Report 97-209

tug (*Sea-Tow 22*) and barge (*Sea-Tow 17*)

tow line parting and subsequent grounding of tug and barge

Greymouth Bar Harbour entrance

4 December 1997

Abstract

On Thursday, 4 December 1997, the tug *Sea-Tow 22* was towing the barge *Sea-Tow 17* inbound across the Greymouth Bar. The tow line parted at about 0500, just as the barge was entering the moles at the entrance to the Grey River. The run in the river carried the barge back out over the bar and, despite several attempts, the crew were not able to retrieve the tow. The tug collided with the barge during one of the retrieval attempts, and ran aground. The barge grounded shortly after. The tug was able to re-float, unaided, on the next rising tide and pull the barge off the beach.

Safety issues identified included poor communication and crew resource management, and the lack of authority over traffic management within harbour limits. Safety recommendations were made to Sea-Tow Limited and the Grey District Council to address the safety concerns.

Tug *Sea-Tow 22* and barge *Sea-Tow 17* aground off Cobden Beach (photograph courtesy of the Christchurch Press)

Transport Accident Investigation Commission

Marine Accident Report 97-209

Vessel particulars:	**Tug *Sea-Tow 22***	**Barge *Sea-Tow 17***
Class:	Ocean going tug (under 500 gross registered tonnage)	Dumb (unmanned) barge
Limits:	New Zealand, South-west Pacific and Trans-Tasman, including Australia	New Zealand Coastal Limits
Length (overall):	23.46 m	85 m
Breadth:	8.0 m	18.8 m
Draught (actual):	Forward: 2.3 m Aft: 3.3 m	1.2 m even keel
Tonnage (gross): Tonnage (dead-weight):	199 t	1721 t 3544 t
Construction:	Steel	Steel
Built:	Auckland, New Zealand in 1991	Whangarei, New Zealand in 1990 (rebuilt and lengthened in 1996)
Propulsion plant:	Two 954 kW Detroit 16V 149 diesel engines each driving a single fixed-pitch shrouded propeller	None
Service speed:	12.5 knots	Not applicable
Maximum bollard pull:	30 t	Not applicable
Owner:	Northland Port Corporation (NZ) Limited	Northland Port Corporation (NZ) Limited
Operator:	Sea-Tow Limited	Sea-Tow Limited
Port of registry:	Port Vila (Vanuatu)	Auckland (New Zealand)
Persons on board:	Crew: 6	Nil
Injuries:	Nil	Not applicable
Nature of damage:	Moderate damage to towing winch and shell plating	Moderate damage to shell plating

Location: Greymouth Bar

Date and time: Thursday, 4 December 1997, at about 0500[1]

Investigator-in-Charge: Captain Tim Burfoot

[1] All times in this report are NZDT (UTC + 13 hours) and are expressed in 24 hour mode.

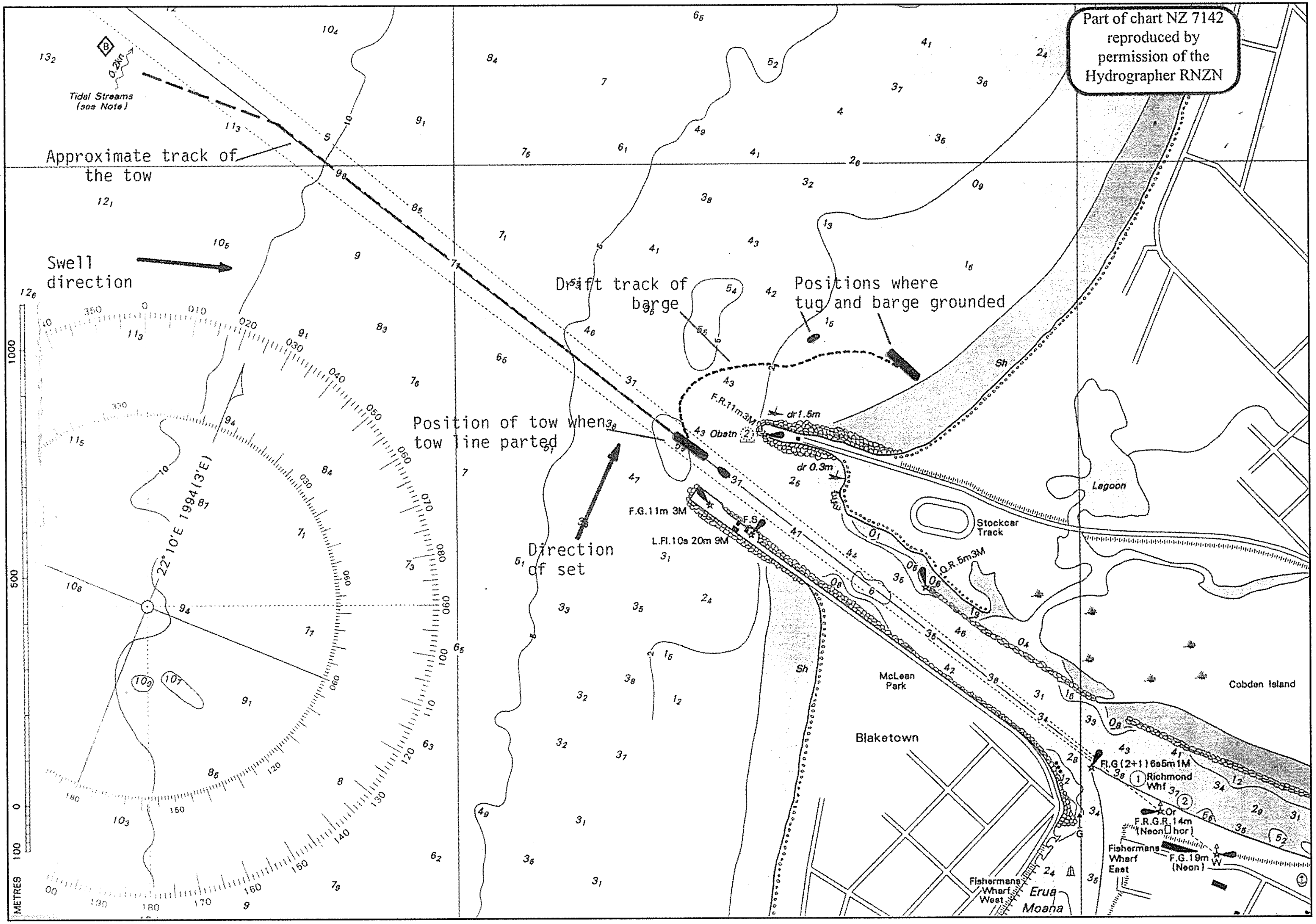

Figure 1
Part of chart NZ 7142 showing key information (diagram broadly to scale)

1 Factual Information

1.1 History of the voyage

1.1.1 At about 0600 on Wednesday, 3 December 1997, the tug *Sea-Tow 22*, towing the empty barge *Sea-Tow 17*, made its approach to the Greymouth Harbour. The tug and barge were engaged on part of a long-term contract to ship coal from Greymouth to Whangarei.

1.1.2 On board was a crew of six comprising the skipper, first mate, chief engineer, second engineer and two deck hands, one of which doubled as the cook.

1.1.3 The skipper brought the tug and barge (*Sea-Tow*) in to about eight cables off the harbour entrance breakwaters (moles) to assess the tide, weather and sea conditions over the bar, which had to be crossed to gain entry into the harbour. The harbour supervisor was standing on the south mole (see Figure 1) to relay bar conditions to the skipper using very high frequency (VHF) radio.

1.1.4 The tide was falling and the skipper decided that conditions were not suitable for crossing the bar, so he stood the tow further off the port to wait for the high tide that afternoon. By midday, the weather had deteriorated further so the skipper moved the *Sea-Tow* further off the coast into deeper water and set it in a holding pattern for the night. Except in near perfect sea and weather conditions, bar crossings were normally made in daylight.

1.1.5 High tide at the Greymouth Bar was predicted for 0206 the next day, Thursday, 4 December. The skipper informed the harbour supervisor that they would "... have another look" at 0500 that day. Half-tide was considered by the skipper to be the lowest at which the tug could safely cross the bar with adequate under-keel clearance. There was a small window of opportunity at 0500 whereby it would be half-tide (falling) and just light enough to see the swells, the moles, the barge and the tow line.

1.1.6 The night was uneventful and when the first mate woke the skipper at 0400 the next morning, the weather and sea conditions were "... fairly oily calm sea. . .very little breeze. . .two metre swell through the approach. . . with the odd big one going through".

1.1.7 The first mate woke the crew at about 0415, while the skipper began the approach to Greymouth. Normally the crew would have been on deck earlier, and the first mate and one deckhand would have been transferred to the barge before entering the harbour; however, the skipper decided to let the crew sleep a little longer as he was unsure if he was going to attempt the bar crossing. According to the skipper, the swell was "... towards the extreme" ("extreme" being the skipper's definition of his own limits with a built in safety margin) for a crossing and it would have been difficult to transfer the crew to the barge in safety due to the swell and marginal light.

1.1.8 The crew shortened the tow line as the *Sea-Tow* entered shallower water. The skipper was conning the tug from the open flying bridge, with the first mate beside him. The chief engineer was operating the tow winch from a raised platform next to the winch, aft, on the main weather deck, and the second engineer was stationed on the wheelhouse deck between the flying bridge and the main weather deck, to act as a communication link between the skipper above, and the chief engineer below (the chief engineer and skipper could not see or communicate with each other from their respective positions). One deckhand was on the bow of the tug, and the other was standing by to assist where required.

1.1.9 The harbour supervisor was standing on the end of the south mole using a VHF radio to relay swell, tide and river information to the skipper. He stated that he told the skipper that there was a 2 to 3 knot run in the river (the skipper stated that he was told there was "no more than 2 knots"). Both the skipper and the harbour supervisor noted that there were long relatively flat periods between sets of swells.

1.1.10 As the skipper continued the approach to the harbour entrance the chief engineer further shortened the tow line to keep it from dragging on the seabed, and started to play[2] the tow line. The skipper was compensating for any shock loading of the tow line also, by adjusting the engine power of the tug.

1.1.11 When the *Sea-Tow* was about two cables off the moles and on the line of the leading lights, the harbour supervisor saw the crests of a set of bigger waves looming behind the *Sea-Tow* and warned the skipper. The skipper estimated the waves were about 2.5 m in height and close together. By the skipper easing the tug power, and the chief engineer playing the tow wire, the *Sea-Tow* was able to cope with the larger set of swells. After the set of larger swells passed through, the skipper commented to the harbour supervisor that he "hoped there were not any more like that". The skipper saw that there was a relatively calm patch for a while and opted to continue with the crossing.

1.1.12 The speed through the water of the *Sea-Tow* varied as the skipper adjusted the power to keep the barge under control, but averaged about 4 knots. Crossing the bar took longer than he envisaged because, according to the skipper, the run in the river was about 4 knots; not 2 knots, as he thought the harbour supervisor had told him. As the *Sea-Tow* proceeded across the bar, the chief engineer was having increasing difficulty keeping the tow line slack as the wave pattern changed. According to the chief engineer, he was unable to relay to the skipper his difficulty for fear of losing his concentration on his task.

1.1.13 Normally, once the barge was inside the moles, the tow line was shortened further to allow the tug more control over the barge in the confines of the river. As the tug entered the moles its ground speed was so low as to be barely discernible. The skipper noticed that the chief engineer had shortened the tow more than he would have liked so he asked the first mate to go down and tell him not to shorten the tow any more until the barge was inside the moles. The chief engineer did not recall receiving this message.

1.1.14 The skipper applied more power to get the *Sea-Tow* moving over the ground, and looked ahead at the leading lights to make sure the *Sea-Tow* was on track. At about 0500, just as the bow of the barge was about to enter between the moles, a larger wave (estimated by some to be about four metres) passed under the barge. The wave, which was described as, "incredibly steep and like a wall of water . . ." passed under the barge and picked up the stern of the tug. The conflicting motions of the tug and barge caused the tow line to snap tight and before the chief engineer could pay out the wire, it parted near the winch. The skipper was looking forward and did not see the large wave and consequently did not reverse the engines, as he normally would have done.

1.1.15 The chief engineer stated that, with the stern of the tug lifting, and the barge falling behind the wave, he lost sight of the barge just before the tow line parted.

1.1.16 The run in the river pushed the barge out over the bar, where it started to drift north due to a northerly set.

1.1.17 The skipper turned the tug in the river and chased the barge around the end of the north mole with the intention of retrieving the recovery pennant[3]; however, the barge had drifted over the pennant and the crew were unable to recover it.

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[2] With a short tow line, there is minimal spring, or give, in the tow. The tension comes on and off the tow line as the tug and barge ride on different waves making it necessary to continually pay out and retrieve the tow line to avoid it snapping tight (often likened to playing a fish on a fishing rod).

[3] A floating line with a buoy attached to its end which normally trails in the water behind the barge and is attached to an emergency tow line on the barge.

1.1.18 The barge, having drifted out of the main river run, was being pushed by the surf into the shallows off Cobden Beach, just north of the north mole (see Figure 1). The harbour supervisor, realising that the barge was being pushed around the north mole, left the south mole to drive through town, across the bridge and out on to the north mole.

1.1.19 The skipper manoeuvred the tug around the stern and on to the port side of the barge, between it and the north mole. He was concerned that the barge might ground on the rocks near the base of the mole, or on the wreck that lay close to its end.

1.1.20 The skipper laid the tug close alongside the barge so the crew could attach a tow line to the mooring bitts near the bow of the barge. The surf pushed the barge down onto the tug and the two vessels collided twice, striking along the flat side of each vessel. The skipper was worried that the tug may be caught under the bow of the barge so he gave the barge one push away from the mole with the tug, and manoeuvred the tug around to the starboard side of the barge to where he intended to try and attach a tow line.

1.1.21 During the manoeuvring around the barge, the two vessels drifted closer in to the shore and at about 0545 the tug grounded before the crew could attach a tow line to the barge. The skipper tried to reverse off but the tug would not move. At about that time, the harbour supervisor arrived at the north mole and, seeing the tug in the surf, told the skipper to "... not go too far in because it was shallow in there". The skipper had manoeuvred the tug in the area off Cobden Beach about two years prior while salvaging the same barge *Sea-Tow 17* after it had broken its moorings, drifted down the river and up onto the Cobden Beach. He thought the water was deeper in the area than it was.

1.1.22 The barge, being of significantly lighter draught than the tug, continued to be pushed towards the beach by the surf, its heavy chain towing bridle[4] and pennant dragging on the sea bed. The kedging effect of the chain kept the barge "bow-out" to sea and eventually its stern grounded near the beach.

1.1.23 Initially the skipper shut down both engines on the tug, but the wave action was working the vessel further inshore, so he restarted one engine and kept it idling astern to hold the position. As the tide fell the tug became hard aground. The stern of the barge was lightly aground, but the bow was still floating being held by the trailing towing bridle and pennant.

1.1.24 The harbour supervisor later boarded the barge from the beach and let go its bow anchor to help hold the bow out to sea.

1.1.25 Over the ensuing five hours: another eye was made in the tow wire, a helicopter was used to pass a messenger line across between the tug and barge, the main tow wire was pulled across to the barge using the messenger, and the tow wire was re-attached to the chain pennant.

1.1.26 At about 1100 the tug was able to re-float on the rising tide and tow the barge off the beach. The skipper took the *Sea-Tow* out and transferred some crew from the tug to the barge. Some time was taken to check the integrity of the tug and barge, and at 1155 the skipper began the approach to Greymouth. The *Sea-Tow* took some time to cross the bar as, although the wave conditions were less severe, there were fewer lulls and the skipper was nursing the temporary tow line attachment.

1.1.27 The *Sea-Tow* entered the moles at 1230, and by 1430 was secured to the wharf where it underwent assessment and temporary repair.

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[4] Chain attached to either side of the barge coming together to a single towing fixture. The arrangement allows better control of the barge in tow.

1.2 Damage information

1.2.1 The towing winch suffered moderate damage as a result of the shock loading on the tow wire before it parted. The shock transferred through the winch drum to the winch frame, resulting in several of the holding-down bolts fracturing. In addition, the pull of the wire caused the pedestal supporting the bearing for the winch drum drive pinion to distort. This distortion caused the coupling between the drive pinion shaft and the output shaft from the hydraulic motor to run out of true (runout). Being the weaker of the two shafts, the hydraulic motor output shaft bent, which caused internal scoring of the rotor sides and end covers inside the hydraulic motor. Several bearings were damaged as well.

1.2.2 The tug *Sea-Tow 22* sustained hull damage near the port side chine[5] in way of the number three port fuel tank. The hull was not breached, but a weld on the internal bulkhead between the fuel tank and the engine room split. Some oil was lost into the engine room bilge before the contents of the fuel tank could be transferred to another tank.

1.2.3 Bottom damage to the tug and barge due to grounding was minimal, being restricted to lost paint and slight indenting only.

1.2.4 The barge *Sea-Tow 17* suffered moderate hull indentation in way of the port side number two void space, which was caused by the collision with the tug. The hull plating was ruptured above the waterline for about 300 mm.

1.2.5 The broken end and about a metre of the tow wire was left protruding out of where it had buried in the lay of the wire turns remaining on the drum. The crew had to use a chain block to free the wire before they could make a new eye in the end. The distance from the break in the wire to the socket, where the wire was attached to the chain pennant, was about 8 m. The distance from where the wire was buried on the winch drum to the stern of the tug was about 6 m, which meant there was about 2 m of wire out over the stern of the tug to the chain pennant at the time the wire parted.

1.2.6 The wire was in good condition and there were no signs of wear or prior damage which could have contributed to it parting. The break was a clean one, with most of the strands breaking in the same plane, with the exception of the wire core, which broke near the socket.

1.3 Tug and barge information

1.3.1 *Sea-Tow 22* was a 23.5 m purpose-built coastal tug. Constructed from steel, the tug was built in Auckland in 1991. The accommodation was amidships with the wheelhouse above the accommodation, slightly forward of amidships. Behind the wheelhouse was the boat deck, which extended aft between two funnels. An open flying bridge was located on top of the wheelhouse. The vessel could be conned from one of three positions: the wheelhouse, the flying bridge or from an open control station at the rear of the boat deck, between the funnels.

1.3.2 Propulsion was by two 954 kW Detroit 16V 149 diesel engines, each driving a single fixed-pitch, shrouded propeller through a reversing gearbox. Full speed was about 12.5 knots; normal towing speed, about 8 knots. The tug had a maximum bollard pull of 30 t.

[5] Edge where the side plating meets the bottom plating.

1.3.3 The tow line consisted of two 48 mm diameter, 6 x 36 strand, galvanised steel wire ropes (short tow and long tow). The short and long tow wires were joined in one length, using a joining link, and laid onto a single-drum, low pressure hydraulic tow winch. The tow wires had a specified normal breaking strain of 148 t. The short tow and long tow were about 240 m and 510 m long respectively, giving a total tow length of about 750 m. One end of the short tow wire was set into an eye-and-socket fixture, to which the barge chain pennant was attached, and the other end of the long tow wire was made fast to the winch. (See Figure 2)

1.3.4 The tow line passed through a set of guide rollers, which moved back and forth across the winch drum on a worm drive, laying the wire evenly across the drum. The tow winch could be operated from one location only, that being a platform raised about 80 cm off the main weather deck, beside the winch (see Figure 3). The skipper could not see the winch operator from the wheelhouse, but could just see the top of his head when standing on the port side of the flying bridge. Verbal communication was difficult due to the noise from the various engine room and accommodation fans on deck. There was no electronic communication system fitted.

1.3.5 The *Sea-Tow 17* was a 3544 t capacity steel barge. The barge was 85 m long and 18.8 m wide. A series of void spaces along the bottom and sides acted as a double skin around and under the cargo hopper. A small superstructure near the bow housed a diesel-driven generator which provided power to operate the winches on board, and charged a bank of 24 v batteries, which supplied power for the barge navigation lights when on a sea passage.

1.3.6 The barge was fitted with two anchors: one at the bow, and a kedge[6] anchor at the stern. The winch for each anchor incorporated a warping drum for mooring line handling and to assist in connecting and disconnecting the tow.

1.3.7 The towing arrangement at the bow of the barge (see Figure 2) comprised three chain pennants: one from each shoulder of the barge coming together to a single attachment, forming the bridle, and the third from the bridle to the socket on the end of the tug tow line. The third chain pennant was 36.5 m long, and together with the bridle, if stretched tight, would range about 54 m ahead of the barge.

1.3.8 An emergency tow wire was permanently attached at the bow and ranged down the port side of the barge to the stern. The wire was held onto the barge by a series of weak attachments. A smaller diameter wire messenger, which was attached to the end of the emergency tow wire, was coiled and lightly secured to a post on the port quarter of the barge. A fibre rope recovery line and buoy was attached to the end of the wire messenger. When on a sea passage, the recovery line and buoy trailed in the water behind the barge. If the main tow line parted, the tug could circle behind the barge, pick up the recovery buoy, pull the wire messenger off the post and use it to pull across and connect the emergency tow line.

1.4 Towing procedures

1.4.1 When towing a barge on sea passage the length of the tow line was adjusted to suit the prevailing sea conditions. The catenary of the tow line was such that it curved down under the water to depths of up to 70 m. In good sea conditions the tow was often shortened to reduce the water friction on the tow line and consequently, increase the speed of the tow. In rougher sea conditions, the tow line was lengthened, to increase the catenary and thus the spring effect.

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[6] An additional anchor, usually carried at the stern, used to assist in manoeuvring a vessel, or limiting the swing around the main anchor when anchored in narrow or congested waters.

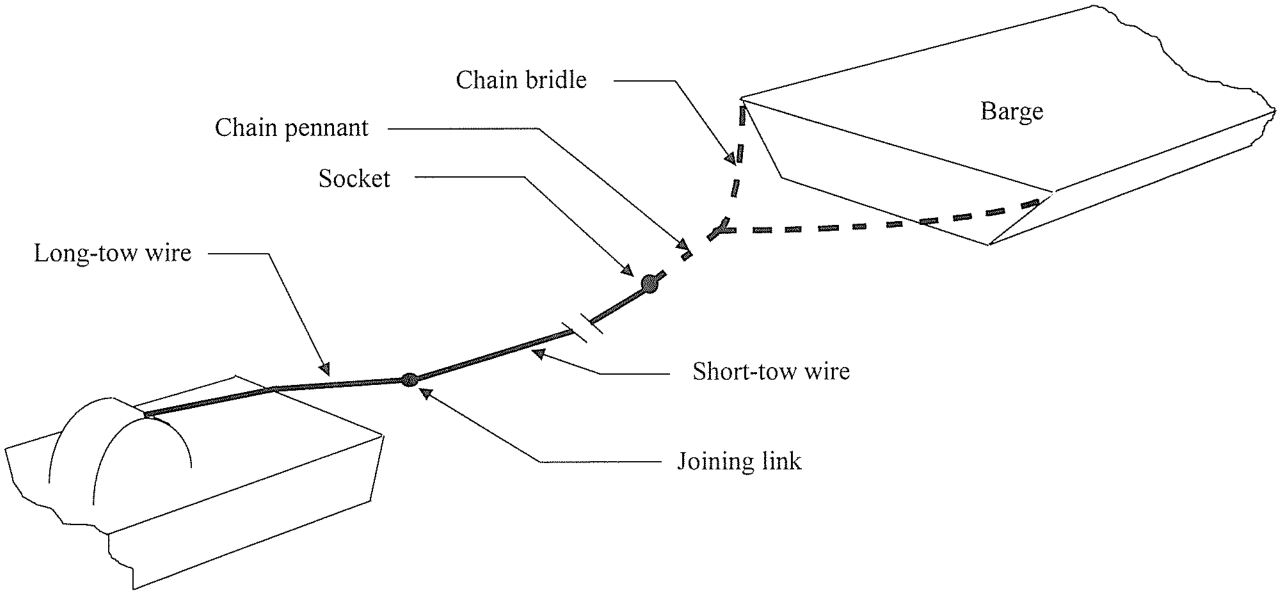

Figure 2
Typical Sea-Tow towing arrangement
(Diagram not to scale)

Figure 3
Photograph showing the position of the winch operator

1.4.2 As the tow approached shallow water the tow line was shortened to ensure that it did not drag on the sea bed, where it could become fouled and damaged. On an approach to a bar harbour the tow line was progressively shortened until there was about 20 m of wire out over the stern of the tug, as preferred by the skipper on the accident trip. Together with the chain pennant and bridle, this equated to about 74 m (stretched) between the stern of the tug and the bow of the barge. At this length, the weight of the chain and tow wire still formed a reasonable catenary to absorb the surge in the tow line.

1.4.3 When crossing the bar, the chief engineer operated the tow winch. The winch was always left in gear and with the manual brake off. The chief engineer's role was to supplement the shock absorbing characteristic of the catenary in the tow line by: paying the wire out if it became taut, and winching it in if the wire became slack; but keeping the over-all length of the tow the same.

1.4.4 The skipper normally conned the tug from the flying bridge, where he had a good view forward, and a better view aft than from the wheelhouse. He also supplemented the shock absorbing characteristic of the catenary in the tow, by reducing the power on the engines if the tow line became too taut, and increasing the power during lulls to keep the *Sea-Tow* moving at a good speed and on a good line.

1.4.5 Once the barge was inside the moles the tow line was shortened further until the chain pennant was on the roller at the stern of the tug. In that configuration the barge was easier to control in the close confines of the river.

1.4.6 Little of the towing procedures was documented in the Sea-Tow Limited Procedures Manual. The procedures had been developed over many years and were passed on verbally, or learned through familiarisation trips and experience. Each skipper had complete discretion as to how and when they entered bar harbours, providing they complied with the following two instructions:

- A diagram showing the towing procedure for restricted waters, which was with the chain towing pennant at the stern of the tug; and

  - **Barge operation during entry -** To retard the barge while crossing the bar, the stern anchor should be lowered just enough to bounce along the bottom. This will keep the barge from sheering and helps control it sufficiently to allow the tug better manoeuvrability. Always turn the barge on arrival and drop the anchor 2.5 shackles up stream of the berth.

    No diversion from this arrangement can be made without prior permission of the office.

1.4.7 The second instruction required crew members to be on the barge to operate the stern anchor before crossing the bar.

1.4.8 The skipper of *Sea-Tow 22* normally transferred crew to the barge, but rarely kedged the stern anchor. According to him, kedging the anchor could cause the barge to slow too much, and he sometimes preferred to let the barge sheer on larger waves when crossing the bar, as he believed this eased the strain on the tow line (due to some of the towing force being taken to straighten the barge) until the large set of waves had passed.

1.4.9 The skipper normally transferred the crew to the barge, before crossing the bar, to handle the mooring lines and anchor when the *Sea-Tow* reached the berth. He occasionally crossed the bar without any crew on the barge if he thought conditions outside the bar were too dangerous to effect the transfer. On those occasions, the tow was brought alongside the wharf and the crew jumped ashore and onto the barge.

1.4.10 It was reported that other skippers also crossed the bar without crew on the barge. The written procedure was a relatively new one, and it was assumed by some of the skippers that it only applied to Sea-Tow Limited's new barge, which was substantially bigger than the *Sea-Tow 17*.

1.4.11 Sea-Tow Limited management could not recall being advised by any skipper that kedging the anchor was not, or could not, be carried out.

1.5 Personnel information

1.5.1 The skipper of *Sea-Tow 22* had been working for Sea-Tow Limited, which involved crossing bar harbours, for about seven years prior to the accident. He had entered Greymouth Harbour on numerous occasions before and was considered by the Sea-Tow Limited to be an experienced tug master.

1.5.2 The skipper held a New Zealand Home Trade Masters Certificate and a Vanuatu Master Foreign-Going Tug Licence (for tugs up to 500 gross tonnes).

1.5.3 The chief engineer held a New Zealand Class II Foreign-Going Engineer Certificate, a Vanuatu Chief Engineer of Steam or Motor Tug Licence (restricted to the South-West Pacific) and a New Zealand Coastal Launch Master Certificate. He had worked for Sea-Tow Limited for about three years on the *Sea-Tow 22* and the smaller tug, *Sea-Tow 21*. The chief engineer was familiar with the winch operation, as the tow winches, and the method in which they were used, were similar on all of the Sea-Tow Limited tugs. He had crossed the Greymouth Bar on numerous occasions. He had been working on the *Sea-Tow 22* with the current skipper for about 2.5 months.

1.5.4 The rest of the officers and crew held the qualifications required by Vanuatu for their respective positions.

1.6 Port information

1.6.1 Greymouth is a bar harbour situated about one mile[7] from the mouth of the Grey River. The river is entered from the north-west, between two man-made moles, over a frequently changing bar near the mouth.

1.6.2 The sand and shingle bar extends out to about three cables from the river mouth and is constantly changing due to silt that is carried down by the Grey River, and a strong prevailing south-westerly wind and sea that pushes sand and silt across the entrance.

1.6.3 After long periods of drought, when the river is low, the depth over the bar can be significantly reduced as the sand and silt builds up over the bar due to wave action. When the river is in flood (freshet) the strong flow out of the river mouth scours a deeper channel across the bar. The rate of flow in the river can reach ten knots in freshets, but is normally around two knots depending on the state of the tide.

1.6.4 Across the entrance to the river, tides are generally north-east flowing on a rising tide, and south-west flowing on a falling tide. A northerly set across the bar and river entrance generally masks the tidal effect; however, on occasion a reverse southerly set can be experienced off the moles.

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[7] "Miles", where used in this report, refer to nautical miles unless otherwise stated.

1.6.5 In bad weather the sea breaks heavily over the outer part of the bar. If there is a large swell the bar becomes dangerous and often unworkable. The minimum depth of water over the bar ranges from 4.9 m, after heavy freshets, to 2.4 m during long spells of dry weather. The depth of water over the bar is further affected by the height of the tide, which can range between 0.7 m and 3.4 m above chart datum during mean high water springs.

1.6.6 Heavy freshets can make the bar unworkable due to the large volume of fresh water flowing out of the river mouth and meeting the incoming swell, causing it to stand up and break. Even if a vessel successfully crossed the bar, it would then have to stem a strong current to reach the harbour. In the case of the *Sea-Tow* this could exceed the maximum speed of the tow. A strong outflow also means a vessel takes longer to cross the bar and consequently, is in turbulent waters for a longer period of time.

1.6.7 Vessels entering the river use two leading beacons, keeping them in line to maintain the desired track across the bar. The leading beacons are essential for keeping a vessel in the deepest water, which is the area of least turbulence, when crossing the bar. They also provide a means for detecting, almost immediately, any sideways drift the vessel may experience as it passes through what could be several areas of opposing tidal and weather driven currents.

1.6.8 On 1 November 1989, when all of the remaining harbour boards in New Zealand were abolished, the functions and assets of the Greymouth Harbour Board, the Grey County Council, the Greymouth Borough Council and the Runanga Borough Council were transferred to the newly formed Grey District Council. These functions included the functions of a harbour board under the Harbours Act 1950. The Local Government Reorganisation (West Coast Region) Order 1989 required the District Council to maintain a Harbour Committee until at least 1 November 1995 to advise the Council on its harbour functions.

1.6.9 The Harbour Committee comprised at least two district councillors and such other people as the Council considered had specialist knowledge which would assist in carrying out its harbour functions. The additional people appointed at various times had specialist knowledge of the coal, fishing, timber and transport industries and regional planning and development. The District Council was empowered to delegate its Harbours Act functions to the Harbour Committee, but chose not to. The Harbour Committee was abolished on 1 November 1995.

1.6.10 From 1989 the functions of the Harbour Board were not managed as a distinct entity but absorbed across the functions of the separate departments of the District Council: asset management, finance and administration, and planning and regulations. There was no single person designated as port manager.

1.6.11 The operational and maintenance aspects of the port became the responsibility of the harbour supervisor reporting to the Council's assets manager. The incumbent harbour supervisor in 1989 retired in 1990 when the harbour supervisor was appointed. The current harbour supervisor held a Commercial Launch Master Certificate, Engineer of Local Motor Ship Certificate, and an advanced Trade Certificate in Automotive Engineering.

1.6.12 In 1996, the Council decided that the port should be managed as an entity and called tenders for a Port Services Management Contract. Coast Link Services won the tender and took up an interim contract on 20 March 1997. Coast Link Services was a partnership and the principal partner took up the role of port manager.

1.6.13 When the port manager assumed his role: pilotage was not compulsory for the port, there was no designated person with the powers of a harbourmaster under the Harbours Act and there were not qualified pilots appointed to provide a service if requested. The pilot/work boat was damaged on 31 July 1997 and was out of service awaiting a Council decision on its future. The port manager addressed these issues in a Resource Deployment Report on 9 October 1997.

1.6.14 The harbour supervisor became answerable to the port manager. His role included passing weather, tide and bar information to the users of the port. He would usually stand on the south mole when large vessels were entering or leaving the port, or any other time on request, and use VHF radio to relay information to vessels such as: run in the river, set across the river entrance and wave heights and configuration over the bar.

1.6.15 The status of the Port of Greymouth was, "pilotage not compulsory" and the harbour supervisor did not have the powers of a harbour master under the Harbours Act 1950. Under this regime the harbour supervisor felt that, in the absence of these powers that his advice offered to masters was "advisory only". Even if he thought conditions were not appropriate, he could not stop a vessel entering or leaving the harbour. He also doubted whether masters with superior maritime qualifications would take his advice or direction.

1.6.16 The harbour supervisor also stated that, if the compulsory pilotage status existed, and powers under the Harbours Act were available to him, then he would have been involved in the decision making process at a much earlier stage. He stated that it was unlikely that the 0500 entry for the *Sea-Tow* would have been approved by him, or that he would have been in attendance on the South Mole at that time.

1.6.17 The harbour supervisor further stated that if he had the power to stop the Sea-Tow entering the harbour on the day of the accident, and was asked to make an on the spot assessment of conditions, he may have allowed it to enter based on the knowledge that the skipper had successfully crossed the bar in command of *Sea-Tow 22* and *Sea-Tow 17* in similar conditions in the past.

1.7 Company information

1.7.1 The company originated in 1920's from the scow trade between Northland, Auckland and the Bay of Plenty, carrying aggregates, sand and timber. In 1983 the company was purchased and re-named Sea-Tow Limited.

1.7.2 The company was purchased by Northland Port Corporation (NZ) Limited in 1992 but remained as Sea-Tow Limited, a division of the Northland Port Corporation.

1.7.3 At the inception of Sea-Tow Limited the main cargoes carried were silica sand, fertilisers and aggregates. With industry and economic changes, the company expanded its operation to encompass more of the New Zealand Coast, and later to Trans-Tasman trade. Bigger tugs and barges were built to accommodate the change in trade.

1.7.4 At the time of the accident, Sea-Tow Limited had two larger tug and barge units, the smaller of which was the tug *Sea-Tow 22* and barge *Sea-Tow 17*, which traded around the New Zealand and to Australia; and two smaller tug and barge units, which traded around the New Zealand coast only.

1.7.5 Sea-Tow Limited's newest and largest tug, the *Sea-Tow 25*, was undergoing entry into the International Safety Management System at the time of the accident involving *Sea-Tow 22*. It was planned that implementation of a safe ship management system would be complete by the middle of February 1998, and that most of the procedures and work instructions would be applied to the other tugs in the fleet.

1.7.6 Northland Port had attained International Standards Organisation (ISO) accreditation to quality standard 9001, and as a division of the corporation, Sea-Tow Limited gained ISO quality assurance standard 9002.

1.7.7 Starting in March 1997, Sea-Tow Limited management arranged a programme of two-day, in-house training modules to foster professional development for tug crews, leading to safe and effective ship management and quality assurance. The concept of teamwork, shared problems, and planning were a few of many topics addressed.

1.7.8 Each module was repeated several times so that all crew members could attend. The venue for the training was Auckland. Sea-Tow Limited was an Auckland based company and all crew members were expected to report to Auckland at the beginning of each contract on board, irrespective of where they chose to live. Similarly, crew were expected to attend the training modules at their own expense; however, Sea-Tow Limited did not deduct any leave for the days the crew attended.

1.7.9 Some of the Sea-Tow Limited crew members did not attend the modules because they felt that the company should have paid their travel to, and accommodation during each module. One of the crew members who did not attend was the chief engineer on the *Sea-Tow 22* at the time of the accident.

2. Analysis

2.1 The approach to the harbour

2.1.1 Whatever the significant swell height in any given area, it can be assumed that periodically, a larger set of swells will pass through the area. When swells reach shallow water, it is normal for them to slow, rise in height, and for the period between them to shorten. In addition, if swells are met by an opposing current, such as that coming out of the Grey River, they will rise and steepen further.

2.1.2 The sea conditions over the bar as the *Sea-Tow* approached were, in the skipper's own words, "towards the extreme". They were, in the skipper's opinion, not suitable to effect a crew transfer to the barge safely before approaching the bar. The set of larger waves that passed under the *Sea-Tow* as it was crossing the bar, and the larger wave that caused the tow line to part, were not freak waves.

2.1.3 With a 2 m significant swell outside the bar and a two knot flow in the Grey River, as estimated by the harbour supervisor, a 4 m wave over the bar would not be considered unusual. Given that the flow in the river was later observed to be about 4 knots, such a wave could be expected.

2.1.4 In making his assessment of the bar, the skipper took the following factors into consideration before proceeding in:

- there were long lulls between the larger sets of waves
- he thought the run in the river had been reported by the harbour supervisor as being no more than two knots

- he had successfully crossed the Greymouth Bar in similar conditions in the past
- the set across the entrance of the moles was reported as being minimal.

2.1.5 The harbour supervisor, in making his assessment, took the following factors into consideration:

- he thought the run in the river was two to three knots only
- the set across the entrance of the moles was minimal
- he had seen that *Sea-Tow* successfully cross the bar in worse conditions.

2.1.6 About 12 hours after the accident, when the tide was at a similar state to that when the accident occurred, the Commission's Investigator-in-Charge made a crude assessment of the river flow by recording the time taken for a floating object to travel the length of the barge. Results indicated that the rate of flow was 4.5 knots. The difference in opinions on the rate of flow in the river highlights the need for equipment to be installed that can accurately determine the rate of flow and height of tide in the river, and the swell height over the bar.

2.1.7 Although the skipper may have been misinformed about the run in the river, it is unlikely that any tug and barge the size of the *Sea-Tow* would be able to cross the bar within a single lull, even if the run in the river was only two knots. While long lulls do provide opportunities to speed the progress of the tow, and adjust for any set, the larger sets of swells either side of the lulls are the ones which will do any damage. The lulls therefore, should not have been a persuading factor when deciding whether to attempt the bar crossing.

2.1.8 According to most of the witnesses, the set across the entrance to the moles did not appear to have been significant during the attempt to enter the river, so it is unlikely that the set was a factor contributing to the tow wire parting.

2.1.9 The explanation "we/they had successfully crossed the bar in worse conditions before" is perhaps more a measure of the skill of the various tug crews than an indication that each of those crossings was made in safety.

2.1.10 Entering bar harbours will always involve an extra element of risk due to the unpredictable nature of the conditions over the bar. For this reason, the skipper and the harbour supervisor (in his advisory role) should have erred on the side of caution when assessing whether a crossing was to be attempted. If crossings are consistently made in marginal conditions, it is only a matter of time before a lapse in concentration, or some unforeseen event, results in an accident.

2.1.11 The harbour supervisor lacked the necessary powers under the Harbours Act to restrict traffic into and out of the harbour. Additionally, judging from his comments, there existed an element of authority gradient between him and the skippers of incoming vessels, whereby he held a Commercial Launch Master Certificate only, which was several grades lower than the certificates held by the Sea-Tow Limited skippers.

2.1.12 Without any person ashore to make a firm decision as to whether a vessel could enter or not, the decision was left up to the crew of the *Sea-Tow 22*. The skipper of *Sea-Tow 22* made the decision to attempt to enter the harbour without consulting the rest of the crew. The lack of authority from ashore, combined with the one-person decision making environment that existed on board the *Sea-Tow 22*, meant that one-person errors or unsound decisions could go undetected or unchallenged with the potential for them to lead to an accident.

2.1.13 The skipper stated that there was no commercial pressure for him to make port that day; however, the operation had already been delayed one day, and the small window of opportunity to enter the harbour that morning, load during the day and depart on the high tide that same afternoon would have been a tempting prospect for most skippers. The "long lull", and "we have done it before" considerations would have been the skipper's justification for making what he knew was a marginal decision.

2.1.14 When the first set of larger waves passed under the *Sea-Tow*, there was still time for the skipper to abort the approach. His comment over the radio to the harbour supervisor about hoping there were no more waves like those, was an indication that he should have been considering aborting the run in. The skipper not aborting at that time indicates a certain level of fixation on entering Greymouth. A challenge from the harbour supervisor, or any member of the crew, at that time may have prompted the skipper to review his plan. Had the chief engineer been within easy communication with the skipper, he would have been able to relate to him the difficulty he was having controlling the tow wire. This too may have prompted the skipper to abort the run in.

2.1.15 The run in the river was such that the ground speed of the *Sea-Tow* was all but stopped by the time the tug entered the river, leaving the *Sea-Tow 17* in a position over the bar where it was vulnerable to wave action. The chief engineer appears to have become so focused on playing the tow line in what he described as very difficult conditions, that he did not notice that he had shortened the tow almost to the length normally used in sheltered confined waters.

2.1.16 The skipper was aware that the tow line was shorter than he would have liked, but did not seem to be aware how short it was. With most of the catenary gone from the tow line, and the skipper applying power to the tug to get the *Sea-Tow* moving over the ground, it would have taken only a moderate opposing motion between the tug and the barge for the tow line to become taut and exceed its breaking strain. When the *Sea-Tow 17* wallowed off the back of the larger wave, and the chief engineer could not pay out the cable in time to relieve the tension, the tow wire parted.

2.2 Attempted salvage

2.2.1 Once the tow wire parted, the skipper's quick decision to turn the tug and try to retrieve the emergency tow line was appropriate, and had the recovery pennant been available to retrieve, the emergency tow wire could have been connected, and the groundings may have been avoided.

2.2.2 Each of the quick decisions the skipper made subsequent to realising the recovery pennant could not be retrieved had merit; however, with the skipper's attention focused on putting a line onto the barge he appeared to have lost situational awareness, and was unaware that both the barge and the tug were drifting steadily into shallower water. In such a situation, it was not practicable for the skipper to consult with the crew before making each decision; however, a challenge from any member of the crew may have prompted him to take a step back, regain situational awareness and pull the tug away, leaving the unmanned barge to ground with no danger to life.

2.2.3 The skipper was initially relying on his experience of two years prior for the likely depth of water off Cobden Beach. Information relating to depths on and around a bar harbour outdates quickly. Had the harbour supervisor's advice on the shallow water been given earlier, it too may have prompted the skipper to pull out to sea before the tug grounded.

2.3 Communications and team work

2.3.1 The teamwork and "shared problem" approach to the operation of the tug, promoted at the in-house training modules, had not been fostered by the skipper of *Sea-Tow 22*. This could be, in part, due to some persons on board not attending the training modules.

2.3.2 Notwithstanding the apparent lack of teamwork and communication on the *Sea-Tow 22*, the location of the towing winch control station near the weather deck made communication between the winch operator and the skipper difficult.

2.3.3 The method adopted by Sea-Tow Limited over the years, where the tow line is controlled by both, the skipper with the engines, and the winch operator playing the wire, requires good communication between the two.

2.3.4 It was virtually impossible for the skipper on the flying bridge to communicate directly with the chief engineer at the towing winch control. The communication gap was partially closed by positioning the second engineer on the wheelhouse deck; however, with the noise of the fans, machinery and the weather elements, the situation was far from ideal.

2.3.5 Over the years, various methods to improve communications between the winch operator and the skipper had been tried, but were generally unsuccessful due to the winch operator requiring both hands for his task: one to hold on and the other to operate the winch. Radio and intercom communications were found to be unreliable due to water ingress.

2.3.6 Additionally, the safety of the winch operator close to the weather deck, which was often awash, is questionable. If the towing winch could be controlled remotely from the boat deck, the operator: would be above the weather deck, would have an unobstructed view of the tow wire and the barge, would be in shouting distance of the skipper on the flying bridge, and would be beside him if the skipper were operating the tug from the aft conning station in other situations.

2.4 Towing procedures

2.4.1 The only written procedure Sea-Tow Limited offered to its tug crews for entering bar harbours was that requiring skippers to kedge the stern anchor from the barge when entering port, and by inference, to have crew on the barge before entering port.

2.4.2 There appeared to be many other procedures that Sea-Tow Limited crews were following, that had evolved through experience and verbal instruction from the company, such as leaving the brake off the tow winch when crossing the bar and playing the wire.

2.4.3 Several of the Sea-Tow Limited skippers were not following the one written procedure, apparently because various skippers had different ideas on the right way to do it, yet the unwritten procedures seemed to be followed religiously.

2.4.4 In an environment where most decisions are left up to the tug skippers, it is important that effective crew resource management is practised on board the tugs to lessen the likelihood of one-person errors leading to accidents.

2.4.5 The tow line would have parted, regardless of whether the skipper had crew on the barge; however, not having crew on the barge after the tow line parted reduced the skipper's options and hindered the attempts to reconnect the tow.

2.4.6 It is unlikely that kedging the stern anchor would have prevented the tow line parting; conversely, it is arguable that kedging the stern anchor, if not controlled properly, could cause the barge to pull up, increasing the strain on the tow line.

2.4.7 Whether to kedge the anchor off the stern of the barge or not, is not considered to be a safety issue, but an operational issue between Sea-Tow Limited and their staff; however, it would be prudent for both Sea-Tow Limited and the Grey District Council, in the interests of safety, to require crew on the barge before the *Sea-Tow* tug and barge combinations cross the bar.

2.4.8 Much of the damage to the towing winch was caused by the winch drive components taking the bulk of the load from the wire before it parted. If the brake had been applied, it is unlikely that any damage would have occurred to the hydraulic drive components. From a safety aspect, risking damage to the winch drive system is the preferred option, if it lessens the likelihood of the tow wire parting while entering a harbour.

3. Findings

Findings and any safety recommendations are listed in order of development and not in order of priority.

3.1 The sea conditions over the Greymouth Bar, combined with the run in the Grey River, created marginal conditions for the *Sea-Tow* to have entered Greymouth Harbour on the morning of the accident.

3.2 The skipper may have been misinformed of the run in the river by the harbour supervisor; however, conditions would still have been marginal if the run in the river was as reported.

3.3 The skipper made the decision to enter the harbour without consultation with his own crew, and without effective input from the harbour supervisor.

3.4 The harbour supervisor not having the powers under the Harbours Act necessary to control traffic entering or departing Greymouth, and the authority gradient between himself and the skipper of the *Sea-Tow 22*, rendered him ineffectual in the decision making process.

3.5 The scantlings and condition of the towing equipment between the tug *Sea-Tow 22* and barge *Sea-Tow 17* were adequate to sustain normal working loads, when prudent seamanship was applied.

3.6 A combination of the marginal wave conditions over the bar, the length of the tow line being too short for those conditions, and the skipper being preoccupied with checking the position of the *Sea-Tow* in the river, caused a strain in the tow wire in excess of its specified normal breaking strain, and it parted.

3.7 The chief engineer focusing on playing the tow wire in the marginal conditions, his limited over-all view of the tow line and barge, and poor communications between him and the skipper resulted in the tow line becoming too short.

3.8 The poor positioning of the chief engineer's winch control in relation to the skipper's conning position on the flying bridge, made it difficult for them to communicate effectively.

3.9 By not having crew on the barge, the skipper reduced the options available to him, before and after the tow wire parted.

3.10 Once the tow line parted, the skipper relied on outdated knowledge of depths in the area and became so focused on the task of connecting another tow line to *Sea-Tow 17*, that he lost situational awareness and caused the tug to run aground.

3.11 If the crew of *Sea-Tow 22* were working in an environment of open challenge and response with the skipper, and the harbour supervisor had provided his advice earlier, some one might have alerted the skipper that the tug was moving into shallow water, and the grounding of the tug *Sea-Tow 22* averted.

3.12 The action taken by the skipper was successful in preventing the barge from grounding on the rocky north mole, or the wreck just off the mole; however, it resulted in collision damage to the tug and barge, and compromised the safety of the tug and crew.

4. Safety Recommendations

4.1 It was recommended to the Grey District Council Port Manager that the Grey District Council:

4.1.1 Take the necessary steps to acquire the powers of a harbour master under the Harbours Act, and make by-laws giving those powers to an appropriate officer of the council (001/98); and

4.1.2 Consider introducing a compulsory pilot, and pilot exemption scheme for the Greymouth Harbour. (002/98)

4.2 The Port Manager for the Grey District Council responded as follows:

4.2.1 Recommendations have been made to the Grey District Council that staff resource be enhanced by:

a) Upgrading the position of Harbour Supervisor to Operations Manager/Harbourmaster and retaining the present officer in the upgraded position.

b) Engaging on part-time contract a maritime operations adviser and Chief Pilot with the qualifications of Master Mariner, to provide professional support to the Operations Manager/Harbourmaster and oversee pilotage and pilotage exemptions functions

c) Enlisting a team of part-time contract pilots to provide pilotage

Action taken is:

a) Potential candidates for the positions of maritime operations adviser and Chief Pilot and part-time contract pilots have been contacted. Most have declined the position, but three interested candidates have been identified. A job description and employment contract is being drawn up so that an appointment can be pursued.

b) An amendment to the Greymouth Harbour Bylaws 1969 to provide a compulsory pilotage and pilotage exemption scheme is being drawn up for consideration by the Council. It is expected that, if Council approves, the recommendations could be implement by 31 December 1998.

4.3 It was recommended to the Chief Executive of Sea-Tow Limited that Sea-Tow Limited:

4.3.1 Liaise with the appropriate sea staff and document recommended procedures for deep-sea and harbour towing, including guide lines for entering and leaving bar harbours (003/98); and

4.3.2 Continue to implement good crew resource management on all of their tugs (004/98); and

4.3.3 Clarify and reinforce the procedure whereby all barges must be manned when in or approaching confined waters. As these procedures will vary between ports, consultation with the relevant port authorities should be undertaken (005/98); and

4.3.4 Install remote control for the towing winches on their tugs in a location where the winch operator can effectively communicate with the skipper, and can work in relative safety with a good view of the tow line (006/98); and

4.4 The Marine Superintendent for Sea-Tow Limited responded as follows:

4.4.1 003/98: Although this has been done verbally over many years, it has now been documented in company procedures as part of compliance with the I.S.M. Code, currently being introduced into the company.

4.4.2 004/98: This has always been the endeavour of the company and will continue to be aggressively pursued in the future.

4.4.3 005/98: The manning of barges on entering and leaving harbours has always been a requirement at Sea-Tow; however, the point at which the crew is transferred to and retrieved from the barge varies at different ports. Transfer is effected by the tug, assist tug, or pilot boat. In some cases, such as Brisbane, Melbourne, Auckland etc. this is not carried out, but prior to berthing, the crew board the barge via the tug or pilot boat.

4.4.4 006/98: Sea-Tow believes that the winch operator should remain at the winch, so that he is closer to the engine room in case of an engine stall, and he can assist on deck with making up and letting go the tow.

Sea-Tow proposes the following instead:

- communications will at all times be carried out by the use of hands-free walkie talkies, and
- a platform will be built, in the case of the Sea-Tow 22, so that the winch operator has a more secure position in which to work.

5. Safety Actions

5.1 The Grey District Council included in its Annual Plan 1997-98, financial provision for installing equipment to enable the port staff to have direct telephone dial access to the West Coast Regional Council's river height recording equipment at Dobson, up river from the port. Changes in river height at Dobson give an indication of later changes in river velocity at the port. Consent was granted by the Regional Council in February 1998 and the equipment has been ordered. Installation is to be in conjunction with Regional Council improvement of the recording equipment and is expected to be completed by 30 June 1998.

5.2 The Port of Greymouth Manager has submitted a proposal to the Grey District Council that it make financial provision in its 1998-99 Annual Plan that equipment be installed in or near the entrance to the harbour to give accurate data on height of tide, river flow, and wave height over the bar. It is proposed that readings from the equipment would be made available to all port users. At the time of release of the report the proposal was under consideration by the Grey District Council for inclusion in the Draft Annual Plan to be released for public submission. If finally approved, some of the equipment (depending on feasibility and cost) may be installed by 30 June 1999. The installation of such equipment appears essential to the safe operation of the port.

15 April 1998

W P Jeffries
Chief Commissioner

Glossary of marine abbreviations and terms

aft	rear of the vessel
beam	width of a vessel
bilge	space for the collection of surplus liquid
bridge	structure from where a vessel is navigated and directed
bulkhead	nautical term for wall
cable	0.1 of a nautical mile
chart datum	zero height referred to on a marine chart
command	take over-all responsibility for the vessel
conduct	in control of the vessel
conning	another term for "has conduct" or "in control"
deckhead	nautical term for ceiling
dog	cleat or device for securing water-tight openings
draught	depth of the vessel in the water
EPIRB	emergency position indicating radio beacon
even keel	draught forward equals the draught aft
freeboard	distance from the waterline to the deck edge
free surface	effect where liquids are free to flow within its compartment
focsle	forecastle (raised structure on the bow of a vessel)
GM	metacentric height (measure of a vessel's statical stability)
GoM	fluid metacentric height (taking account the effect of free surface)
GPS	global positioning system
heel	angle of tilt caused by external forces
hove-to	when a vessel is slowed or stopped and lying at an angle to the sea which affords the safest and most comfortable ride
Hz	hertz (cycles)
IMO	International Maritime Organisation
ISO	International Standards Organisation
kW	kilowatt
list	angle of tilt caused by internal distribution of weights
m	metres
MSA	Maritime Safety Authority
NRCC	National Rescue Co-ordination Centre
point	measure of direction (one point = 11¼ degrees of arc)
press	force a tank to overflow by using a pump

SAR	Search and rescue
SOLAS	Safety Of Life At Sea convention
sounding	measure of the depth of a liquid
SSB	single-side-band radio
statical stability	measure of a vessel's stability in still water
supernumerary	non-fare-paying passenger
telegraph	device used to relay engine commands from bridge to engine room
ullage	distance from the top of a tank to the surface of the liquid in the tank
VHF	very high frequency
windlass	winch used to raise a vessels anchor