a diving platform and work station	McConnell Dowell
Kawau	6.09 m workboat used as a tender for the *Flexifloat*	McConnell Dowell

3.1.2. On 28 October 2008, the dredge *Machiavelli* was digging a trench for one of the outfall pipes for the Christchurch Ocean Outfall project in Pegasus Bay. The tug *Kurutai* was standing by the *Machiavelli.* Between 0545 and 0615, the dredge crew members changed shift and used the *Mugwop* to transfer between the dredge and the Sumner jetty.

3.1.3. At about 1030, the surveyor for Heron Construction took the master of the *Kurutai* to Sumner jetty in the vessel *White Pointer*, where a relieving master was waiting to be taken to the tug. At about 1100, the relieving master boarded the *Kurutai*. The surveyor then used the *White Pointer* to conduct a survey of the trench that was being dug by the *Machiavelli* before taking the tug's engineer and deck-hand to Lyttelton, leaving the master alone on board the tug.

3.1.4. At about 1200, the wind started to increase. At 1300 the wind had increased to 35 knots, so the day-shift dredge supervisor ceased dredging operations, lifted the jack-up legs of the dredge and the *Machiavelli* was moored to its port anchor.

3.1.5. Around the same time, diving operations from the *Flexifloat* barge were suspended and the decision was made to take the *Flexifloat* back to Lyttelton. The tug *Waiomana* was secured into the back of the barge and proceeded to push the barge towards the port. At around 1330, one of 2 securing ropes between the tug and barge parted. A replacement line was secured, but the hook of the hand winch that was used to tension the securing arrangement straightened under load. The master of the tug decided that the sea conditions made it too dangerous to attempt to re-secure the tug to the barge and had one of the *Flexifloat* crew let go one of the barge anchors. Because the barge was close to the shore, the master of the *Waiomana* called the *Kurutai* and the local coastguard for assistance.

3.1.6. At about 1400, the master of the *Kurutai* received the request for assistance. At that time the master was still alone on the tug, so the day-shift supervisor used the *Mugwop* to transfer 2 crew members from the *Machiavelli* to the tug to act as crew, then proceeded towards the anchored *Flexifloat* to assist.

3.1.7. However, en route the *Mugwop* pitched into a wave, throwing the day-shift supervisor forwards; his face hit the metal rail above the steering console. He immediately diverted to Sumner, calling on the night-shift dredge supervisor and the other night-shift crew to come in to take over from him. He phoned the surveyor, who was waiting for the 2 new tug crew members to arrive at Christchurch Airport, to come to Sumner to drive him to a medical centre.

3.1.8. At 1407, the Sumner Coastguard was alerted and tasked to assist the *Flexifloat,* which had 12 persons onboard and was estimated to be about 200 m off Godley Head. At about 1437 the Coastguard vessel *Hamilton Jet Rescue* arrived on the scene and stood by the *Flexifloat* and *Kurutai* as a towline was secured between the 2 vessels

3.1.9. At 1444, the Coastguard reported that the *Kurutai* had the *Flexifloat* under tow and was taking it into Lyttelton Harbour, and the *Hamilton Jet Rescue* stood down and returned to its base. As the tug and barge reached the shelter of the harbour, the *Waiomana* was reattached and resumed pushing the barge to Lyttelton. Once it had released the *Flexifloat*, the *Kurutai* continued into Lyttelton to pick up the 2 new crew members who were waiting there to join the vessel.

3.1.10. The night-shift crew arrived at the *Machiavelli* at about 1630. They decided that the weather was too rough to lift the *Mugwop* out of the water, so they tied the boat to the stern of the dredge.

3.1.11. Once the new crew members were on board the *Kurutai*, it left Lyttelton, returning to stand-by the *Machiavelli*. On arrival the *Kurutai* anchored close to the dredge.

3.1.12. At about 1730, the wind had increased to 55 knots, so the decision was made to tow the *Machiavelli* into the shelter of Lyttelton Harbour. The dredge crew noticed that the wash at the stern of the dredge was likely to cause damage to the *Mugwop*, so they decided that the dredge operator and engineer/deckhand would drive the *Mugwop* into Lyttelton, then arrange for the crew's vehicles to be brought across from Sumner. The *Mugwop* left the dredge between 1820 and 1830, with the night-shift engineer/deckhand driving and the dredge operator in the bow.

3.1.13. At 1841, the supervisor received a call from the dredge operator's mobile phone, but when he answered the call he heard only wind-like noise. When the connection was broken he tried several times to return the call, but without success. He also tried the engineer's mobile phone, but that had been left on board the dredge.

3.1.14. At about 1909, the dredge supervisor telephoned the surveyor to inform him that the *Mugwop* was en route to Lyttelton and that the crew intended to collect the vehicles from Sumner. Knowing that there was no company vehicle at Lyttelton for them to drive to Sumner, the surveyor decided to drive to Lyttelton to meet the *Mugwop* and drive the 2 crewmen to Sumner.

3.1.15. At about 1920, when the surveyor arrived at Lyttelton, he could not see the *Mugwop*, so started to search the wharves around the port. Not finding it anywhere, he decided to take the *White Pointer* to the outer harbour to see if the *Mugwop* had broken down on its way into the port. While he was searching the outer harbour, he saw the *Kurutai* towing the *Machiavelli* coming into the harbour and headed towards them.

3.1.16. There were many cell-phone calls in the next 45 minutes trying, unsuccessfully, to trace the whereabouts of the *Mugwop* and its crew. At 2015 the day-shift dredge supervisor called a member of the Sumner Coastguard, who in turn went to the Coastguard station and alerted them that the *Mugwop* was overdue. The Coastguard was engaged in a training session using its boat, the *Hamilton Jet Rescue*, and was able to start a search immediately. At about the same time the surveyor onboard the *White Pointer* was communicating by very-high-frequency (VHF) radio with the Sumner Coastguard vessel. Sumner Coastguard advised the Police Communication Centre at 2031, and at 2038 the Police advised the Rescue Coordination Centre New Zealand.

3.1.17. An extensive search-and-rescue operation was launched involving Coastguard vessels from Sumner and Lyttelton, the *White Pointer* and the *Kurutai*, and a helicopter and 2 fixed-wing aircraft.

3.1.18. At 0133 on 29 October 2008, about 7 hours after the accident was thought to have occurred, the body of the dredge operator was located by the helicopter about 2.4 nautical miles east of Godley Head in position 43^0 33.89'S 172^0 51.39'E. One of the Coastguard vessels was guided to the position and recovered the body.

3.1.19. Extensive sea, air and land searches continued for the next 4 days, but were disrupted by adverse weather. The *Mugwop* was never found; only 3 fuel containers were recovered that were thought to have come from the vessel, but they did not have any definitive distinguishing marks.

3.1.20. About 15 days after the accident, on 12 November, the body of the engineer/deckhand was found in the Avon–Heathcote Estuary near Redcliffs.

3.1.21. The coronial autopsy report concluded that the cause of death of the dredge operator was immersion and drowning. The report noted that he had no significant external injuries.

3.1.22. Toxicology tests on the dredge operator conducted during the autopsy said that no alcohol was present, but screening tests for the active ingredient of cannabis, tetrahyrocannabinol (THC), were positive and blood tests revealed a concentration of 1.4 micrograms per litre. The test results determined that this indicated that the dredge operator had recently used cannabis, but it was not possible from the results of the tests to determine what effect it may have had on his performance.

3.1.23. The coronial autopsy report on the engineer/deckhand concluded that there were no findings that were not consistent with drowning as a cause of death, but gave the opinion that the cause of death was anatomically unascertained. The same report also said that it had not been possible to conduct toxicology or histology tests owing to the time elapsed before the body was recovered.

3.2. The Christchurch ocean outfall project

3.2.1. The marine section of the Christchurch ocean outfall project was about 2.8 kilometres and involved tunnelling from a treatment station under the estuary to join a seaward pipe segment. The project was put out for expressions of interest, and 5 companies were asked to tender. Owing to the project being partially on land and partially at sea, the tendering companies were often joint ventures or had large elements of sub-contracting. McConnell Dowell won the tender for the pipeline.

3.2.2. McConnell Dowell being the principal contractor brought onboard 3 other main subcontractors to provide diving, dredging and pipe-welding services. In addition, on the maritime side it employed a number of other smaller companies, including vessel owners, on individual contracts to provide specific services or be available for specific parts of the operation. The organisational structure is shown in Figure 2.

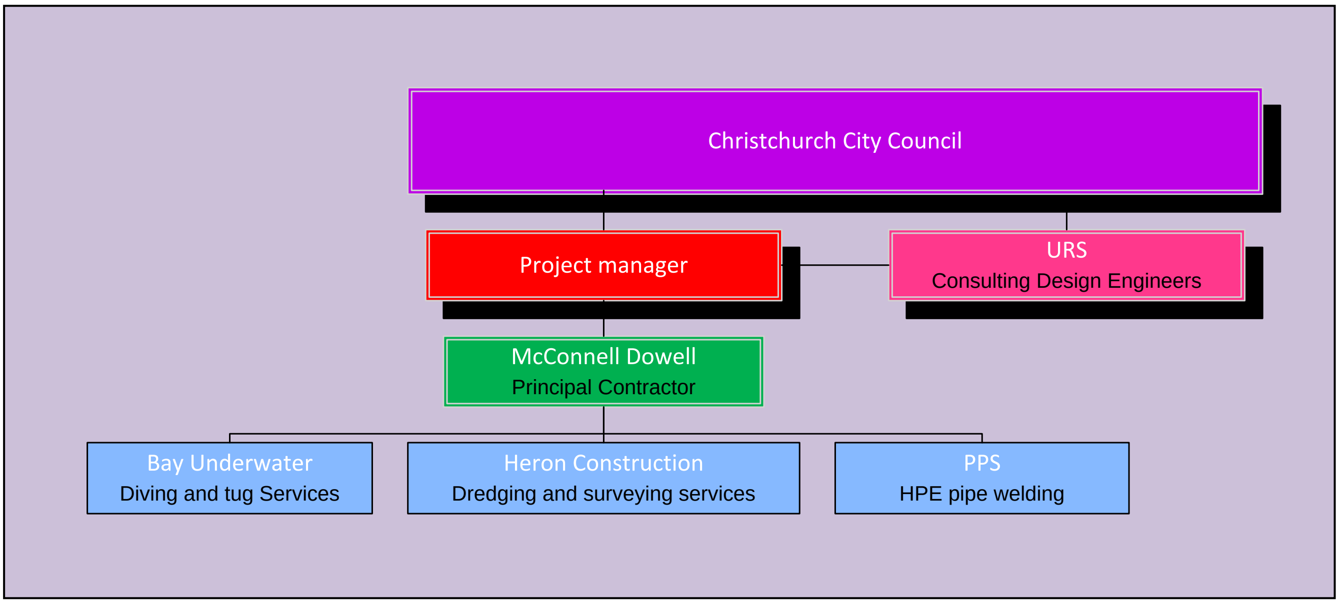

Figure 2
Organisational chart of Christchurch ocean outfall project

3.2.3. As part of the expressions of interest, submitting companies provided generic health and safety plans, which the Council vetted as part of the process. Once the contract was let, the principal contractor in collaboration with the sub-contractors prepared procedures for each specific task, together with risk assessments of the hazards that could be faced on those tasks. These documents took the form of construction execution procedures and job safety environmental analysis, which were living documents that were amended as required throughout the project. Regular safety meetings involving the client, the contractor and the sub-contractors were held at which the general progress of the project was discussed as well as what was expected to occur in the immediate future. Health and safety was a standard item at those meetings, with discussions of both incidents that had occurred since the last meeting and risks in the upcoming operations. In addition, McConnell Dowell conducted safety audits of specific parts of the operation. Following a serious harm accident in December 2007 onboard the tug *Kurutai*, the Council commissioned an independent site safety audit. The audit was carried out in February 2008 and the McConnell Dowell part of the project was found to be compliant.

3.2.4. McConnell Dowell started work on the project in April 2007 with a contractual completion date of September 2008. The land-based part of the project started in April 2007 and involved the use of a tunnelling machine to bore under the estuary and install the pre-formed concrete pipes. That part of the project progressed without any undue delay and the tunnel-boring machine reached the outer limit of the tunnel, which was about 500 m from the shore and to seaward of the breaker line, on time and within budget. The work site for the shore-based tunnelling was disestablished in August 2008.

3.2.5. The marine section of the project began in December 2007. This involved preparing the heavy-density polyethylene pipes. The individual sections of pipe were to be welded together into a 360 m long pipe string, which then had the associated concrete anchor blocks attached at intervals along its length. The *Machiavelli* started digging the trench in December 2008, and once a section of trench had been dug, a section of pipe was towed out to the site where it was sunk into position. The last operation required multiple vessels and diving support to ensure that the pipe mated correctly with the previous one and lay correctly in the trench. This operation required good weather and sea conditions and the co-ordination of multiple contractors. In all there were 7 pipe strings that had to be constructed and installed. At the time of the accident 4 pipe strings were in place on the sea floor and preparations were being made to sink the fifth one.

3.2.6. It had been planned to complete the pipe-laying part of the project by September 2008, but a number of technical and weather delays resulted in completion on 24 March 2010, some 18 months over time and at a final cost of $83.4 million.

3.3. Vessel information

The *Mugwop*

3.3.1. The *Mugwop* was a production RIB that had been built by Naiad Inflatables (NZ) Limited in 1996 and marketed as the 5.8XL Sportline. It had initially been purchased by a construction company, but its history after that could not be established, until a private owner sold it to Heron Construction in November 2005. At that time the dredge *Machiavelli* was working on a project in New Plymouth and the *Mugwop* was used as its tender.

3.3.2. The hull was constructed of 3 millimetre (mm) aluminium and was fitted with inflatable pontoons along each side. A built-in fuel tank was enclosed in a sealed void space that ran along the keel line of the boat. A screw plug was fitted to drain any water that might leak into the void. There was no bilge pump installed on the boat; instead, the cockpit was the self-draining type through 2 duckbills[2] fitted to the transom.

3.3.3. The inflatable pontoons comprised a fabric outer cover and inner tubes. The outers were 425 mm in diameter and made from heavy-duty polyester-reinforced PVC. They were attached to the hull by upper and lower entrapped boltropes that were rove into extruded channels that ran the entire length of the hull above and below the aluminium hull inwhale (the section of the

[2] Holes in the transom with a short length of flexible hose trailing in the water outside the boat. Water flows out through the hoses by gravity. Water cannot flow back through the hose because it kinks and seals the end of the hose shut,

hull that supported the pontoons). Each outer was inflated to a recommended pressure of 14 000 to 21 000 newtons per square metre (between 2 and 3 pounds per square inch) by an inner tube made of butyl rubber of 1.5 mm thickness. The inflation valves protruded through holes in the aluminium inwhale so that the pontoons could be inflated from inside the boat.

3.3.4. The following are extracts from the instruction manual for Naiad boats:

> The buoyancy tubes are an integral part of the stability of the craft and loss of any segment may adversely affect that stability. Due care must be exercised when operating the boat with damaged buoyancy tubes.
>
> Craft Stability
>
> The inflatable pontoons add significantly to the stability of the craft. Losing one section or side will alter the stability, in some cases significantly. All commercial craft will have stability data included in the manual. Contact the manufacturer if clarification is required. Generally craft with a taller superstructure and consequently a higher centre of gravity will be more dependent on the extra stability the inflatable tubes provide. It is therefore very important to maintain and care for the pontoons and ensure they are fitted correctly.
>
> Bow tie-down tag.
>
> Two tags are sewn into the outers at the bow, one at the top boltrope and one at the bottom boltrope. All models have these tags. Though design changes have meant that it is not necessary to fix these in models 5.8XL and smaller, it is most important that the 5.8 Offshore model and larger models have the lower tag attached to the bow. This tag prevents the outers from sliding forward and ensures that the gap between the lower bolt rails and the outer is kept to a minimum to prevent water entering between the outer and inner.
>
> The retaining tag at the bow must be fitted correctly to the hull of all models being used commercially and on models 5.8 Offshore and bigger on pleasure craft. This tag prevents the outer bags from creeping forward and keeps the gap between the hull and the outer to a minimum. A recent design of the aluminium inwhale has improved the fitting at the bow.
>
> The lower boltrope must be pulled in as hard as possible to reduce the gap. There are two holes in the tag, one is a spare in case of damage to the other. If the other is used a new hole must be drilled and tapped to suit.

3.3.5. Before work started on the Christchurch ocean outfall project, the *Mugwop* had not been registered as a commercial vessel, but because it was routinely being used to transfer crew, the owner initiated the process of bringing the vessel into a safe ship management system. On 11 June 2008, Survey Nelson started the process by applying for an MSA number (registration number) and completed an audit of the vessel from which a work list was given to the owner. At the same time Survey Nelson gave a generic safe ship management manual to the owner for him to adapt to the specific operation of the vessel.

3.3.6. The work list issued by the surveyor comprised a number of items to be supplied including fire extinguishers, pyrotechnics, navigation charts, a compass deviation certificate and other small gear required under the Maritime Rules. Survey Nelson sent a number of reminder letters to Heron Construction, including a final reminder on 4 September 2008 requesting verification that the work list had been completed. On 25 September 2008 Heron Construction faxed Survey Nelson confirmation that the work list was complete.

3.3.7. On 14 October 2008, the Survey Nelson surveyor signed a Fit for Purpose Document for the *Mugwop* (Appendix 2), which stated that the *Mugwop* was fit to ply as a non-passenger vessel to within 5 nautical miles of the coastline and that it could carry 6 crew. A section of Special Conditions/Limitations/Restrictions was included, which required:

> It is the Master's responsibility to assess the weather conditions and sea state prior to commencing the voyage.
>
> The Skipper/Owner is responsible to ensure that when the crew are on duty, that they are fit to carry out that duty.
>
> The ship is not to alter or modify its configuration or change its use with out Survey Nelson Ltd's consent as this may affect the ship's stability and the status of the SSM Certificate.
>
> The Skipper is responsible for the safe loading of the ship and must at all times be conscious of the ship's stability, trim and freeboard.
>
> The vessel to be trailered between limits.
>
> When vessel operating in Restricted Inshore limit – an auxiliary motor to be carried fitted.
>
> Vessel is restricted to carrying a maximum of l000kgs in total, including crew.
>
> Vessel is further restricted by the qualifications of the Skipper and Crew.
>
> The minimum manning was a local launch operator certificate.

3.3.8. The morning after the *Mugwop* was reported missing, on 29 October 2008, an application for the issue of a safe ship management certificate was sent to Maritime New Zealand from Survey Nelson. Because the *Mugwop* was reported missing at the time, Maritime New Zealand did not process the application.

3.3.9. The attending surveyor said that as he was going to be away for some time, he only signed the Fit for Purpose Document to sit on file until the work list was completed. The Director of Survey Nelson in submission said that the application for a safe ship management certificate should not have been sent from his office and he had no knowledge that it had been.

3.3.10. The *Mugwop* had suffered 5 problems during the Christchurch project. The outer covers for the inflatable tubes had been replaced by the dredge crew after the sudden deflation in December 2007, initially with second-hand outers purchased locally and then with new outers manufactured to order from Naiad. In March 2008 the outboard motor was causing the transom to flex, so the boat was sent to a local marine engineering company for repair. It replaced some of the hull plating and reinforced it with 40 mm aluminium angle bar and 32 mm square channel. In addition, a small hole in the hull below the waterline on the forward starboard side was welded.

3.3.11. About a month before the accident the steering failed. The night-shift engineer/deckhand replaced the entire steering unit, but the crew reported that the new steering was stiff. About one week before the accident, the trim control on the outboard motor failed. The hydraulic actuating ram was removed and sent to Auckland for repair, leaving the outboard motor permanently in the trimmed fully-in-position, a condition it was still in at the time of the accident.

3.3.12. The trim control allows the vertical axis of the outboard to be adjusted to achieve the best operating angle of trim for the boat for its loaded weight distribution and the sea conditions at the time. When the motor is trimmed fully down, the boat settles in a more level or possibly bow-down configuration depending on the motor set-up and boat loading. When the motor is trimmed out and up, the boat achieves a bow-up configuration because the thrust from the propeller exerts a downward component on the transom (stern), forcing the bow up.

3.3.13. A level or bow-down configuration is generally used to get the boat planing. This configuration is also used when heading into waves because the deeper vee section of the bow takes the brunt of the first impact with a wave, slicing through it rather than the hull absorbing the first impact on the flatter section towards the rear of the boat. This gives a softer ride for occupants and reduces slamming forces on the hull.

3.3.14. Once a boat is planing on calm water, the motor is usually trimmed out to raise the bow so that the boat is running only on the flatter and usually wider section of the hull near the rear. This reduces the friction area between the hull and the water, increasing maximum speed and reducing fuel consumption.

3.3.15. When a boat is travelling in the same direction as the waves, as the *Mugwop* would have been when it disappeared, it is good practice to trim the motor out to raise the bow, particularly when travelling at the same speed as or overtaking the waves. This is to reduce the likelihood of the bow burying into the back of a wave, which can lead to a boat broaching. For an RIB like the *Mugwop*, this would also reduce the reliance on the inflatable tubes at the bow for buoyancy.

3.3.16. The *Mugwop* had a fixed marine VHF radio that was installed under the steering console to protect it from the weather. An additional portable VHF radio was not carried and was not required to be. A 406 emergency position indicating radio beacon (EPIRB)[3] sat in a bracket to one side of the steering console within easy reach of the driver. The daylight and night flares were stored in a locker on the front of the steering console.

[3] The newer type of EPIRB that was programmed to transmit GPS position and identification data to the Rescue Coordination Centre New Zealand via satellite, when activated.

The *Machiavelli*

3.3.17. The backhoe dredge *Machiavelli* had been built in Turkey in 2005 for the Netherlands dredging company De Donge, which had sold it directly from the shipyard to Heron Construction. The dredge consisted of a 53 m long by 15 m wide and 3.3 m deep pontoon or barge, on which a Liebherr P 994 excavator had been mounted. The dredge was able to work in depths of up to 21 m. The pontoon was fitted with 3 legs or spuds, each of 1.4 m square construction and 30 m in length. The forward spud was fitted into a traveller, which allowed movement over a distance of 7.5 m in a fore and aft direction; this movement allowed the operator to “walk” the dredge to reposition it without the use of a tug.

3.3.18. The dredge had no propulsion equipment, so only the hull was under classification with Bureau Veritas. Its gross tonnage was 684 and the nett tonnage was 194. An international load line certificate had been issued on 15 March 2006 and an appropriate load line and deck line were marked onto the side of the hull.

Figure 3
The *Machiavelli*

The *Kurutai*

3.3.19. Originally named the *Sea-tow 22*, the *Kurutai* was an ocean-going tug. It had been built in 1991, was 23.46 m in length overall, with a breadth of 8 m and maximum draught of 3.8 m. It had 2 Detroit V16 diesel engines that produced 1908 kilowatts (kW) of power and propelled 2 fixed-pitch propellers sited in fixed nozzles. It had a bollard pull of 30 tonnes (t). It had been purchased by Heron Construction in August 2007. The tug was in safe ship management with SGS NZ Limited.

Photograph courtesy of McConnell Dowell

Figure 4
The *Kurutai*

The *White Pointer*

3.3.20. The *White Pointer* was a purpose-built survey vessel 8.5 m in length. It was constructed of aluminium and was propelled by a Hamilton jet unit that was powered by a Volvo diesel engine that produced 231 kW. A safe ship management certificate was issued by Survey Nelson for the *White Pointer* on 11 January 2008 and was valid until 28 August 2011, allowing it to operate in the inshore area.

The *Waiomana*

3.3.21. The tug/workboat *Waiomana* was constructed of steel and had been built in 1960. It had a length overall of 13.93 m and a gross tonnage of 23 and a single diesel engine developing 94 kW of power and driven through a single fixed-pitch propeller. It held a safe ship management certificate issued by Nortel (1998) Limited on 15 August 2007. It was certified to operate within the 12-mile inshore limit of Banks Peninsula.

The *Flexifloat*

3.3.22. The *Flexifloat* barge was constructed of 17 individual pontoons that were locked together to form a working platform. It was designed with a recess in the aft end for 3 reasons: it provided a sheltered area for divers to enter and exit the water; it allowed the use of the crane; and it was an area into which the tug could secure itself to "push" the barge. An "H" frame had been welded at the head of the recess to guide the crane wire during the outfall pipe deployment. It also provided a securing point for the tug when it was made fast for pushing the barge.

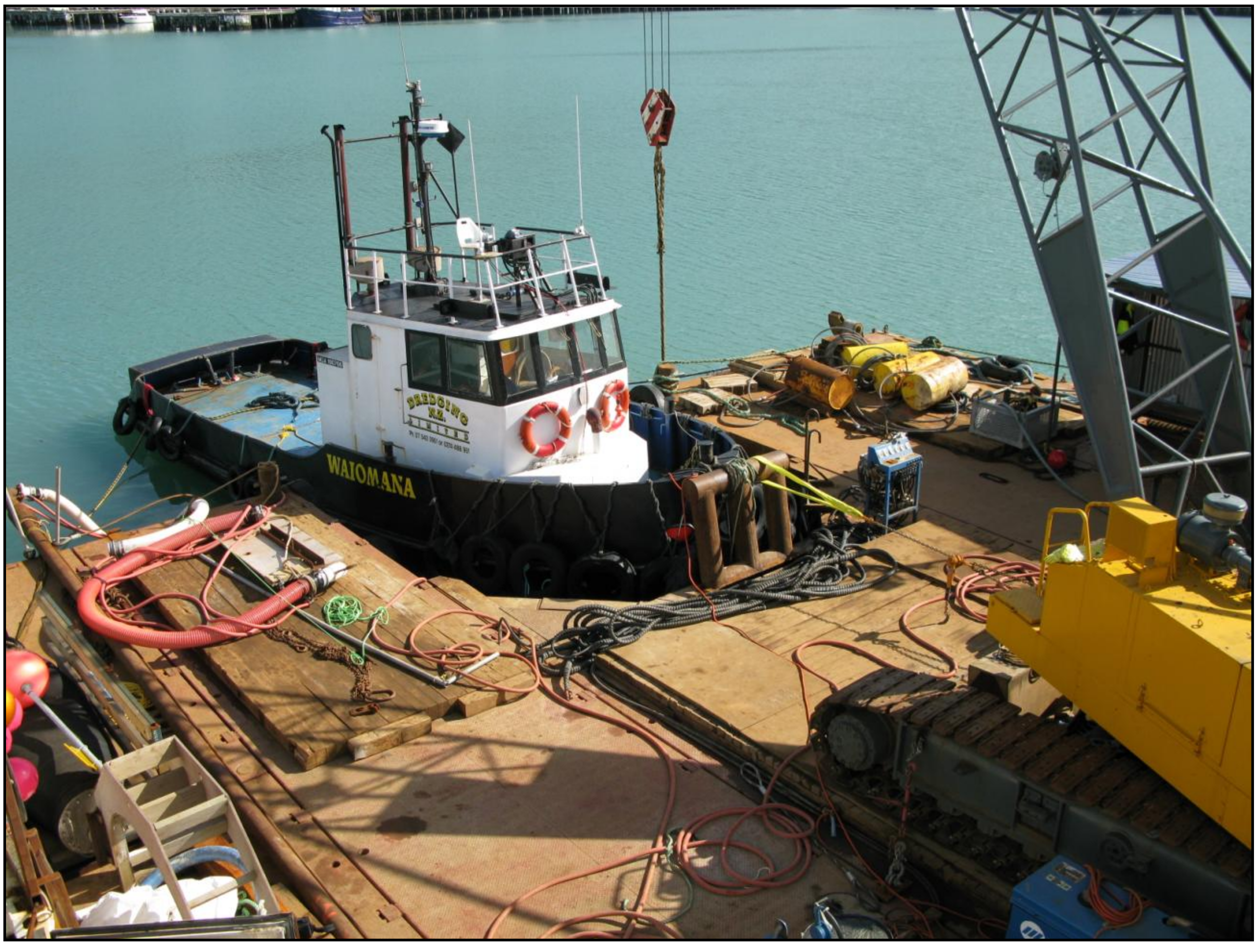

Figure 5
The *Waiomana* secured to the *Flexifloat*

3.3.23. Pushing is often the preferred method for manoeuvring a tug and barge in confined waters, as it allows the master of the tug to control the forward and reverse motion and to steer the barge as an extension of the tug. The 2 vessels, however, have different buoyancy characteristics, so try to move independently of one another in a seaway. In dedicated pushing tug and barge arrangements, the tug is attached mechanically into a slot in the stern of the barge. The usual arrangement for the connection of the *Waiomana* to the *Flexifloat* was less permanent, with the tug being held into the recess at the stern and secured in place by:

- a polypropylene rope to the “H” frame
- a fixed-length wire strop with an eye at each end on the port quarter of the tug
- a hand-tightened 3.2 t Titan wire rope winch on the starboard quarter.

Usually the ropes that secured the tug to the barge were sufficiently strong to maintain the rigidity of the 2 vessels, but when the state of the sea deteriorated, as it did in the *Flexifloat* incident, the movement between the tug and barge became sufficient to strain the securing lines until they broke.

3.3.24. During the morning of the day of the accident, the fixed-length wire strop had been lost overboard, so a black-and-yellow 100 mm plaited polypropylene rope had been used to secure the port quarter of the tug to the *Flexifloat*. During the voyage back into Lyttelton Harbour, that rope had chafed where it crossed the deck edge of the barge and had eventually parted. Another mooring rope had been quickly secured, but when the hand winch was tightened the securing hook on it straightened. It was after this that the tug master decided it was too rough to re-secure the tug into the barge, so arranged for the barge to anchor and called for assistance from the larger tug, the *Kurutai*.

3.3.25. In addition to the convenience of manoeuvring the tug and barge in the push mode, because the consist was less than 40 m in length and less than 500 t, it was not required to take a harbour pilot to transit the harbour. However, if the tug towed the barge in the conventional manner, the length would have been deemed to be the overall length from the bow of the tug to the stern of the barge, which would have been more than 40 m and therefore necessitated the employment of a pilot for each transit, a substantial cost over the period of the project.

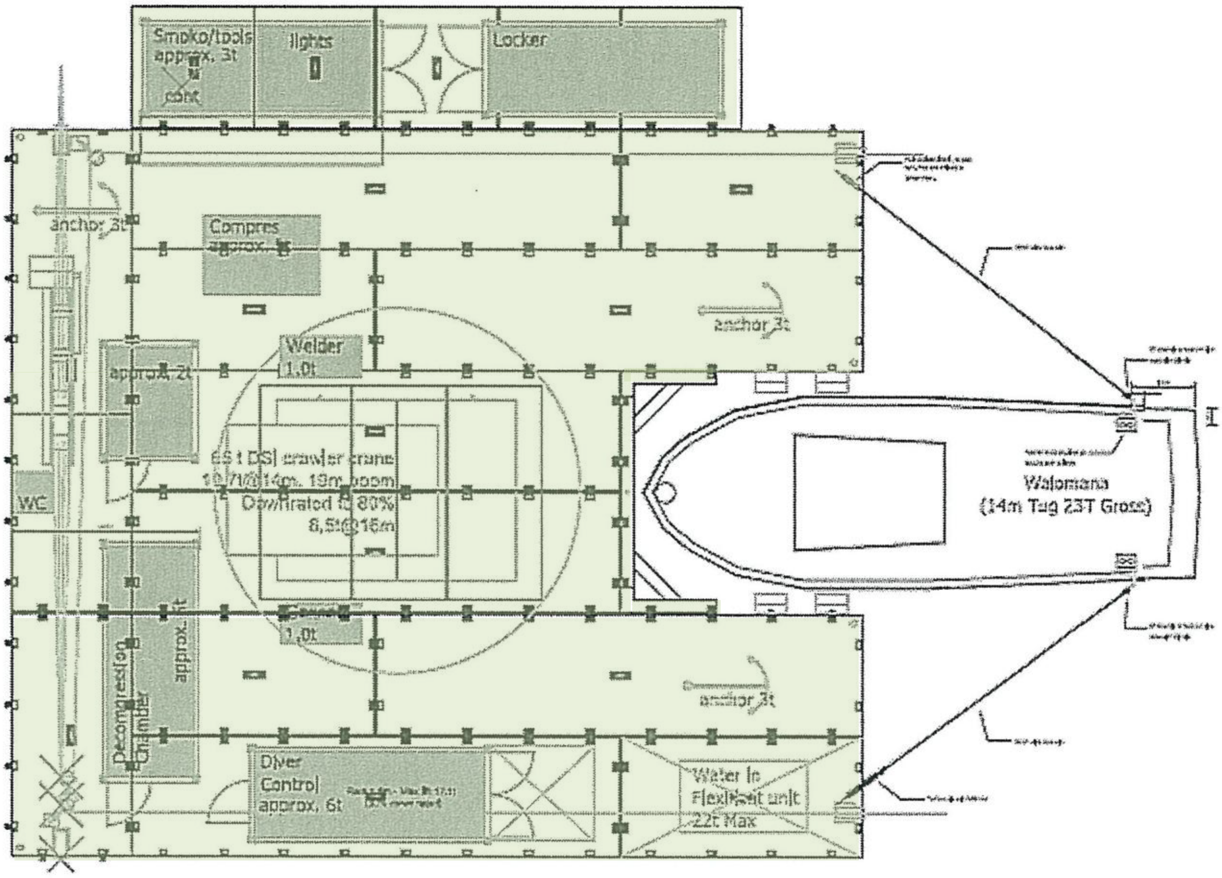

Figure 1. Plan sketch of the Flexifloat with Waiomana in push configuration.

Photograph courtesy of McConnell Dowell

Figure 6
Layout of the *Flexifloat* with the *Waiomana* in "push" configuration

Post accident inspections and audits

3.3.26. Following this accident, Maritime New Zealand conducted audits of 14 vessels that were involved in the project. Almost all the vessels had general deficiencies, such as out-of-date flares, but only one of them, a Naiad 7.5 *Phoenix Rescue*, which was also being used for personnel transfers, had conditions imposed on its operation because it did not have any shelter and therefore should not have been used outside enclosed limits. The inspection of the *Machiavelli* was deferred while it was brought into the safe ship management system. The *Flexifloat* had some issues regarding its layout and was in contravention of the Maritime Rules when personnel were allowed to remain onboard while it was under tow. In response, McConnell Dowell compiled new standard operating procedures for the use of the barge and changed the layout of the equipment on the barge.

3.4. Company and personnel information

Heron Construction Company Limited

3.4.1. Heron Construction was an Auckland-based family business established in 1964. The company specialised in the areas of dredging and marine construction works and operated throughout New Zealand and the South Pacific. The present 3 directors of the company are the sons of the founder and all 3 remain active in the day-to-day operation of the company.

3.4.2. The ocean outfall project manager for Heron Construction, who was also the day-shift dredge supervisor, was the son of one of the directors. He had joined the company in 1988 and taken a fitter and turner apprenticeship. In about 1995 he had become involved in dredge operations, mostly on backhoe dredges. He had worked on the *Machiavelli* since it arrived in 2005. He had no formal maritime qualifications, but had recreational boating experience on small jet boats and similar craft.

3.4.3. The day-shift dredge operator had started working for Heron Construction when the *Machiavelli* started work in New Plymouth in 2005. He had initially gone to sea as a fisherman and gained a commercial launchmaster certificate in 1992.

3.4.4. The day-shift engineer/deckhand had started working for Heron Construction when the *Machiavelli* started work in New Plymouth in 2005. He had a background in fishing vessels and had gained a second-class diesel trawler engineer certificate. He did drive the *Mugwop* regularly, but had not had any training in its operation.

3.4.5. The night-shift dredge supervisor had spent his early working life in transport-related industries before starting dredging with an earthworks company in Auckland. In 2005 he had started work for Heron Construction, operating the digger on the *Machiavelli* in the New Plymouth project. He regularly drove the *Mugwop* during the shift changes, but held no formal maritime qualifications and had not received any formal training in operating the vessel.

3.4.6. The night-shift dredge operator had been operating heavy machinery for all of his working life. He had been working for a construction company in Auckland and had been approached by Heron Construction in October 2007 to operate the dredge digger on the Christchurch ocean outfall project. He held no formal maritime qualifications and had received no formal training in operating the vessel.

3.4.7. The night-shift engineer/deckhand had been a boat builder and shipwright with a Lyttelton based marine engineering company. He had also spent time on fishing vessels in the Christchurch area and was said to be familiar with the harbour entrance. He had joined Heron Construction in about June 2008 and carried out the deck and engine maintenance. He held no formal maritime qualifications and had received no formal training in operating the vessel, but he did have his own boat and had worked on small fishing vessels.

3.4.8. The surveyor had initially worked as a construction and land surveyor. He had commenced work with Heron Construction early in 2007 as a hydrographic surveyor. His job was to use the hydrographic equipment on the *White Pointer* to survey the trenches as they were dredged. Initially McConnell Dowell supplied a skipper for the *White Pointer*, but in recent times it had become more usual for the surveyor to drive the boat himself or use the crew from the *Kurutai* to drive the boat while he conducted hydrographic surveys. He held no formal maritime qualifications and had received no formal training in operating the vessel.

3.4.9. The day-shift dredge operator had worked on fishing vessels in the late 1980s and gained his commercial launchmaster and radio operator certificates in 1992. In 2005, he had joined Heron Construction to operate the digger on the *Machiavelli* for the New Plymouth project. He was the only person on the dredge staff certified to operate the *Mugwop*.

3.4.10. The on-coming master of the *Kurutai* had started his seagoing career in Icelandic fishing vessels before moving to New Zealand, and continued working on fishing vessels here. He had commenced working for Heron Construction in January 2008 as master of the *Kurutai*. He held a New Zealand offshore master certificate with an STCW 95 endorsement (internationally recognised qualification). He also held a pilot exemption certificate for the port of Lyttelton.

3.4.11. The off-going master of the *Kurutai* had been employed to tow the *Machiavelli* from Tauranga to Timaru in September 2007. He had been employed as full-time master on the *Kurutai* in January 2008. He held a mate of a deep sea fishing vessel certificate.

Bay Underwater Services New Zealand Limited

3.4.12. Bay underwater Services New Zealand Limited (Bay Underwater) was the provider of diving services and also supplied the tug *Waiomana* to tow the *Flexifloat*.

3.4.13. The owner of Bay Underwater had been in the diving and marine service industry for about 22 years and had owned the company for 17 years. He held an inshore launchmaster certificate.

3.4.14. The master of the *Waiomana* was from a fishing background. He held a New Zealand coastal master certificate. He had been employed by Bay Underwater to be master of the *Waiomana* for the project.

McConnell Dowell

3.4.15. McConnell Dowell was a multi-national construction company that operated in Australia, Asia, New Zealand, the Pacific and the Middle East. McConnell McDowell New Zealand had been awarded the contract for the Christchurch ocean outfall project. Previously the company had worked on a number of construction projects, including wharves, jetties, marinas, dredging and submarine pipelines in the Pacific region.

3.4.16. The marine superintendent of the Christchurch ocean outfall project at the time of the accident had been with the company for about 12 years and had spent most of that time working on building projects involving wharves and bridges in the Pacific. His initial involvement in the Christchurch project had been at the tunnel site at New Brighton, which he started in March 2007. When his work at the tunnel was completed he was offered a role in the marine side of the operation and started work as a barge supervisor on the *Flexifloat*. In July 2007 he was promoted to his role of marine superintendent. He had no commercial marine qualifications.

3.5. Climatic conditions

3.5.1. Before McConnell Dowell tendered for the project it had identified that the weather in Pegasus Bay would be a critical factor in the operation, so it employed MetOcean Solutions Limited to provide historical weather and oceanography data in order for it to calculate the extent of downtime that could be expected during the project. That information was shared with Heron Construction and it estimated that the downtime on the project would be about 50%. Once the project had been let, MetOcean Solutions was contracted to provide wind, wave and current forecasts for the area. The 6-day forecasts were computer generated at 12-hourly intervals and automatically emailed to the marine superintendent of McConnell Dowell. In addition to the forecasts, McConnell Dowell personnel were able to access the MetOcean website for more information.

3.5.2. MetOcean Solutions generated forecasts at about 0300 and 1500 each day and emailed them to McConnell Dowell within the hour. At 0342 on 27 October, the weather forecast predicted northwesterly winds rising to 20 knots and gusting to 30 knots. The sea was predicted to rise to a significant wave height of 0.7 m with a maximum of 1.3 m following the north-westerly change. The swell was predicted to be 0.3 m from the east. A MetService marine weather forecast issued at 0508 on 27 October predicted the same northwesterly weather for 28 October.

3.5.3. Another MetOcean forecast was supplied at 1541 on 27 October. It predicted similar weather, but with slightly stronger winds for 28 October.

3.5.4. At 0342 on 28 October the most recent MetOcean forecast was received; this reiterated the north-westerly winds of about 20 knots with gusts up to 35 knots during 28 October, but dying down and changing to south-westerly the following day. The McConnell Dowell marine superintendent annotated the weather forecast to the effect that 29 and 30 October would be suitable to tow and sink the next section of pipe. The expected weather conditions were reinforced by a MetService marine weather forecast issued at 0522 on 28 October.

3.5.5. McConnell Dowell had installed a wave rider buoy in Pegasus Bay in position 43° 30.72'S 172° 48.00'E to give live information on wave heights. On 28 October, the recorded significant wave height peaked at 1.3 m at 1500, and was 1.25 m at 1830. The maximum wave height was 2.1 m at 1600 and 1.9 m at 1830

3.6. Maritime legislation on the design, construction and survey of rigid inflatable boats

3.6.1. Maritime Rules Part 40C Design, Construction & Equipment-Non-SOLAS Non Passenger Ships gave the design parameters for restricted-limit vessels engaged in operations like those the *Mugwop* was carrying out: crew transfers. The Rules described the general details for non-passenger vessels; Appendix 5 specifically concerned inflatable and rigid inflatable boats, with Annex 1 showing the tests that needed to be carried out on such boats (see Appendix 1 to this report for details).

3.6.2. In the case of the *Mugwop*, the design was required to meet Part 40C.7. Survey Nelson relied on Part 40C.7 (2) or (4) when it determined that the boat did not require a full survey to bring it into safe ship management:

> (2) A new ship of less than 7.5 metres in length overall does not require approval of the ship's design if it is a series production boat and the design has a record of at least 5 years of safe operation under similar conditions to that intended for the new ship.
>
> (4) An existing ship of less than 7.5 metres in length overall to which rule 40C.7(3) does not apply does not require approval of the ship's design if the ship, or a ship of the same design and construction, has a record of at least 5 years of safe operation in the intended service and similar area of operation.

3.6.3. Appendix 5 of the Rules set out the construction and stability requirements for RIBs such as the *Mugwop*. Sections 5 to 8 of Appendix 5 described the design and attachment of the inflatable tubes to the hull, with particular reference to the bow region where the greatest loads occurred. Section 9 said that an RIB with the dimensions of the *Mugwop* was required to have 4 separate inflatable compartments; it only had 2.

3.6.4. Maritime Rules Part 40C.16 required the *Mugwop* to be fitted with a shelter that provided protection for all persons that might be carried, because the vessel was certified to proceed beyond enclosed limits; the *Mugwop* was not fitted with such a shelter.

3.6.5. Annex 1 to the Rules required a damaged stability test where the maximum number of persons to be carried must be supported within the boat with the entire buoyancy on one side deflated. There were also swamping and freeboard tests.

3.6.6. Section 5 of Annex 1, similar to Maritime Rules Part 40C.9 and Part 40C.13 (7) above, allowed for the acceptance of tests performed on a prototype of a standard production vessel.

> (a) New and existing boats must be subject to the above tests, provided that for standard production types, a surveyor may accept documented evidence of tests of the prototype witnessed by a surveyor. Such documentation must be for a prototype with the same or a greater number of persons, and similar motor, fuel and equipment or greater specification.
>
> (b) In the case of an existing boat that is unable to meet the minimum freeboards of (4), a surveyor may consider a lesser 'operational freeboard' taking into account the safe operational history of the boat in the operating limits and type of service provided.

No tests were conducted on the *Mugwop*.

3.7. Other occurrences during the Christchurch ocean outfall pipeline project

3.7.1. The first marine accident on the project was a serious harm injury to a crew member of the tug *Kurutai*. On 8 December 2007 at about 1500, during anchor-handling activities, a deck hand's legs were caught between a wire rope under tension and the bulwark of the vessel. The wire partially severed his left leg and lacerated his right leg. In hospital his left leg was amputated.

3.7.2. The second accident was the capsize of the crew transfer vessel *Kingfisher* on the Sumner Bar on 13 March 2008 (Maritime New Zealand, 2008). The *Kingfisher* was a purpose-built 9.2 m aluminium vessel designed to transfer personnel between the pipeline area and Sumner or Lyttelton. The Maritime New Zealand file indicated that there were questions over the vessel's stability, but that it passed an independent stability test in post-accident testing. There were also some issues with the design approval and the fit-for-purpose certification for the vessel.

3.7.3. There had been other maritime non-injury accidents and incidents during the project; these included the swamping of a small aluminium workboat that became caught under a wharf and the loss of control of the *Flexifloat* while under tow.

3.8. Previous occurrences involving rigid inflatable boats

3.8.1. The Commission has investigated 3 occurrences that involved the loss of one or more inflatable tubes on RIBs.

3.8.2. The first accident occurred on 2 March 1996 off the Kaikoura coast and involved the 12.6 m long Whale Watch vessel *Uruao*, which after slamming into the back of a wave lost its inflatable tubes and subsequently capsized with the loss of one life. At the time the vessel was running with a following sea and drove over the crest of one wave and into the back of the next . There were 4 separate inflatable tubes held in place by a single outer cover. It was this cover that partially detached from the boat on impact with the wave and allowed the inflatable tubes to detach from the hull. It was concluded that the pontoons failed due to overloading of the fabric outers near the bow, exacerbated by the fabric being worn and torn and the securing tag at the bow not being bolted to the hull.

3.8.3. The second accident occurred on 11 October 1997 at the entrance to Wellington Harbour and involved the 7.5 m Naiad Coastguard rescue vessel *UDC Rescue*. On that occasion the vessel was running with waves of one to 1.5 m at a speed of about 28 knots, when it overtook a wave and pushed into the back of the wave in front. The outer cover "peeled" back and released the 2 forward inflatable tubes. The skipper was able to beach the vessel without any further incident. It was determined that the cause was degradation of the outer covers and their securing tongue detaching from the bow.

3.8.4. The third accident occurred on 8 December 1998, off Motiti Island in the Bay of Plenty and involved the 8.5 m Naiad Coastguard vessel *Rescue 1*, which lost 3 of the 4 inflatable tubes when the outer cover failed. The vessel was responding to a mayday call and travelling at about 35 knots in a following sea when it launched off one wave and came down into the back of the next. The outer cover split the entire length of the starboard side and released the 2 inflatable tubes on that side; the forward port tube also deflated. The *Rescue 1* remained afloat and was able to return to the home port under its own power. At the time of this accident the inflatable bladders were fitted with pressure relief valves and it was thought that when working in the sea the increase in pressure caused the relief valve to lift momentarily, allowing the tubes to deflate slowly and allow movement of the outer cover. Eventually the outer cover tore, resulting in the loss of the inner inflatable tubes.

3.8.5. Since these accidents, improvements have been made to the design of Naiad vessels, including improved fabric for the outer covers, a continuous lower bolt rope, the fitting of non-pressure relief valves, improved securing arrangements for the outer covers at the bow, and shorter but more inflatable tubes to give better redundancy should one puncture or deflate. The *Mugwop* had been built before or at about the same time as these improvements were made, and when its fabric outers had been replaced they incorporated all these new features, with the exception of having more inner tubes.

4. Analysis

4.1. Introduction to issues

What happened to the *Mugwop*?

4.1.1. The *Mugwop* was never found and neither crew member survived, so what happened to it will always be a matter of speculation, but enough is known about the general condition of the boat and the way it was operated to provide insight into what may have happened. The possibilities are explored below

Survival and substance impairment

4.1.2. If the *Mugwop* did suffer a catastrophic failure of some kind, this section discusses the chances of the crew surviving, and the equipment that the boat did not have or that the crew did not have the opportunity to use, which could have increased those chances.

Was the *Mugwop* fit for purpose?

4.1.3. The Commission has determined that the *Mugwop* was not fit for its intended purpose at the time of the accident. The reasons are discussed in this section.

Safe ship management and knowledge of maritime operations

4.1.4. The report discusses the role of safe ship management, the responsibilities of the parties under that system, and the need for organisations to have access to sufficient knowledge in maritime operations for the size and complexity of the Christchurch ocean outfall project

4.2. What happened to the *Mugwop*?

4.2.1. Whatever happened to the *Mugwop,* the onset appears to have been rapid and the result catastrophic; probably resulting in both crew members entering the sea unexpectedly. One crew member at least survived long enough to make a mobile phone call to the supervisor on the dredge, but the phone call was unsuccessful, possibly due to the phone having been immersed. The VHF radio was not used and the EPIRB was not activated; both were in easy reach of the driver.

4.2.2. The significant wave height in the area was recorded at around 1.3 m, with maximum waves around 2 m. The waves were travelling in the same direction as the *Mugwop* would have been heading, and we know from talking to other employees that the crew enjoyed driving the *Mugwop* at faster rather than slower speeds, fast enough to enjoy the thrill of powering over waves. Although the sea conditions were bad enough to suspend dredging and diving operations, an RIB should have been able to make the trip back to Lyttelton in relative safety, provided the boat was in good condition and was driven with care.

4.2.3. In a head sea the speed of such a boat has to be adjusted to prevent crashing into the next wave, so excessive speed is not usually a problem. However, in a following sea (Pike, 1989) the boat speed can appear slow in relation to the movement of the sea, so it is possible to lose the feeling of vulnerability and to allow the vessel to attain a higher speed without realising it. When the boat is overtaking waves, once it reaches the crest of the wave the bow will pitch downwards into the trough, often with sufficient speed to bury the bow into the wave ahead.

4.2.4. The danger of operating an RIB in a following sea is supported in an article by Paul Glatzel (Glatzel, 2001), who is an advanced powerboat instructor. When a boat falls into a trough and pushes into the preceding wave, the forward part of the inflatable collar imparts maximum lift on the bow as it is still falling, thus applying maximum stress on the inflatable pontoon securing arrangement forward, the weakest point of the detachable inflatable tube design.

4.2.5. One technique for reducing the tendency for the bow to bury into a wave is to have the outboard motor trimmed out to raise the bow. Applying more power as the boat enters the trough raises the bow and starts the boat climbing the back of the wave in one smooth motion. Three things are needed to achieve this: sufficient engine power; driver experience; and the ability to trim the motor out. The *Mugwop* had sufficient power but it could not be established if the driver was aware of the technique. Without the outboard motor trim mechanism the driver had no means of adjusting the trim of the boat. In smooth water this would not necessarily have been a safety issue, but when operating the boat in rough sea conditions, the trim mechanism was critical for safe operation. The defective motor trim mechanism was one defect that could have contributed to the loss of the *Mugwop*.

4.2.6. RIBs have been referred to as the "four-wheel drive of the sea", but of course any boat has its limitations. In all 3 previous occurrences the Commission has investigated involving RIBs, the boat was travelling at high speed in a following sea, and lost all or most of its inflatable pontoons. The reason for this was that when the bow buried into the back of a wave, the forces on the bow area were at their highest. Whether the pontoons could withstand the pressure would have depended on how hard the boat was being driven and the condition of the pontoons, including how well they had been fitted. The pontoon securing tag at the front of the boat was not attached to the aluminium hull. It can be seen hanging down unsecured in the photograph at the beginning of this report.

4.2.7. The *Mugwop* had only 2 inner bladders, one on each side, when under the current Maritime Rules commercial vessels of a similar size and engine power to the *Mugwop* should have had 4, 2 down each side. A 4-bladder option was available that could be fitted to the Naiad 5.8 XL. A catastrophic failure of the fabric outer covers at the bow would almost certainly have resulted in the inner tubes dislodging, or even if remained attached to the hull, at least deflating. Whether subdividing each pontoon into 2 inner tubes would have meant the back 2 inner tubes remained inflated in this case is difficult to say; it would have depended on the dynamics of the failure, but it can be concluded that the *Mugwop* would have had a better chance of survival than it did with having only one inner tube each side. It is feasible then that this non-compliance with Maritime Rules could have contributed to the *Mugwop*'s disappearance.

4.2.8. The loss of the pontoons on the *Mugwop* at high speed would likely have been catastrophic, leaving only the aluminium portion of the hull to keep it afloat. Whether the aluminium hull had enough reserve buoyancy to stay afloat would have depended on how loaded it was and how it was being driven. For example, the boat might have stayed afloat in calm water, but when driven at high speed in waves could simply have had insufficient reserve buoyancy at the bow and literally been driven under.

4.2.9. With only 2 crew and fuel on board, the *Mugwop* was not heavily loaded, but the rigid aluminium hull was known to leak, taking on a considerable amount of water into the void space under the floor plates when the boat remained in the water for any length of time. The leak does not appear to have been investigated, and the crew managed it by removing the hull drain plugs each time the boat was brought aboard the *Machiavelli*. The *Mugwop* had been in the water for more than 5 hours before the crew set off for Lyttelton. Taking on water for that length of time would have increased the weight of the hull and therefore reduced its reserve buoyancy. This was a second defect that could have contributed to the *Mugwop*'s disappearance.

4.2.10. One of the crew who was there when the floatation tubes deflated in December 2007 said that the boat was sinking as the crane hook was attached. He was of the opinion that the boat would have sunk if they had not managed to attach the lifting strop to the crane when they did, which would suggest that without its pontoons and with some water in the hull the *Mugwop* had little reserve buoyancy.

4.2.11. To summarise the main points so far, if the *Mugwop* was being driven at high speed in a one to 2 m following sea with the outboard motor trimmed fully down and the fabric outer securing tag not attached to the hull at the bow, it is feasible that it could have suffered a catastrophic failure of the inflatable pontoons at the bow. Such a failure would seem more likely if the hull had been partially full of water, particularly so if the water had been free to slosh forward when the bow pitched down. The general risk of failure of the pontoons would also have been higher if they had been underinflated.

Finding - The *Mugwop* likely suffered a rapid catastrophic event and sank, leaving the crew floating in the sea before they could use the boat's fixed VHF radio or activate their emergency position-indicating radio beacon (EPIRB).

Finding - The *Mugwop* feasibly suffered a total failure of its inflatable pontoons because it was likely travelling with a following rough sea (for a boat of that size) with a bow-low trim and possibly travelling faster than the waves at the time, which was similar to conditions that have caused inflatable pontoons to fail at the bow on at least 3 other rigid inflatable craft in New Zealand.

Finding - There were 4 defects that made the *Mugwop* more vulnerable to catastrophic failure of its inflatable pontoons and sinking:

- the hull was leaking and had probably taken on board a not insignificant quantity of water, decreasing its reserve buoyancy and possibly accentuating any pitch forward into a wave
- the outboard motor could not be trimmed out to achieve a bow-high trim
- the inflatable pontoons did not have the required subdivision in the inner tubes
- the securing tag for the pontoon outer covers was not attached to the hull.

Finding - The sea conditions, although rough enough to suspend dredging and diving operations, should have been within the capabilities of a rigid inflatable boat the size of the *Mugwop*, provided it was well maintained and driven with care.

Finding - There is sufficient history of structural failures with rigid inflatable craft in New Zealand to warrant an educational programme aimed at educating commercial and recreational users on the limitations of such craft and to dispel a common belief that they have no limit to their capability.

4.3. Survival and substance impairment

4.3.1. The debate over whether wearing life jackets should be compulsory in small craft has been around for some time within the New Zealand maritime industry, and one argument in the debate centres on the fact that accidents with smaller high-speed craft can happen quickly and with little warning. On the *Mugwop*, both crew members were wearing life jackets, which would have increased their chance of survival, but nobody knew of their plight. The debate should extend to the storage and accessibility of other life-saving equipment as well.

4.3.2. The EPIRB was located in an ideal location, within easy reach of the driver. Had an opportunity allowed the driver to retrieve and activate it, this alone could have saved the 2 crew members' lives. Within a short time, depending on the location of satellites, the Rescue Coordination Centre New Zealand would have received the alert together with an accurate position for rescue sea and air craft to begin the search, during daylight. Personal EPIRBs, commonly known as PLBs, can also be attached to life jackets worn by crew members to give a greater level of safety.

4.3.3. Fixed VHF radios are vulnerable to failure if submerged or external aerials are damaged. A waterproofed portable VHF radio can be a useful alternative means of communication, as can a mobile phone in areas of coverage, but like the flares, carrying such equipment is of limited value if it is not going to be usable in the event of a sudden catastrophic event. Flares and portable radios are often found stowed away in lockers on small craft, usually to keep them out of the weather and clear of activity areas.

4.3.4. The concept of having a "grab bag" containing important survival equipment close to the conning position has some merit. Most survival equipment either is waterproof or can easily be made waterproof. In the cold waters off Lyttelton, communicating their distress situation was critical to the 2 crew members' survival. An EPIRB would have given timely and accurate information on their location. Flares could also have been used to alert others if they were in distress, and guided searchers to their location. A portable VHF marine radio in a waterproof cover is an effective distress and search-and-rescue tool, particularly when close to other VHF users, as the *Mugwop* was at the time. Any one of these aids to survival could have helped save the lives of the 2 crew members if the *Mugwop* sank leaving them floating in the water.

4.3.5. There was no communications strategy for vessels operating on the Christchurch ocean outfall project, so vessels routinely travelled between the shore and the work site without notifying their intentions to anyone. The lack of a trip-reporting system did cause some confusion about the intention of the boat crew, which caused delays in the *Mugwop* being reported as overdue. People ashore and on the dredge did not at first consider that something untoward had happened to the boat, so instead concentrated on places where the crew may have gone. Once it was determined that the *Mugwop* was overdue, good co-ordination between the Heron Construction personnel and the Sumner Coastguard enabled the rapid deployment of search craft and the initiation of a full search-and-rescue operation, but not until it was almost dark; not ideal conditions to find persons or wreckage in the water.

4.3.6. The surface sea water temperature at the time of the accident was about 14 degrees centigrade. People can survive up to 6 hours in waters at a temperature of 15 degrees centigrade, depending on the clothing worn (Maritime New Zealand website, 2010). The life jackets that both men was wearing were an inshore waters type; not designed to keep the wearers' heads clear of the water if they were unconscious. It is likely in the case of the dredge operator that the onset of hypothermia led to drowning, because he was wearing a life jacket and the autopsy report said that he did not have any physical injuries that would have incapacitated him. The engineer/deckhand possibly suffered a similar fate to the dredge operator, but owing to the long time before his body was recovered this could not be determined.

4.3.7. The actual survival time of a person in the water before succumbing to hypothermia is dependent on the rate of heat loss from the body. The International Maritime Organization (IMO) marine safety committee guide for cold water survival (IMO, 2006) states in part:

> 4.1 The rate of body heat loss depends on the:
>
> .1 water and air temperature;
>
> .2 wind speed;
>
> .3 sea conditions;
>
> .4 length of time spent in the water;
>
> .5 protective clothing worn;
>
> .6 body type of the survivor;
>
> .7 mental and health status of the survivor;
>
> .8 level of alcohol and certain drugs in the survivor's body; and
>
> .9 manner in which survivors conduct themselves.

4.3.8. Toxicology tests on the dredge operator showed that he had recently used cannabis, although it could not be concluded to what degree his performance would have been impaired, or the effect this would have had on his behaviour leading up to the accident. The presence of alcohol or drugs can increase heat loss in an immersion case owing to behavioural and physical influences.

4.3.9. It is known that death after entry into water during an accident and subsequent drowning will be more likely where there is reduced muscular effort efficiency in the short term or hypothermia in the longer term (Tipton, Elgin, Gennser, Golden, Ryan 1999). Cannabis increases this risk as recent marijuana consumption reduces muscle peak exercise performance and duration (Renaud, Cormier 1986). Recent cannabis use also causes peripheral vasodilatation (opening up the arteries in limbs and head) which accelerates heat loss in the same way as alcohol consumption (Hillard, 2000). Both are known to increase the rate of onset of hypothermia owing to increased heat loss from the body. Studies such as those by Piomelli (2003) report reduced drive and cognitive performance following cannabis consumption, which can also be expected to increase the risk of swim failure. The conclusion that can be drawn from this is that recent cannabis consumption not only increases the risk of having maritime accidents or incidents, and falling into water, but also reduces the probability of survival once immersed.

4.3.10. By the time the dredge operator's body was found he had been immersed for about one hour longer than the expected survival time for the water temperature and type of lifejacket worn. Because there is no way of determining how long he survived, it cannot be said that cannabis was a direct contributory factor to his death, but this could not be ruled out either. The engineer/deckhand was at the helm when the *Mugwop* left the *Machiavelli,* and it is likely that he was at the helm at the time of the foundering. Because of the delay in recovering his body, toxicology was not possible.

4.3.11. The use of cannabis in any recreational and commercial maritime activity is of concern. The Commission believes that impairment of boat driver or crew performance is an issue that will need to be addressed. In its report 09-201, the Commission discussed the part played by alcohol in fatal marine accidents. The report likened the act of driving a boat as being equal to, if not more demanding than, driving a car on the road, with the boating casualty statistics showing that the consequences can be the same.

4.3.12. Between 2000 and 2007, alcohol was identified as a factor in 18% of recreational boating fatalities in New Zealand, and was found to have been a contributing factor in 8 fatalities over a 35-month period (National Pleasure Boat Safety Forum, 2008).

4.3.13. As long as there is no limit to the allowable blood alcohol level for drivers in charge of commercial and recreational boats, and as long as there is no legal mechanism for testing boat drivers for blood alcohol or for the presence of other substances that are known to cause impairment, such as cannabis, the risk to the public remains unacceptably high.

4.3.14. In report 09-201 the Commission recommended that the Secretary for Transport legislate for alcohol limits and testing for recreational and commercial operators.

> ***Finding*** - The sea water temperature at the location of the accident would have given a typical immersion survival time of about 6 hours for a person wearing a life jacket. The body of one of the 2 crew members was found after about 7 hours, meaning any factor that delayed the start of the search could have contributed to their deaths.
>
> ***Finding*** - Given the number and daily movements of vessels involved in the ocean outfall project, the marine operation should have had a communications plan that incorporated a trip-reporting system to track the movements of all vessels; such a system would have identified the *Mugwop* as overdue much sooner and resulted in an earlier search effort.
>
> ***Finding*** - The emergency position indicating radio beacon (EPIRB) and fixed VHF radio were installed in the best possible location on the *Mugwop*, but apparently could not be used or retrieved by the crew. A secondary means of radio or telephone communication protected from water immersion and easily accessible, together with flares, would have increased the chances of the *Mugwop*'s crew declaring their distress and being located.
>
> ***Finding*** - The level of THC or cannabis detected in the dredge operator's body indicated recent ingestion and would have accelerated the onset of hypothermia, but it cannot be said whether this contributed to the dredge operator's death because his body was not recovered until after the typical maximum survival time for that water temperature.
>
> ***Finding*** - The use of substances that impair performance during a commercial marine operation is a concern that has been raised in industry forums, and is already the subject of a recommendation to the Secretary for Transport in relation to other maritime accidents.

4.4. Was the *Mugwop* fit for purpose?

4.4.1. The *Mugwop* was being used to transfer crew between Christchurch and the project site, which was within an area designated by Maritime Rules as inshore, with a restriction not to be used more than 5 miles from the coast. Maritime Rules set standards for a boat to comply with, but the *Mugwop* did not comply with all of those standards, so should never have been issued with a Fit for Purpose Document.

4.4.2. The *Mugwop* was not completely surveyed by the safe ship management company on the basis that it was an existing standard production boat, but for this to have been allowed a prototype boat of similar design, specification and engine size had to have undergone a design and stability assessment. There was no documentary evidence that this had ever been done. If it had been done properly, it would have been found that the buoyancy pontoons did not have the required subdivision, that the tag at the bow was not secured to the hull, and that the boat was not fitted with the required spray cover for 15% of the boat's length. The safe ship management company should have picked up these issues and the vessel not permitted to operate until they had been rectified.

4.4.3. The *Mugwop* was leaking into the void space; through where and at what rate had not been determined, but from crew accounts the boat had to be lifted from the water and drained on at least a daily basis. Aluminium boats generally do develop leaks when the hulls age and flex in operation. The boats' age and how they are worked will largely determine the condition of the hulls. The *Mugwop* was about 12 years old, and 7 months before its disappearance had required replacement of some hull plating at the stern and strengthening of the transom to prevent it flexing under the weight of the outboard motor.

4.4.4. The void space was an integral part of the hull that should have been empty of water. As already mentioned, water in the void space would erode the boat's reserve buoyancy and place a greater reliance on the inflatable pontoons to stay afloat. Serious leaks into the void space were therefore a serious safety issue that more than likely contributed to the loss of the *Mugwop*.

4.4.5. This inquiry has identified a number of defects and non-compliance with Maritime Rules, of which some should have been picked up and remedied before a Fit for Purpose Document was signed by the attending surveyor and before an application for a safe ship management certificate was made, and others that developed post-survey were incumbent on the owner to rectify. The concept of safe ship management is the owner taking responsibility for the safe operation of the boat at all times, not just at the time of survey, which is now considered.

> ***Finding*** - The *Mugwop* should not have been issued with a Fit for Purpose Document because it did not meet the requirements of the Maritime Rules; and it was even less fit for purpose at the time of its disappearance because of 2 critical defects that had subsequently developed, both of which probably contributed to its loss.

4.5. Safe ship management and knowledge of maritime operations

4.5.1. The construction of the ocean outfall pipeline involved both civil engineering and maritime operations. The shore-based health and safety processes appeared well defined and followed known and practised guidelines, although the Commission did not review those in any depth. The maritime operations, however, had not been ingrained with a well-developed safety culture. The loss of the *Mugwop* was the third significant maritime accident in less than one year, and there had been other incidents that could have developed into accidents, such as the loss of control of the *Flexifloat* on 2 occasions, the second being on the same afternoon that the *Mugwop* disappeared. McConnell Dowell had used construction "execution procedures" and "job safety environmental analysis" for identifying hazards and assessing risks, but looking at the number of and circumstances around occurrences, these mechanisms had not delivered improved risk management. The Maritime New Zealand audit conducted following the disappearance of the *Mugwop* supports this view.

4.5.2. At the time of the accident the dredge crew had been on site for about 11 months. During that time they had made crew transfers twice a day, each of which required 2 round trips. Previous assignments of the *Machiavelli* had been based in or near the entrances to ports and did not require as long trips in open sea to exchange personnel, so boat driving was not considered a required skill of the dredge workers. Consequently, the only person certified to operate the boat was the day-shift dredge operator; however, during the time in Christchurch all the crew had driven the boat, with some driving it more frequently than others. None of the crew had received any training in the general running of the boat or specifically in heavy weather operations. Crew who are to operate an RIB in open water should be trained in its safe operation, and should know its peculiarities and weaknesses. This was a high-risk operation for which the crew should have been appropriately trained.

4.5.3. The maritime part of the ocean outfall project involved a complex array of vessels that had to work in unison to complete the task. These vessels were either owned or operated by 3 different companies, mainly Heron Construction and McConnell Dowell. The concept of safe ship management is that the crew of each vessel, together with the owner or operating company, are responsible for ensuring that each vessel is at all times fully compliant with the relevant Acts, Regulations, Maritime Rules and any local government bylaws. At the beginning of the project, each vessel should have been fully entered into safe ship management and compliant. Neither the *Machiavelli* nor the *Mugwop* had been fully entered, and as mentioned earlier in this report, the *Mugwop* had several major deficiencies. McConnell Dowell should have ensured that this basic requirement had been met for each of its own and its contractors' vessels. Understanding the intricacies of all of this legislation requires some knowledge of it, and sometimes in the case of smaller operators, some assistance from safe ship management providers and their surveyors.

4.5.4. The operation of the *Mugwop* and the *White Pointer* with unqualified and untrained drivers, and accepting the *Kurutai* being temporarily undermanned whilst at sea, and allowing personnel to remain on the *Flexifloat* while it was under tow were all examples of non-compliance with the Maritime Rules that governed the operation of these vessels.

4.5.5. A number of the vessels involved had people assigned to them who had the required maritime qualifications, but what appears to have been missing within Heron Construction and McConnell Dowell was people at the right level with enough knowledge in maritime operations and the regulatory requirements that had to be met. Neither the ocean outfall project manager for Heron Construction nor the marine supervisor for McConnell Dowell came from a maritime background or had intimate knowledge of safe ship management.

> ***Finding*** - The ocean outfall marine operation did not have sufficient maritime knowledge at the appropriate level of management to understand the fundamental principles of safe ship management and what it was supposed to achieve, and how to apply those principles to an operation that spanned 3 operators and several vessels, each with its own safety management system.
>
> ***Finding*** - Neither of the crew on the *Mugwop* at the time it disappeared held the required maritime qualification to drive the boat, and neither had received any training on the special features and idiosyncrasies of driving rigid inflatable boats in rough seas.

5. Findings

Findings are listed in order of development and not in order of priority.

5.1. The *Mugwop* likely suffered a rapid catastrophic event and sank, leaving the crew floating in the sea before they could use the boat's fixed VHF radio or activate their emergency position-indicating radio beacon (EPIRB).

5.2. The *Mugwop* feasibly suffered a total failure of its inflatable pontoons because it was likely travelling with a following rough sea (for a boat of that size) with a bow-low trim and possibly travelling faster than the waves at the time, which was similar to conditions that have caused inflatable pontoons to fail at the bow on at least 3 other rigid inflatable craft in New Zealand.

5.3. There were 4 defects that made the *Mugwop* more vulnerable to catastrophic failure of its inflatable pontoons and sinking:

- the hull was leaking and had probably taken on board a not insignificant quantity of water, decreasing its reserve buoyancy and possibly accentuating any pitch forward into a wave
- the outboard motor could not be trimmed out to achieve a bow-high trim
- the inflatable pontoons did not have the required subdivision in the inner tubes
- the securing tag for the pontoon outer covers was not attached to the hull.

5.4. The sea conditions, although rough enough to suspend dredging and diving operations, should have been within the capabilities of a rigid inflatable boat the size of the Mugwop, provided it was well maintained and driven with care.

5.5. There is sufficient history of structural failures with rigid inflatable craft in New Zealand to warrant an educational programme aimed at educating commercial and recreational users on the limitations of such craft and to dispel a common belief that they have no limit to their capability.

5.6. The sea water temperature at the location of the accident would have given a typical immersion survival time of about 6 hours for a person wearing a life jacket. The body of one of the 2 crew members was found after about 7 hours, meaning any factor that delayed the start of the search could have contributed to their deaths.

5.7. Given the number and daily movements of vessels involved in the ocean outfall project, the marine operation should have had a communications plan that incorporated a trip-reporting system to track the movements of all vessels; such a system would have identified the *Mugwop* as overdue much sooner and resulted in an earlier search effort.

5.8. The emergency position indicating radio beacon (EPIRB) and fixed VHF radio were installed in the best possible location on the *Mugwop*, but apparently could not be used or retrieved by the crew. A secondary means of radio or telephone communication protected from water immersion and easily accessible, together with flares, would have increased the chances of the *Mugwop*'s crew declaring their distress and being located.

5.9. The level of THC or cannabis detected in the dredge operator's body indicated recent ingestion and would have accelerated the onset of hypothermia, but it cannot be said whether this contributed to the dredge operator's death because his body was not recovered until after the typical maximum survival time for that water temperature.

5.10. The use of substances that impair performance during a commercial marine operation is a concern that has been raised in industry forums, and is already the subject of a recommendation to the Secretary for Transport in relation to other maritime accidents.

5.11. The *Mugwop* should not have been issued with a Fit for Purpose Document because it did not meet the requirements of the Maritime Rules; and it was even less fit for purpose at the time of its disappearance because of 2 critical defects that had subsequently developed, both of which probably contributed to its loss.

5.12. The ocean outfall marine operation did not have sufficient maritime knowledge at the appropriate level of management to understand the fundamental principles of safe ship management and what it was supposed to achieve, and how to apply those principles to an operation that spanned 3 operators and several vessels, each with its own safety management system.

5.13. Neither of the crew on the *Mugwop* at the time it disappeared held the required maritime qualification to drive the boat, and neither had received any training on the special features and idiosyncrasies of driving rigid inflatable boats in rough seas.

6. Safety Actions

General

1.1. The Commission classifies safety actions by two types:

(a) safety actions taken by the regulator or an operator to address safety issues identified by the Commission during an inquiry that would otherwise result in the Commission issuing a recommendation; and

(b) safety actions taken by the regulator or an operator to address other safety issues that would not normally result in the Commission issuing a recommendation.

Type (a) safety actions

6.1. Maritime New Zealand conducted a full audit of all vessels engaged in the ocean outfall project and required their operators to correct any deficiencies that were identified. One vessel was identified as being unsuitable to be used as a crew transfer vessel and another was stopped from being used as a towing vessel.

6.2. McConnell Dowell put in place a number of safety initiatives as a result of this accident:

- all personnel are to wear lifejackets when not in an enclosed cabin onboard a vessel
- lifejackets are to be type 402 with head-up support
- dual frequency 406 and 121.5 kilohertz personal locator beacons to be worn with lifejackets
- a scanner was purchased that was capable of locating the beacons
- a 24-hour shore-based radio station was set up for routine operations and emergency responses
- a comprehensive reporting system for the vessels was set up, including trip reports and waypoint calling points.
- the standard operating procedure for crew transfers was reviewed and updated
- appointed a dedicated marine superintendent.

7. Safety recommendations

General

7.1. The Commission usually issues its safety recommendations to the appropriate regulator even though another person or organisation may appear to be the more appropriate recipient. This is because the regulator will, in many cases, be better placed to facilitate the implementation of the safety recommendations through its statutory, legal or other arrangements with the persons or organisations concerned.

7.2. The Commission makes recommendations to the Ministry of Transport for matters that might require changes to rules or other legislation.

7.3. The following recommendations were made to the Secretary for Transport and the Director of Maritime New Zealand in previous reports but are repeated here because the issues of substance impairment and the safe ship management system are discussed in this report also.

Previous recommendations

Previous recommendation 1 (Commission report 09-201)

7.4. Until legislation is made setting limits for and testing of alcohol and other performance impairing substances for recreational and commercial boat drivers, the risk of alcohol-related accidents will be elevated.

It is recommended that the Secretary for Transport address this safety issue by promoting appropriate legislation to set maximum allowable levels of alcohol and other performance impairing substances for persons in charge of recreational and commercial craft, and supporting legislation to allow testing for such levels in these cases.

Previous recommendation 2 (Commission report 05-212)

7.5. On 2 April 2007 the Commission recommended to the Director of Maritime New Zealand that she undertake a full review of the safe ship management system and make changes to ensure the system promotes and effectively regulates a safe and sustainable maritime industry consistently throughout New Zealand. (Recommendation 009/07)

7.6. On 24 July 2007, the Director of Maritime New Zealand replied:

> MNZ constantly monitors the SSM system, which has been formally reviewed three times since its introduction in 1998. Each review, by independent bodies external to MNZ, found that the philosophy behind the system was sound, and since the system was introduced safety statistics in all commercial maritime sectors have improved. While feedback from the industry indicates solid support for the intent of the system MNZ considers that there is still room for improvement in how the system is implemented and delivered by MNZ and SSM companies.
>
> In line with our continuous improvement policy, a review of the SSM system has been identified as the key strategic priority for MNZ in its 2007-2010 Statement of Intent. MNZ has commenced a programme of work to enhance the sustainability and effectiveness of the SSM system by:
>
> Ensuring that the regulatory framework supporting SSM is robust and appropriate by reviewing the maritime rules that govern its operation. A draft discussion document summarising proposed changes to Maritime Rules Part 21 (Safety Management Systems) and Part 46 (Surveys, Certification and Maintenance) is due for public release in late 2007;
>
> Complementing existing guidance material (Health and Safety: A Guide; FishSAFE Health and Safety Guidelines; various leaflets) with additional material including a comprehensive resource to support owners in the

development of their SSM systems, specific fatigue management material, and health and safety guidelines for passenger and non-passenger operations. This additional material is being progressively released through until December 2007 in association with targeted training material;

Increasing the amount and quality of formal and informal training and education that is available to all those working in the system, including MNZ and SSM Company staff, surveyors, owners and operators. This training will be supported by the development of a mentor network utilising experienced industry participants to provide support and advice to their peers;

Reviewing the current capacity and quality of service delivery by both MNZ and SSM Companies in the area of SSM and comparing this with requirements in order to identify and address necessary areas for improvement;

Allocating additional resources to the SSM team within MNZ to allow for more responsive contact with industry and other stakeholders, along with the provision of personalised assistance where required to owners and operators; and structured auditing by MNZ of SSM service providers.

This work is being actively progressed and monitored within MNZ. It is also intended to establish an external consultative group to ensure that all industry and other stakeholders remain fully involved with, and aware of, the programme as it is developed and implemented.

Previous recommendation 3 (report 06-204)

7.7. It was recommended that the Director of Maritime New Zealand ensure that the current review of safe ship management and the amendments to Maritime Rules Part 21 and Part 46 results in:

- safe ship management companies discharging their responsibilities to ensure their client vessels comply fully with the required standards
- Maritime New Zealand discharging its own responsibilities for the oversight of the maritime industry standards in accordance with the Maritime Transport Act 1994
- owners of vessels discharging their responsibilities to ensure their vessels remain in compliance with the rules at all times.

(Recommendation 013/08)

7.8. The Director of Maritime New Zealand replied that once the review had been completed and recommendations implemented, the results would be evaluated against these goals and objectives. This was anticipated to take place in the second half of 2009.

New recommendation

7.9. There is a perception out in the commercial and recreational boating sectors that rigid inflatable craft are so robust that they have no limits to how hard they can be driven. This perception has contributed to the failure of the inflatable pontoons on least 3 other rigid inflatable boats, 4 if this accident is included, leaving 3 people dead as a result. There might be other occurrences that the Commission is not aware of.

It is recommended therefore that the Director of Maritime New Zealand disseminate to industry, information on small boat driving technique in rough seas and include special reference to the forces imparted on craft particularly when driving at high speed in following seas, and the ramifications this could have for rigid inflatable craft. (008/11)

On 17 March 2011, the Director of Maritime New Zealand replied, in part:

> I can confirm that Maritime New Zealand plans to develop and issue a safety bulletin to industry on safety issues associated with operating rigid inflatable craft. We expect to be in a position to release such a bulletin by December 2011.

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Appendix 1: *Mugwop* Fit for Purpose Document

Survey Nelson Ltd

FIT FOR PURPOSE DOCUMENT

Name of Ship:	MUGWOP	**Project No.** 13342
Owner(s) Full Name	Heron Construction Co Ltd	
Address	PO Box 72561 Papakura Auckland 2244	SAR Contact - [redacted]
Contact Contact Phone Vessel Phone	[redacted]	MSA / MNZ No. 133276

Ship Details

Call sign		LOA	5.80 meters
Fishing No.		Engine Power	86 kW
Home Port	Auckland	Tonnage (Rule 48)	
Port of Registry		Loadline (Rule 47)	mm min
Official No.		Freeboard (Rule 40D) (trawlers)	mm min
Year of Build	1996	Hull materials	RIB

Fit To Ply As: Non-Passenger N/A N/A

Limits (Rule 20)	RI							
Passengers								
Crew	6							
LSA	6							

Limits: Enclosed Waters - Inshore - Restricted Coastal - Coastal - Restricted Offshore - Offshore - Unlimited.

Inshore - Restricted - to within 5 nautical miles of the coastline

Special Conditions / Limitations / Restrictions

It is the Master's responsibility to assess the weather conditions and sea state prior to commencing the voyage.
The Skipper/Owner is responsible to ensure that when the crew are on duty, that they are fit to carry out that duty.
The ship is not to alter or modify its configuration or change its use with out Survey Nelson Ltd's consent as this may affect the ship's stability and the status of the SSM Certificate.
The Skipper is responsible for the safe loading of the ship and must at all times be conscious of the ship's stability, trim and freeboard.
The vessel to be trailered between limits.
When vessel operating in Restricted Inshore limit – an auxiliary motor to be carried fitted.
Vessel is restricted to carrying a maximum of 1000kgs in total, including crew.
Vessel is further restricted by the qualifications of the Skipper and Crew.

Manning requirements (Rule 31 A, B, C): Minimum as per 31B.14 - Minimum LLO

Ship Survey Due Dates (Rule 46.17(b)

Hull & Valves		Opened Yes / No	Date Due	05/2010 Outboard
Shaft	Main Due	N/A	Port Due	Stbd
Rudder Shaft	Main Due	N/A	Port Due	Stbd

Other Valid Certificates Specify:
MNZ issued Exemptions Specify:

Remarks:

☐ This Ship and its equipment complies with the applicable Maritime Rules and Marine Protection Rules (21.13(2)(VII), Ships Registration Act 1992 and Health & Safety in Employment Act 1992 (as amended)
The Ship is Fit for its Intended Service & Intended Operating Limits on
Date 14-10-08 Expiry Date 15-05-2010

Name of Surveyor of Ships [redacted] Signature [redacted]

FFP Issue 10 01/09/08 See TERMS & CONDITIONS overleaf

Part 40C – Design, Construction and Equipment Non – passenger ships that are not SOLAS Ships

Appendix 5 Inflatable and rigid-inflatable boats

Rule 40C.9(6)

1. Inflatable boats

(1) If a surveyor assigns inshore limits to an inflatable boat under rule 20.5, the owner and master of the boat must ensure that it

(a) remains within 20 miles of a safe haven; and

(b) operates only in favourable weather.

(2) An inflatable boat must comply with the requirements of the International Standard ISO 6185:1982 Shipbuilding and Marine Structures - Inflatable Boats -Boats made of reinforced elastomers or plastomers, or substantially comply with that standard to the satisfaction of the Director.

2. Rigid - inflatable boats

(1) A surveyor must not assign coastal limits (including restricted coastal limits) to a rigid-inflatable boat unless –

(a) it is purpose designed for the carriage of persons; and

(b) it has a substantial enclosure for persons.

(2) If a surveyor assigns coastal limits to an inflatable boat under rule 20.5, the owner and master of the boat must ensure that it remains within 60 miles of a safe haven.

(3) Inflatable portions of rigid-inflatable boats must be constructed of materials of

(a) sufficient tensile and tear strength; and

(b) sufficient resistance,

to withstand the environmental and abrasive conditions that may be expected in the service in which the boat is to be operated.

(4) The rigid hull of a rigid inflatable ship must be constructed of wood, fibre reinforced plastic, aluminium alloy or steel.

(5) The location of the inflatable portions relative to the hull must be such as to minimise loads on the inflatable portions, particularly when the boat is pounding into a sea.

(6) The design and detail of the attachment of the inflatable portions to the rigid hull, particularly in the bow region where the greatest loads occur, must be adequate for the conditions that may be expected in the service in which the boat is to be operated.

(7) Where the inflatable portions are bonded to the rigid hull, the attachment design must be such that the principal loads are taken in shear rather than in peel.

(8) Where the inflatable portions are mechanically fastened to the hull, the attachment design must be consistent with the service loads to which the inflatable portion is subjected, and must minimise any chafing of the inflatable portion fabric and connections to that fabric.

(9) Where the inflatable portions are necessary in order for the boat to meet the buoyancy and stability requirements of this Appendix, the inflatable portions must consist of the minimum total number of separate compartments shown in Table 40C.8, if no compartment exceeds 60 percent of the total volume.

Table 40C8

Maximum Permissible Power	**LxB**	
	5 to 9	Greater than 9
10hp to 25hp	2	3
Greater than 25hp	3	4

Where L = length in metres

B = breadth in metres

(10) Each inflatable compartment required by clause 2(9) must be fitted with a non return valve for manual inflation and a means of deflation. A pressure relief valve must also be fitted unless a surveyor is satisfied that this is unnecessary.

(11) Where a transom is fitted, it must not be inset by more than 20 percent of the boat's length from aft.

(12) A boat operating outside enclosed waters must meet the requirements of rule 40C.16.

(13) An open boat that in the opinion of a surveyor has inadequate sheer forward must have a raised spray cover, to deflect water, over not less than 15 percent of the boat's length forward.

(14) Vulnerable places on the outside of the inflatable portions should be provided with rubbing strips to the satisfaction of a surveyor.

(15) Suitable patches must be provided for securing any fittings to the inflatable portions.

(16) Buoyancy, stability, freeboard and passenger numbers for rigid inflatable boats which

(a) are less than 12 metres in length over all; and

(b) carry 12 or less persons; and

(c) are not fitted with decks above the hull to which persons have access, must be determined in accordance with the requirements of Annex 1 to this Appendix.

(17) For rigid inflatable boats that –

(a) are 12 metres or more in length overall; or

(b) carry more than 12 persons; or

(c) are fitted with decks above the hull to which persons have access

the intact stability requirements of Appendix 1 for a single hull ship carrying more than 12 persons must be applied. Further, it must be shown that the boat with the entire buoyancy on one side deflated has sufficient residual stability, that

(d) any angle of equilibrium does not exceed 7 degrees from the upright; and

(e) the resulting righting lever curve has a range to the downflooding angle[39] of at least 15 degrees beyond any angle of equilibrium; and

(f) the maximum righting lever within the range is not less than 100 mm; and

(g) the area under the curve is not less than 0.015 metre radians.

(18) Safety equipment must be provided in accordance with the requirements of Appendices 3 and 4. In addition, for boats proceeding more than 5 miles from a safe haven, the following must be carried, unless the buoyancy and stability required by this Appendix for the boat can be achieved without the inflated portions:

(a) for repairing punctures, a repair kit in a suitable container;[40] and

(b) an efficient manually operated bellows or pump.

[39] The downflooding angle is to be taken as the angle at which there is zero freeboard at any part of the damaged boat

[40] It is recommended that a clamp type repair kit be carried on rigid inflatable boats.

Annex 1 Tests to be carried out on inflatable and rigid inflatable boats

Appendix 5(16)

The following tests must be carried out on a boat floating in still water and observed by a surveyor:

(1) *Stability tests*

(a) The tests must be carried out with the engine and fuel tank fitted or replaced with an equivalent mass, and each person may be substituted by a mass of 75 kgs for the purpose of the tests.

(b) The maximum number of persons to be carried on the boat must be crowded to one side, with half this number seated on the buoyancy tube. This procedure must be repeated with the persons seated on the other side and at each end of the boat. In each case buoyancy must be positive and a surveyor must record the freeboard to the top of the buoyancy tube.

(c) Two persons on board the boat must recover a third person from the water into the boat. The third person must feign unconsciousness and have his or her back towards the boat so as not to assist the rescuers. The stability of the boat must remain positive throughout the recovery[41]

(2) *Damage tests*

(a) Damage tests should be carried out with the boat loaded with the maximum number of persons to be carried on the boat. The engine and fuel tank with full fuel must be fitted, or replaced by an equivalent mass, and all equipment appropriate to the intended use of the boat must be fitted.

(b) Tests witnessed by a surveyor must be for the following conditions of simulated damage

(i) with the forward buoyancy compartment deflated; and

(ii) with the entire buoyancy on one side of the boat deflated.
The tests are successful if, for each condition of simulated damage, the maximum number of persons to be carried is supported within the boat.

[41] Each person involved should wear an appropriate lifejacket during this test.

(3) Swamp test

(a) It must be demonstrated that an open or partially open boat, when fully swamped, is capable of supporting its full outfit of equipment, the maximum number of persons to be carried on the boat and a mass equivalent to its engine and full tank of fuel.

(b) In the swamped condition, the boat must not be seriously deformed.

(c) The boat's drainage system must be demonstrated at the conclusion of the test.

(4) Freeboard test

Subject to 5(b), the freeboard of a new boat must not be less than

(a) 300 mm or one-half the buoyancy tube diameter, whichever is the larger, measured from the upper surface of the buoyancy tubes; and

(b) 250 mm at the lowest part of the transom;
with the boat in the following conditions[42]

(c) carrying all its equipment, engine and a full fuel load, provided that any or all of these may be replaced with an equivalent mass; and

(d) carrying all its equipment, engine and a full fuel load and the maximum number of persons permitted to be carried, provided that any or all of these may be replaced with an equivalent mass (for persons, an average individual mass of 75 kgs must be used), with the boat trimmed as necessary to represent a normal operating condition.

(5) New and existing boats

(a) New and existing boats must be subject to the above tests, provided that for standard production types, a surveyor may accept documented evidence of tests of the prototype witnessed by a surveyor. Such documentation must be for a prototype with the same or a greater number of persons, and similar motor, fuel and equipment or greater specification.

(b) In the case of an existing boat that is unable to meet the minimum freeboards of (4), a surveyor may consider a lesser 'operational freeboard' taking into account the safe operational history of the boat in the operating limits and type of service provided.

[42] Where fitted, drainage socks may be tied up for this test.

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