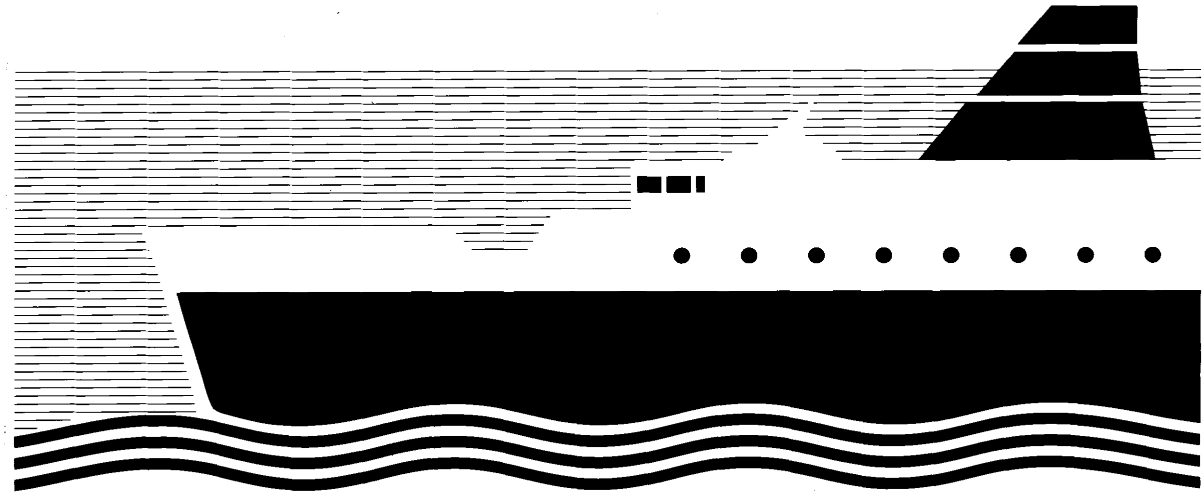
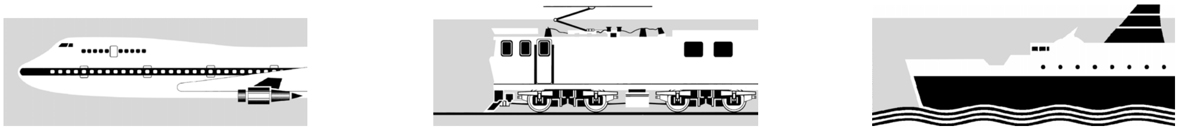


MARINE OCCURRENCE REPORT

03-206 tanker *Capella Voyager*, grounding, Whangarei 16 April 2003



TRANSPORT ACCIDENT INVESTIGATION COMMISSION

NEW ZEALAND

Report 03-206

tanker
Capella Voyager

grounding

Whangarei

16 April 2003

Abstract

On Wednesday 16 April 2003, at about 1820, the motor tanker *Capella Voyager* grounded while entering Whangarei Harbour to berth at Marsden Point Oil terminal. The hull in the area of the forepeak tank was set up, creased and ruptured, water flooded into the forepeak tank.

The *Capella Voyager* subsequently berthed safely at the oil terminal where the cargo was discharged. Temporary repairs were effected and the forepeak pumped out at Marsden Point before the ship sailed for Singapore to complete permanent repairs. There was no discharge of oil into the environment.

Safety issues identified included:

- adequacy of provision of swell data for waters at the entrance to Whangarei Harbour
- adequacy of berthing limitations in adverse swell conditions
- adequacy of knowledge of a vessel's physical movements over the vestigal bar in dynamic conditions.

In view of the safety actions taken by the Maritime Safety Authority, Northland Regional Council, Northport and North Tugz Limited no safety recommendations have been made.

Capella Voyager alongside Marsden Point oil refinery wharf at Whangarei

Contents

Figures

Abbreviations

✠A1E	class notation indicating the hull of a ship is built under survey to ABS requirements for unrestricted sea service and that the anchoring and mooring equipment meet ABS requirements
✠ACCU	class notation indicating that a ship is fitted with Automatic Centralized Control Unmanned
✠AMS	class notation assigned to machinery and boilers constructed and installed to ABS Rules requirements
ABS	American Bureau of Shipping
ARPA	automatic radar plotting aid
ECDIS	electronic chart display and information system
GPS	global positioning system
kt(s)	knot(s)
kW	kilowatt(s)
nm	nautical mile
rpm	revolutions per minute
t	tonne(s)
UHF	ultra high frequency
VHF	very high frequency

Glossary

ARPA	automated system to plot and monitor targets on radar. Used by a watchkeeper to assist in collision prevention
ballast	weight, usually seawater, put into a ship to improve stability
bow	the front of a ship
bulkhead	the term given to a wall on a ship
chart datum	zero height referred to on a marine chart
collision bulkhead	strong bulkhead usually located 5% of ship's length astern of the stem. It is only pierced by piping which is generally closed by a valve. Designed to prevent a ship from flooding after a head on collision
con (conduct)	directing the course and speed of a ship
course	direction steered by a ship
displacement	the amount of fluid, measured in tonnes, displaced by an object floating or immersed in it
doppler log	a device that uses the doppler effect to measure a ship's speed
draught	depth in water at which a ship floats
ECDIS	a type-tested navigation system that displays selected information from electronic charts along with positional information from navigation sensors
echo sounder	a device for measuring the depth of water below a ship's bottom
forecastle	raised structure on the bow of a ship
frame(s)	the ribs of a ship much like a skeleton
gross tonnage	a measure of the internal capacity of a ship; enclosed spaces are measured in cubic metres and the tonnage derived by formula
helm	the amount of angle that the rudder is turned to port or starboard to steer the ship
heading	direction in which a ship is pointing at any moment
heave	the oscillatory vertical rise and fall, due to the entire hull being lifted by the force of the sea. Also called heaving
knot	one nautical mile per hour
leading lights	light(s) that identify the safest track in a channel. Used by the mariner to monitor and maintain a ship's position within a channel
made fast	tied up, attached
port	left hand side when facing forward
significant wave height	average height of the highest one third of the waves
starboard	right hand side when facing forward
tidal stream	the horizontal movement of the water due to tide
tidal window	the time range during which there is enough water or the tidal stream is at a slow enough rate for a ship to enter or leave a port
ullage	the depth of the space in a tank not occupied by fluid
under keel clearance	the clearance between the bottom of a ship and the seabed
wave period	the time taken for two successive crests to pass a fixed point

Data Summary

Ship Particulars:

Name:	*Capella Voyager*
Type:	tanker
Class:	ABS ✠A1E "Oil Carrier", ✠AMS, ✠ACCU
Classification:	American Bureau of Shipping
Length (overall):	258.90 m
Breadth (extreme):	48.30 m
Gross tonnage:	80 914
Built:	Ishibras, Rio de Janeiro, 1992
Propulsion:	Sulzer 6RTA72, direct reversing diesel engine
Service speed:	loaded 14.2 kts ballast 16.2 kts
Owner:	Chevron Transport Corporation Limited, Bermuda
Operator:	ChevronTexaco Shipping Company LLC, California
Port of Registry:	Nassau, Bahamas
Minimum crewing requirement:	16
Date and time:	16 April 2003, at about 1820[1]
Location:	Whangarei
Persons on board:	crew: 27 passengers: nil
Injuries:	nil
Damage:	hull plating deformed forward of the collision bulkhead and ruptures in way of the forepeak water ballast tank
Investigator-in-charge:	Captain I M Hill

[1] All times in this report are New Zealand Standard Time (UTC +12 hours) and are expressed in the 24 hour mode.

1 Factual Information

1.1 History of the event

1.1.1 On Wednesday 16 April 2003, at about 1820, the motor tanker *Capella Voyager* grounded in the entrance channel of Whangarei Harbour while the ship was entering the port.

1.1.2 The *Capella Voyager* arrived off the port of Whangarei at 0300 on Wednesday 16 April 2003. The master conned the ship onto the leading line of 320º about 2 nm from the Fairway buoy. Once the ship was settled onto the new heading, the bridge team intending to embark a pilot at the pilot boarding station decided that the ship's movement, due to the weather and swell conditions, was outside their criteria for berthing.

1.1.3 The master of the *Capella Voyager* informed the pilot by very high frequency (VHF) radio that the movement of the ship was too great to allow safe entry into the port and cancelled the berthing operation. The pilot, aboard the waiting pilot boat, agreed to the cancellation and informed the master that the next available pilot boarding time for berthing would be 1800 that evening.

1.1.4 The master of the *Capella Voyager* conned the ship into clear water to drift and await the next pilot boarding time (see Figure 1).

1.1.5 The master of the *Capella Voyager* was in contact by satellite communications with the ship's agent and the general manager of North Tugz, the harbour operators, during the day. North Tugz requested that at the next pilot boarding time a pilot join the ship to assess the situation, irrespective of whether or not the ship entered harbour. The master agreed to this request.

1.1.6 At about 1600 the master conned the ship back towards the entrance, arriving onto the leading line by about 1630, to await the pilot. The sea and swell had moderated and the master thought that the movement of the ship was such that it could berth safely.

1.1.7 At approximately 1730, 2 pilots boarded the ship about 2 nm from the Fairway buoy (see Figure 1). After discussion with the master agreement was reached that a "dry run" would be made towards the Fairway buoy to assess the ship's movement on the approach. The ship was steadied on the leading line course of 320º and the approach made. At about 1 nm from the Fairway buoy, a slow turn of 360º to starboard was made.

1.1.8 Once clear of the Fairway buoy the master and pilots discussed and agreed that they could proceed with the berthing. A full berthing meeting was then held between the master, pilots and relevant ship's crew where one of the pilots was nominated to conduct the berthing (the pilot).

1.1.9 The *Capella Voyager* completed the turn and the pilot conned the ship onto the leading line to make the approach. At about 1813, the bridge of the *Capella Voyager* passed the Fairway buoy, at a speed of about 5 knots, with the ship positioned in the deepest part of the channel slightly to the north of the leading line (see Figure 2).

1.1.10 At about 1815 the *Capella Voyager* pitched by the head, rolled, shuddered and then pitched, rolled and shuddered again. The bridge team believed that the ship had made contact with the channel bottom forward. The second officer, who was stationed forward, reinforced this belief when he contacted the bridge by UHF radio and said that the forward mooring party thought that the ship had made contact with the bottom.

1.1.11 The *Capella Voyager* was by this time committed to the channel, so the pilot continued to con the ship into port. The master instigated procedures to determine whether or not the ship had made contact with the bottom. The ship was still handling normally and inspection of the echo sounder trace did not show clearly if the ship had made contact with the bottom.

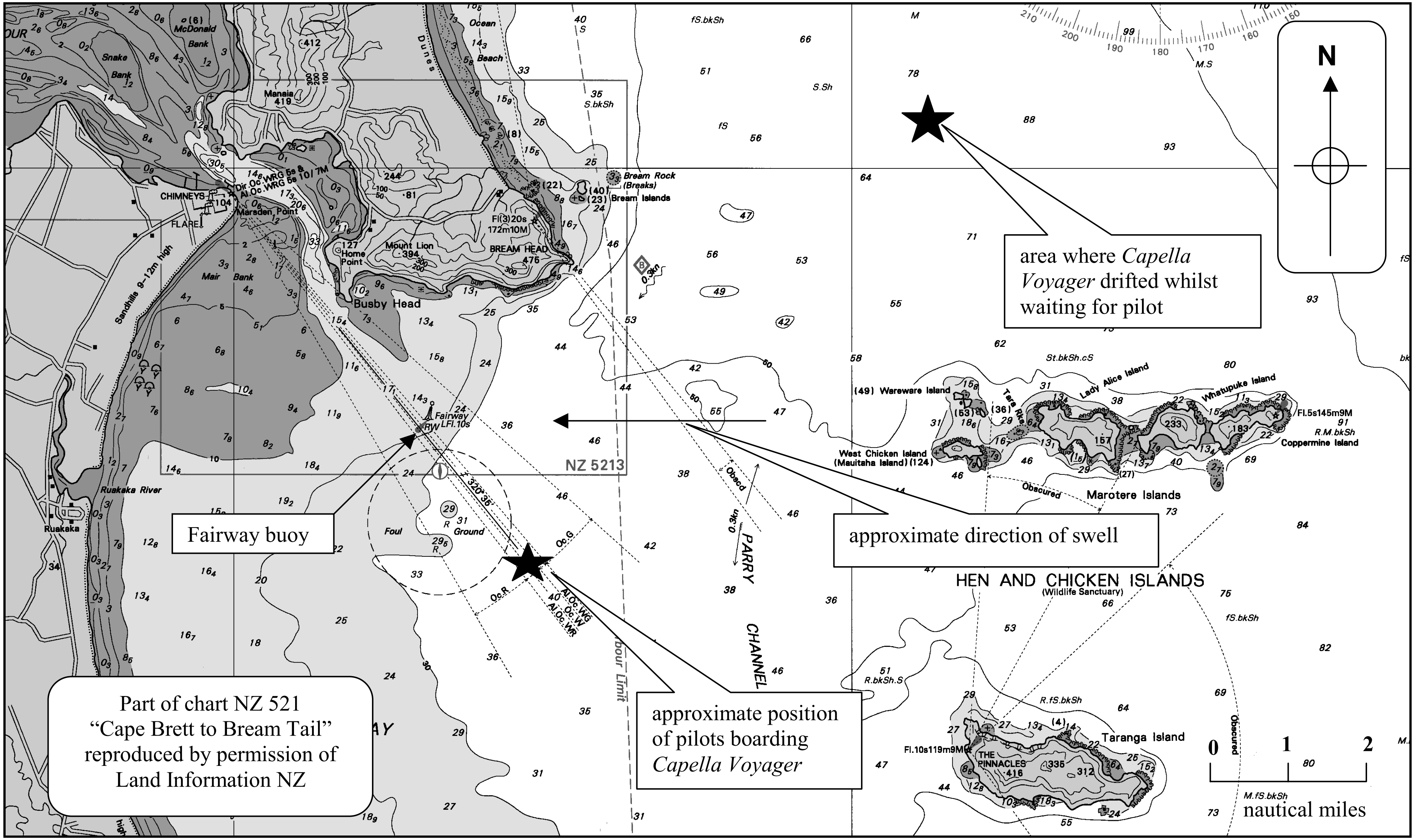


Figure 1
General area of the accident

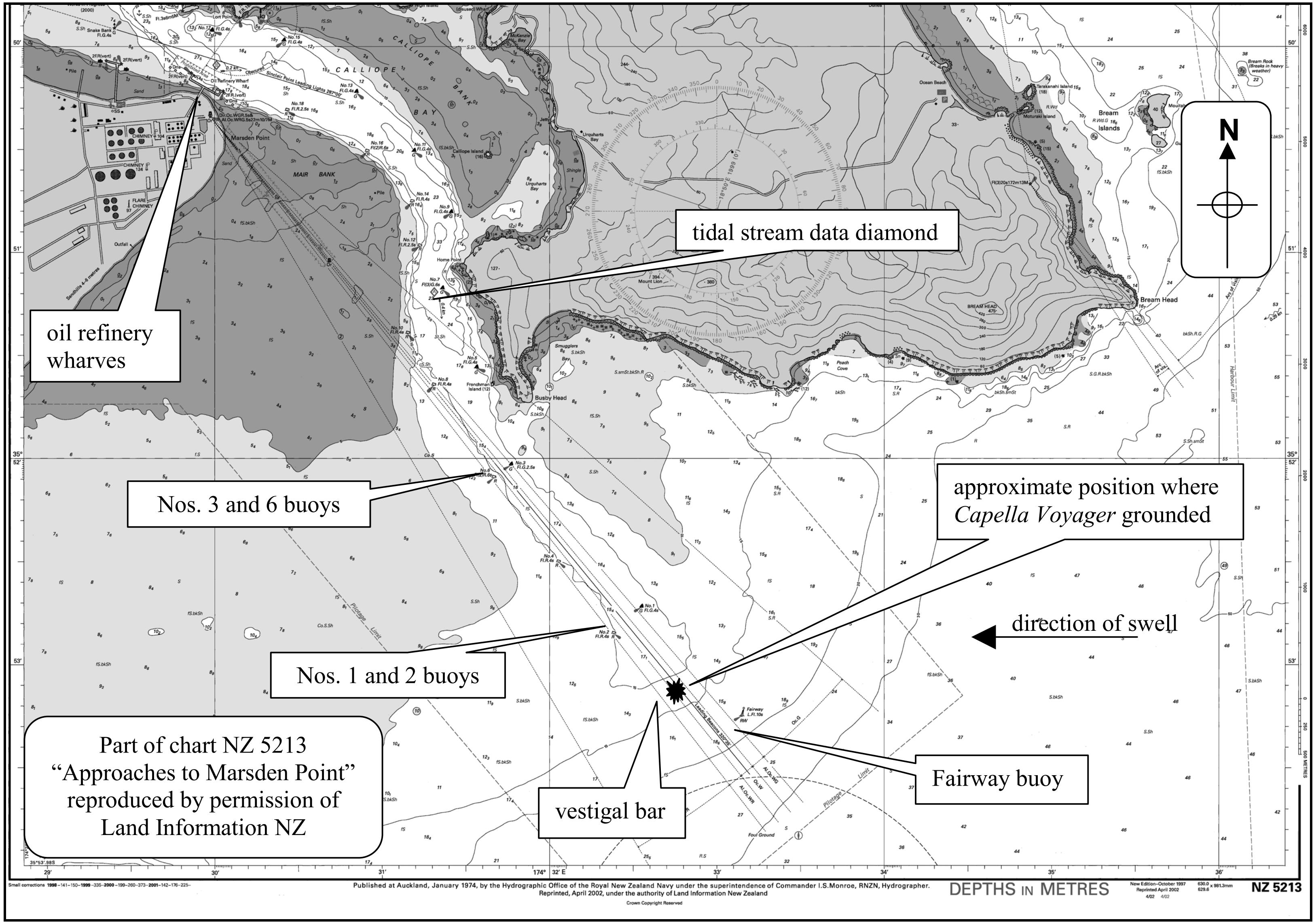


Figure 2
Whangarei approach channel

1.1.12 When the *Capella Voyager* started to make fast at Marsden Point Refinery jetty, the master sent the chief officer to check the tank gauges, as a first indication of possible damage. The chief officer found that the forepeak tank gauge reading was 8 m, when the reading before arrival had been empty. All other gauges were at the readings prior to arrival at Whangarei.

1.1.13 The chief officer instructed the crew to take hand sounding of the fore peak tank, which confirmed the gauge reading. He also organised that all ballast tanks should be hand sounded and cargo tank ullages taken and then verified by hand ullaging.

1.1.14 The ship's staff were concerned that the increase in forward draught due to the flooded forepeak tank would cause the ship to ground whilst alongside the oil terminal. When the *Capella Voyager* was safely moored, arrangements were made to discharge the cargo as soon as it had been ascertained that none of the cargo tanks were broached.

1.1.15 Divers surveyed the hull but were only able to work during slack water periods due to the strength of the tidal current flowing past the jetty. A series of inspections confirmed that the damage to the hull was confined to the forefoot in way of the forepeak tank.

1.1.16 Temporary repairs were made at Marsden Point before the ship was allowed to sail for Singapore to make permanent repairs.

1.2 Ship and equipment information

1.2.1 The *Capella Voyager* an oil tanker built in Brazil in 1992, was owned by the Chevron Transport Corporation Limited, a Bermudan corporation, a wholly owned subsidiary of the ChevronTexaco Corporation. ChevronTexaco Shipping Company LLC of California operated the tanker. The ship was registered in the Bahamas and had valid certificates issued by or on behalf of that government and the American Bureau of Shipping (ABS).

1.2.2 The *Capella Voyager* had an overall length of 258.9 m and a breadth of 48.3 m, with a gross tonnage of 80 914. It had a mean summer draught of 16.785 m giving a displacement of 159 478 t. The ship's arrival draught at Whangarei, prior to the grounding was 14.39 m forward and 14.42 m aft giving a displacement of 134 134 t. The ship was carrying about 107 800 t of crude oil.

1.2.3 The ship was powered by a single Sulzer 6RTA72 direct reversing diesel engine, developing 15 445.50 kW driving a single fixed-pitch 5-bladed propeller giving a loaded service speed of 14.2 kts. It had a single semi-balanced rudder, located directly behind the propeller, capable of a maximum angle of 45º with ship's speeds between zero and 8 kts and limited to 30º at ship's speeds above 8 kts. The *Capella Voyager* was not fitted with a bow thruster.

1.2.4 The manoeuvring speeds for the *Capella Voyager* were as follows:

Condition	RPM	Speed	
		Loaded	Ballast
Full Ahead	57	9.9 knots	11.3 knots
Half Ahead	46	7.9 knots	9.1 knots
Slow Ahead	35	6.0 knots	6.8 knots
Dead Slow Ahead	27	4.6 knots	5.2 knots

1.2.5 The ship was fitted with 2 ARPA radars, which were both positioned to starboard of the centre of the wheelhouse. Other navigation aids included Doppler log, 2 differential GPS receivers, 2 echo sounders, 2 ECDIS systems, 3 VHF radios, 2 gyro compasses with repeaters and a magnetic compass. All navigation equipment was reported to have been functioning correctly at the time of the grounding.

1.2.6 Gyro compass repeaters were positioned at the steering position, to port of the centreline in the wheelhouse, and one on each bridge wing. The wheelhouse repeater and the 2 bridge wing repeaters were of the conventional bowl type, with the 2 bridge wing repeaters pedestal mounted and the wheelhouse repeater mounted on the forward bulkhead. In addition to the repeaters, both radars and the ECDIS system had heading readouts on them.

1.3 Personnel and port company systems

1.3.1 North Tugz Limited was a new joint venture maritime services provider for the port of Whangarei. This organisation was formed at the beginning of April 2003 between the original North Tugz, a division of the Ports of Auckland, and Northport Limited, a joint-venture between Port of Tauranga and Northland Port Corporation formed in 2002. Ports of Auckland had formed North Tugz when it had taken over as the maritime services provider to the Marsden Point refinery in 1999 from the Northland Port Corporation (NZ) Limited.

1.3.2 Four pilots were available in the port of Whangarei. North Tugz Limited employed 3 of the pilots, one of whom was also the Marine Manager for North Tugz Limited. The fourth pilot was employed by the Northland Port Corporation but was fully incorporated into the working roster of North Tugz Limited.

1.3.3 All the pilots were qualified to handle tankers into the Marsden Point oil refinery. The 2 pilots on board the *Capella Voyager* at the time of the grounding were both employed by North Tugz Limited.

1.3.4 The pilot who was conning the *Capella Voyager* at the time of the grounding had gone to sea as a deck officer apprentice in 1971. He gained his Master's foreign going certificate in 1982 and was promoted to master in 1990. In 1995 he commenced work with the Northland Ports Corporation and gained a restricted pilot licence in 1996. In 1998 he became an unrestricted pilot. He had recently finished re-familiarisation with berthing procedures at the refinery, as he had not been piloting into the refinery for the previous 2½ years.

1.3.5 The accompanying pilot had gone to sea as a deck officer apprentice in 1963. He gained his Master's foreign going certificate in 1976, and in the same year commenced work with the Northland Harbour Board, Northland Ports Corporation predecessor. By 1988 he had become an unrestricted pilot for the port of Whangarei. He had completed his re-familiarisation and had resumed piloting ships into the refinery in November 2002.

1.3.6 The *Capella Voyager* had a complement of 27, comprising a Swedish master, an Italian chief engineer, with the remainder being of multinational origins. At the time of the grounding the master, chief officer, deck cadet, helmsman, lookout and ship's clerk were on the bridge. One of the 2 second officers was stationed forward.

1.3.7 The master of the *Capella Voyager* had gone to sea in 1964 and had gained his Master's foreign going certificate in 1971, and was promoted to master in 1979. He had spent the previous 31 years working for Chevron group and had sailed on oil tankers of all sizes.

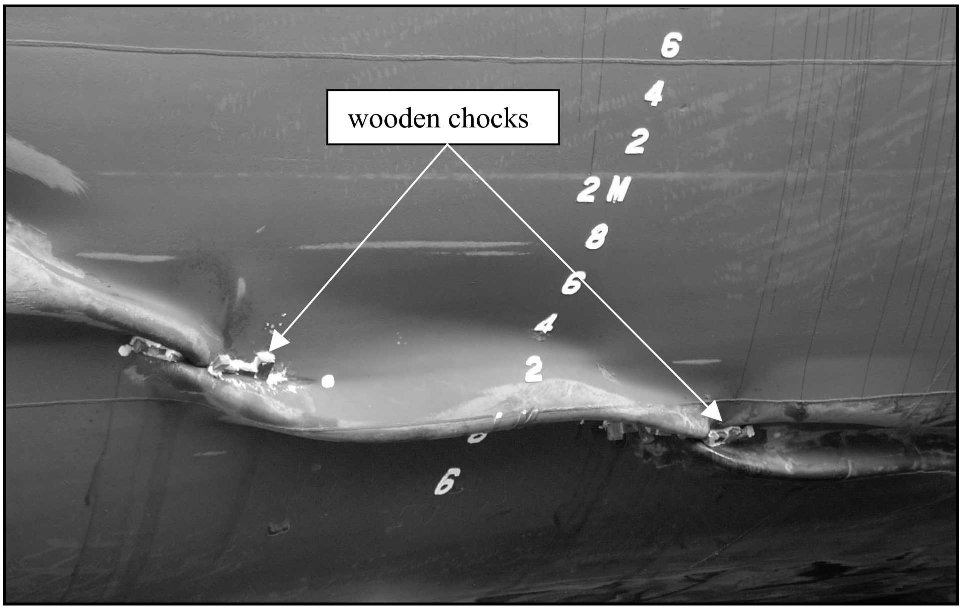
1.4 Damage

1.4.1 While the ship was at Marsden Point divers discovered damage to the hull of the *Capella Voyager*. The damage was confined mainly to the area forward of the collision bulkhead which was located at frame 85.

1.4.2 The hull was set up with the plate deformity beginning about 600 mm astern of the first lateral weld behind the bulbous bow. The damage increased in width and amplitude as it progressed aft, about 14 m, until it reached frame 85, where the deformity reached 250 mm and extended the full width of the hull. About 0.5 m forward of frame 85 a penetration was evident.

1.4.3 At about the 1 m draught mark significant creasing of the port side hull plating was found starting at the bulbous bow and extending about 21 m aft. The creasing appeared as folds in the hull plating with radii of about 50 mm and extending out about 250 mm from the profile of the hull. There was a series of ruptures to the hull plating associated with the troughs of the folds (see Figure 3).

1.4.4 Temporary repairs were made to the hull at Marsden Point by divers. The ruptures in the hull plating were filled with wooden chocks hammered into epoxy mastic (see Figure 3).



photographs courtesy of MPA Singapore

Figure 3
Buckled plating damage on the bow of the *Capella Voyager*, note wooden chocks in hull ruptures

1.5 Climatic conditions and tidal information

1.5.1 During the 48 hours prior to the grounding, the wind at Whangarei harbour had been from a generally easterly to south-easterly direction due to a high-pressure weather system over central New Zealand. A low-pressure weather system formed to the north of the North Island and moved south-south-easterly towards the Chatham Islands increasing the easterly wind flow before it changed to a south-westerly flow (see Figure 4).

1.5.2 The port of Whangarei is situated on the boundary between two of the New Zealand coastal waters forecast areas, namely Brett and Colville. Coastal waters forecasts are issued by the New Zealand Meteorological service (Metservice) at well-documented regular intervals on Inmarsat 'C', HF and VHF radio via Taupo Maritime Radio. Forecasts and facsimile maps are also available from the Metservice website and the Metfax service.

1.5.3 The coastal waters forecast issued at 0018 16 April 2003 and valid until midnight 16 April 2003, for the Brett and Colville sea areas was as follows:

- PLENTY COLVILLE
  Southeast 30 knots, tending southwest 20 knots in the evening. Rough sea easing. Easterly swell rising to 4 metres. Fair visibility in showers.
  OUTLOOK FOLLOWING 12 HOURS: Southwest 15 knots.
- BRETT
  Southeast 30 knots, easing to 20 knots around midday, tending southwest 15 knots in the evening. Rough sea easing. Easterly swell rising to 4 metres. Fair visibility in showers.
  OUTLOOK FOLLOWING 12 HOURS: Southwest 15 knots.

1.5.4 The coastal waters forecast issued at 1222 16 April 2003 and valid until midday 17 April 2003 for the Brett and Colville sea areas was as follows:

- PLENTY COLVILLE
  Southeast 20 knots, tending southwest 15 knots overnight. Moderate sea easing. Easterly swell 4 metres easing. Fair visibility in showers.
  OUTLOOK FOLLOWING 12 HOURS: Westerly 15 knots.
- BRETT
  Southerly 20 knots, easing to southwest 10 knots this evening. Moderate sea easing. Easterly swell 4 metres easing. Fair visibility in showers tomorrow morning.
  OUTLOOK FOLLOWING 12 HOURS: Westerly 15 knots.

1.5.5 The meteorological notes in the New Zealand Almanac for 2002/2003 stated that coastal weather forecasts are a general indication of average conditions expected in a particular coastal area. The forecasts are for open waters to within 60 nm of the coast and do not apply to enclosed areas such as small bays and harbours. There was no weather forecast specifically for the port of Whangarei.

1.5.6 North Tugz Limited accessed weather data from the Metservice website and the Metfax system on a regular basis. Specific weather data was accessed whenever a critical port operation such as the berthing of a deep draught tanker was scheduled. The data received was made available to the duty pilot and other employees.

1.5.7 The *Capella Voyager* received weather data via the Inmarsat 'C' service and also weather facsimile maps by radio from the Australian Bureau of Meteorology at regular intervals. These maps contained the same information as the Metservice maps and were being used as the ship had recently transited through the Australian region en route to Whangarei.

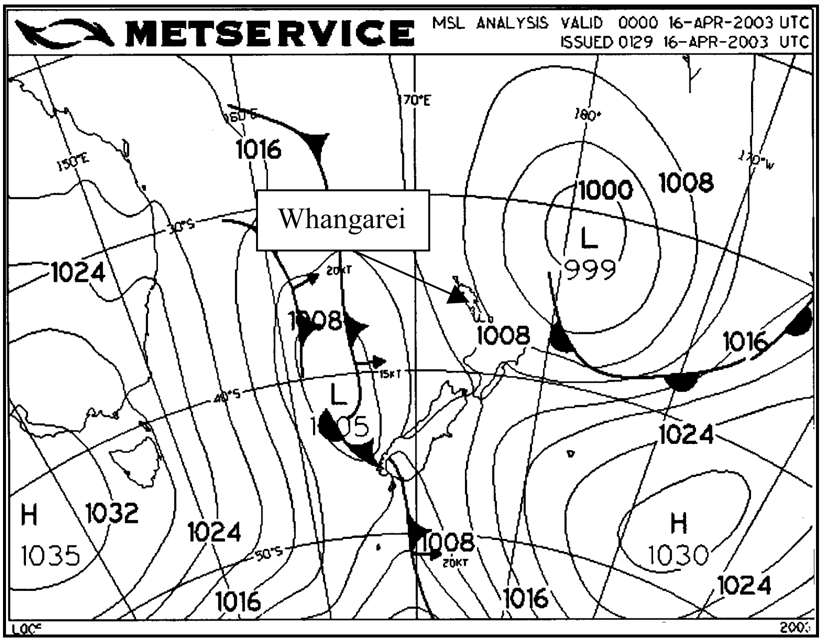


Figure 4
Mean sea level analysis synoptic chart for 1200 16 April.

1.5.8 The spring range of tides as tabulated in the New Zealand Nautical Almanac for Marsden Point was 2.06 m and the neap range was 1.51 m. The range at the time of the grounding was 2.3 m, and, therefore, a high spring tide.

1.5.9 The predicted tide for Marsden Point as detailed in the New Zealand Nautical Almanac for 16 April 2003, was:

High Water		Low Water		High Water	
0644	2.7 m	1258	0.3 m	1915	2.6 m

1.5.10 Northland Port Corporation had a recording tide gauge situated at Marsden Point that gave the following readings for the afternoon of 16 April 2003. The readings were averaged as the gauge and, therefore, the graph were affected by the sea and swell waves present at the time.

Low Water		High Water	
1308	0.67 m	1910	2.90 m

1.5.11 The nearest wave rider buoy to Whangarei Harbour was situated about one nm north of the Mokohinau Islands group, about 26 nm due east from the Whangarei Fairway buoy. While this buoy was located in open water and was for use by the Auckland Regional Council, the wave data would nevertheless be indicative of swell in the Whangarei area. The distance from the wave rider buoy may have modified the actual height and period of the waves, as may have the closeness of the land and the presence of intervening small islands. The readings recorded at the buoy on 16 April 2003 were as follows:

time	significant height (m)	wave period (s)
1700	3.92	12.6
1800	3.26	11.9
1900	3.99	13.3

1.5.12 The master of the *Capella Voyager* estimated the swell at the time the pilots boarded to be between 1 and 2 m. The pilots estimated the swell to be about 3 m, broadly in line with the readings from the wave rider buoy. The master and pilots all agreed that the swell was from a generally easterly direction.

1.5.13 Tidal information contained on chart NZ 5213 indicated a current flow of about 1.7 knots in a direction of about 005° (T) at a position 35º51'.3 S 174º31'.3 E south-west of buoy No.7 and Home Point (see Figure 2).

1.6 Description of the port

1.6.1 Whangarei Harbour lay at the northern end of Bream Bay. It afforded access to 3 ports, the tanker and deep-water berths at Marsden Point, a cement works wharf at Portland and Port Whangarei.

1.6.2 The harbour was entered from the Fairway buoy by an outer channel with a least width of 240 m, marked by buoys into the entrance west of Busby Head and through a narrows off Marsden Point.

1.6.3 Between the Fairway buoy and Nos. 1 and 2 buoys, the first set of buoys in the marked channel, the channel passed over a vestigial bar (see Figure 2), composed of fine sand and broken shell, with a minimum depth of 14.8 m. This depth was obtained from the latest close grid hydrographic survey, which was undertaken in July 2002. There was anecdotal evidence that the least sounding over the vestigial bar had never been known to be less than 14.8 m. The New Zealand Pilot (Admiralty Sailing Directions NP51) reported that the outer channel had a least reported depth of 14.6 m at the seaward end. The pilots used the promulgated channel depth of 14.6 m for the calculation of under keel clearance (UKC).

1.6.4 From Nos. 1 and 2 buoys, which were on the inner side of the vestigial bar, the channel deepened and ran between 2 shallow grounds until abeam of Busby Head where it became more sinuous before the Marsden Point wharves were reached.

1.7 Pilotage, passage planning and bridge resource management

1.7.1 The normal procedure for the pilotage of deep draught ships to the refinery wharves was for a pilot to board the ship about 2 nm south-east of the Fairway buoy. Pilots boarded 1 hour 15 minutes before high water at Marsden Point, and thus passed the Fairway buoy one hour before high water, and arrived at the berth 15 minutes before high water. This timing allowed the ship to berth and tie up with a minimum of current running.

1.7.2 The pilot who was assigned to join the ship on the morning of 16 April left the pilot boat berth in Whangarei at about 0430 after checking the weather conditions at the pilots' town office. He informed the master of the *Capella Voyager* by VHF radio that he was en route and the master informed him that the weather conditions were not good off the port.

1.7.3 When the pilot boat was about halfway to the ship the master of the *Capella Voyager* contacted the pilot by VHF radio, and informed him that the ship was positioned on the leads in the position required by the pilot. The master also informed the pilot that he considered the 5º roll of the ship to be excessive, and due to his concern about maintaining UKC cancelled the berthing. The pilot agreed to the cancellation and made his way to Marsden Point to inform the terminal and berthing parties.

1.7.4 The pilot re-joined the pilot boat in the afternoon at about 1630 in the company of another pilot, who was to act as advisor and backup to the first pilot. The pilot boat was able to maintain full speed on the way to the *Capella Voyager* and the 2 pilots joined the ship earlier than anticipated about 2 nm from the Fairway buoy at about 1730.

1.7.5 At that time the *Capella Voyager* was on the leading line. After initial discussions with the master both the pilots and the master agreed that the sea and swell had moderated considerably from the morning and agreement was reached to make a trial run towards the Fairway buoy. This was to assess what the ship's motion would be in the channel. The depth of water in which the trial run was made was about 35 m.

1.7.6 The pilot conned the ship towards the Fairway buoy noting that there was very little movement of the ship. At about 1 nm from the Fairway buoy the pilot conned the ship into a slow turn to starboard. As the ship turned the pilots, master and other involved members of the ship's crew held a comprehensive meeting on the bridge, so that the progress of the ship could be monitored by the pilots and master, where the pilotage plan was discussed and agreed upon.

1.7.7 At the meeting, the master presented the ship's passage plan and pilotage card with information relating to the manoeuvrability of the ship. The plan was well documented and followed the accepted guidelines of passage planning and bridge resource management. The pilots presented the North Tugz pilots' passage and berthing guide containing relevant information and a matrix for height of tide and the calculation of static under keel clearance.

1.7.8 When the meeting was complete, the ship was nearly back on its original heading. The pilot conned the ship onto the leading line and proceeded towards the Fairway buoy, which the ship passed at about 1815, one hour before high water Marsden Point as required by the passage plan. The pilot had calculated that at 1815, the height of tide at Marsden Point would have been about 2.5 m, combined with a channel depth of 14.6 m to give a depth of water of about 17.1 m. The draught of the ship was 14.4 m, giving a static under keel clearance of 2.7 m, or 18.75 % of the ship's draught, considerably larger than the 10 % minimum required.

1.7.9 The master of the *Capella Voyager* advised the pilot that he had calculated the squat to be about 0.4 m at a speed of 5 knots, and that the increase in draught due to roll was 15 inches [0.381 m] per degree of roll. The pilot calculated the maximum allowable roll to be about 3º to maintain the minimum under keel clearance of 10 % of the ship's draught.

1.7.10 The pilot did not calculate the effect of heave on the draught of the ship, nor did he calculate the amount of pitching the ship could experience before the 10 % under keel clearance safety margin was breached. However, both the master and the pilot visually observed the amount of pitching by watching the movement of the foremast against the horizon during the "dry run", and considered it to be within limits.

1.7.11 When the ship was about half-way between the Fairway buoy and Nos. 1 and 2 buoys, the bow being about a ship's length from the buoys, the bow dropped into a trough formed behind a larger than average swell wave. As the bow dropped the ship rolled to the swell and shuddered, the bow rose again, dropped and rolled once more behind another large swell wave and shuddered for a second time.

1.7.12 The observers on the bridge of the ship thought that the ship may have grounded as it pitched in the swell waves. However they were unable to confirm this immediately. Because by this time the ship was committed to entering harbour with no room to turn or manoeuvre out of the channel, the pilot continued to con the ship into port, while the master, second pilot and members of the bridge team investigated to ascertain whether the ship had grounded.

1.7.13 The pilot conning the ship noticed that as it approached Nos. 1 and 2 buoys the ship started to yaw, although not outside the confines of the channel, and continued to yaw until passing Nos. 3 and 6 buoys.

1.8 Waves and wave actions

1.8.1 Waves are created by wind blowing over water. As they travel away from the area where they are generated they evolve into long, smooth-crested waves called swell waves. Local wind can also generate waves. These are called sea waves and have short, choppy shapes.

1.8.2 Swell waves can travel for long distances in deep water without losing the energy they acquired from the wind. But as they travel into shallow water their shape and direction change. In shallow water, the waves slow down, their crests can bend and change direction, and their vertical profile steepens. They eventually become so steep that they become unstable, fall over themselves, breaking and losing most of their energy in the surf zone.

1.8.3 If swell waves are arriving from a direction other than perpendicular to the shallows the waves will bend, trying to conform to the contours of the sea bed. This bending of the waves is known as refraction and results from the inshore portion of the wave having a slower speed than the portion still in deep water. This refraction will cause a change in both height and direction in shallow water.

1.8.4 The effect of heave on a ship caused by swell waves is hard to detect and even more difficult to quantify without specialist equipment and calculations that are not readily available on ships. The effect of the ship pitching is easier to detect and can be estimated using simple calculations. For the *Capella Voyager* to breach the 10% under keel clearance safety margin the ship needed to pitch 0.3º, and for the ship to ground on the bottom of the channel a pitch of 1.01º was required. Roll combined with pitch and heave would exacerbate the situation.

1.8.5 The coupling motions of heave, pitch and roll have been discovered from both experimental observations and theoretical simulations. An extreme phenomenon is parametric resonance. In this case, the energy in heave and pitch motions may be transferred to roll motion mode through non-linear coupling.[2]

1.8.6 Research has shown that parametric instability occurs when a ship sails in quartering waves with a very low encounter frequency. In other wave conditions the effects of coupling of heave, pitch and roll are small.[2]

2 Analysis

2.1 The master of the *Capella Voyager* made a decision based on his seafaring knowledge, the handling and physical characteristics of his ship and the depth of water available in the channel when he postponed the berthing operation in the morning.

2.2 The master, in postponing the berthing operation, was able to allow the weather and swell to moderate, as it was forecast to do, and was able to assess the state of the sea and swell better by observing it during daylight hours.

2.3 The bridge team of the *Capella Voyager* had prepared a pilotage plan for entering the harbour and this, coupled with the information supplied by the pilot, formed a robust plan for the entry of the ship. The pilots, master and relevant members of the bridge team held a comprehensive berthing meeting prior to entering the channel, with emphasis on team work, and challenge and response in line with the principles of Bridge Resource Management (BRM).

2.4 The pilots' calculations in determining the under keel clearance available to the *Capella Voyager* calculated only the static under keel clearance and other than squat and roll, did not include any ship dynamic information that may have shown that the proposed pilotage was in doubt.

2.5 The estimation of the amount that the bow of the ship was pitching by visual observation of the ship's foremast against the horizon could be considered to be rudimentary at best. Relying on watching the foremast from the bridge, at a distance of about 190 m, in marginal transit conditions would have been less than satisfactory. The amount the bow of a ship moves is dependant upon not only the height of the swell but also its length and period in relation to the length of the ship.

2.6 The maritime services provider, at the time of the occurrence, relied on the pilot's estimation of the swell height because there was no system to provide accurate data on the height of the sea and swell. The maritime services provider accessed weather forecasts on a regular basis but did not have access to forecasts of the swell height other than that contained in the general weather

[2] "Simulation of Ship Motions – Coupled Heave, Pitch and Roll" by Sheming Fan and Jinzhu Xia, University of Western Australia, 20 March, 2002

forecasts for the coastal sea area in which the port was situated. These forecasts apply to open waters within 60 nm of the coast and would only provide a general guide to the swell expected.

2.7 The pilots estimated the swell to be about 3 m in height. A simple calculation to allow for swell and squat expected may have indicated that entry would have been marginal with any loss of under keel clearance due to the ship rolling, which could be expected with a sea on the quarter.

2.8 The depth of water in which the trial run towards the Fairway buoy was made was relatively uniform at about 35 m and the seabed generally flat. The swell over such a seabed would not necessarily indicate the swell conditions that could be expected in the area around the vestigial bar where the seabed rose steeply causing the form and period of the swell waves to change.

2.9 The *Capella Voyager* had received the latest coastal weather forecasts via Inmarsat 'C' and had noted the predicted swell heights. However, when the master of the *Capella Voyager* aligned the ship up on the leads in the afternoon, he observed that the sea and swell had moderated considerably from that forecast and from that experienced in the morning. He was positive that the ship could make the transit without incident because the swell was lower and the pilots voiced no concerns after coming through the swell on the vestigial bar in the pilot boat.

2.10 At the time of the grounding the *Capella Voyager* was heading about 320º with a swell from a generally easterly [090º] direction. The swell was therefore on the starboard quarter and if the swell had altered in height, period or direction as it ran onto the shallow ground it may have been enough to induce parametric instability and increase the motion of the ship. The yaw observed by the pilot conning the ship may have been a result of such motion.

3 Findings

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

3.1 The motor tanker *Capella Voyager* grounded in the entrance channel to Whangarei when the bow of the tanker fell into troughs behind a series of larger than expected swell waves.

3.2 All aspects of bridge resource management were used in the navigation and passage planning of the *Capella Voyager*.

3.3 The pilot calculated the static under keel clearance but did not make any allowance for dynamic conditions other than squat and roll.

3.4 The estimation of the pitching of the ship by watching the foremast's movement was prone to inaccuracies and should not have been relied upon in the prevailing marginal transit conditions.

3.5 There was no way of accurately determining the direction and height of swell waves in the entrance channel at the time of the grounding.

4 Safety Actions

4.1 Immediately after the occurrence the Northland Regional Council implemented the following actions to ensure the safety of navigation in the port:

- placed a draught restriction of 11.8 m on the port until an accurate hydrographic survey was carried out. This did not impact on the coastal tanker trade or the log ship trade, but ensured that any deep draught ships such as crude oil tankers would have a greater safety margin.
- insisted on having a hydrographic survey being carried out to determine the depth of water on the vestigial bar. Two hydrographic surveys were carried out, one gave a least depth of 14.8 m and one gave a least depth of 15.1 m the difference in depth being due to the accuracy of the measurement criteria.

4.2 The Northland Regional Council in conjunction with the Maritime Safety Authority, Northport Limited, and North Tugz Limited, introduced the following interim safety measures:

- ship's speed of heavily laden tankers would be reduced to about 5 to 6 kts in the area of the vestigial bar so as to reduce the effect of ship's squat to an estimated maximum of 0.4 m.
- pilotage would be aborted if:
  - the swell height was judged to be greater than 1.0 m
  - the heel angle or roll of the ship was greater than 1º
  - any heave was detectable on the ship
- the marine services provider was to obtain regular swell data and swell warnings from the Metservice so as to be better able to help the pilots make the decisions.

These were while:

- a study into, and purchase of, a system to determine the swell heights in real time was carried out
- real time kinetic information was obtained for the types of crude oil tankers that utilise Whangarei to produce a computer model to determine their movement in the seaway.

4.3 In view of the safety actions taken by the Maritime Safety Authority, Northland Regional Council, Northport and North Tugz Limited no safety recommendations have been made.

Approved for publication 19 November 2003

Hon W P Jeffries
Chief Commissioner

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