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**Project Next Generation  
Dredging and Disposal Plan**

**Heron Construction Ltd**

**Backhoe Dredging of Rocky Points,  
Approaches & Berth Pockets**

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*Prepared by*

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## 1. Introduction

This document is to be read in conjunction with the Environmental Management Plan (EMP). This document details a portion only of the overall development works, being the "**Backhoe Dredging**" to be undertaken by **Heron Construction Ltd** during the period June 2015 to March 2016.

The backhoe dredging work is required in areas that it is known that Port Otago's suction dredge *New Era* cannot undertake the necessary dredging works. This is on the points at Rocky Point and Acheron Head where there is hard volcanic rock present in the proposed channel. In addition the berths and their approaches at Port Chalmers is an area where the *New Era* is unable to manoeuvre to safely and efficiently complete the dredging.

Due to the tools and equipment being used and the methodology of work, this work is defined in the consents as "**Incremental Capital Works**".

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## 2. Summary

|  |  |
|--|--|
| <b>PROPOSED COMMENCEMENT</b>                                 | 18 <sup>th</sup> June 2015   |
| <b>ESTIMATED COMPLETION DATE</b>                             | 30 <sup>th</sup> March 2016  |
| <b>DREDGING INTENSITY</b>                                    | Incremental Capital Works  |
| <b>DREDGING PLANT PROPOSED</b><br>(See attached spec sheets) | Backhoe Dredge <b>Kimahia</b><br>2 x 240m <sup>3</sup> split hopper barges <b>Karaha &amp; Kaheru</b><br>Support Tug <b>Pacific Way</b>  |
| <b>TARGET DEPTHS</b>   | All areas: <b>14.0m</b>  |
| <b>ESTIMATED VOLUME</b>                                      | 70,000m <sup>3</sup>   |
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## 2.1 Development & Updating of the D&DP

This dredging and disposal plan (D&DP) has been developed by Port Otago Ltd in accordance with Otago Regional Council resource consent condition number 17 of 2010.193, and the requirements within the EMP.

As with the development of the design & execution of the capital dredging works, the D&DP will also be an iterative and evolving process. This D&DP document will be a "live" document - ever developing in response to changes and findings.

The three areas discussed as follows will be the key drivers for change or alteration of the D&DP:-

1. additional dredging & disposal, or construction activity. This will include the specific input from the Contractors(s) with respect to their equipment & methodology.
2. comments or input from Technical Group members and / or Otago Regional Council;
3. input resulting from changes to construction methodology etc... resulting from monitoring and reporting undertaken as part of daily / weekly works.

All revisions of the D&DP will be issued directly to consultative group members, and the most recent versions being displayed on the Port Otago Next Generation website. For incremental capital dredging the updating of the D&DP will be on an as required basis, with the more detailed work program being updated on a monthly basis.

## 2.2 Roles and Responsibilities

As the Principal to the project, Port Otago Ltd has a number of key responsibilities in relation to the development and implementation of the D&DP. As a first step the following responsibility matrix has been developed. Heron Construction as Contractor also have roles and responsibilities of the Contractor and their staff, will be generic and developed further upon their appointment.

| Role                  | Responsibility  |
|-----------------------|---|
| Port Otago Management | <ul style="list-style-type: none"><li>➤ Development and continued evolvement of the EMP;</li><li>➤ Consultation with affected parties during development, and after implementation of the EMP;</li><li>➤ Implementation and monitoring of the EMP;</li><li>➤ Ensure Port Otago personnel and sub-Contractors have an understanding and awareness of the existence of, and the requirement to adhere to, the requirements of the EMP;</li><li>➤ Ensure timely reporting of all requirements under this EMP;</li><li>➤ Report to key stakeholders any major environmental incidents that may have an impact on the marine environment;</li><li>➤ Exercise due diligence and compliance with the resource consent conditions and EMP;</li><li>➤ Ensure full co-operation with Statutory Authorities in regards to any audits of compliance with Conditions of Consent and the EMP.</li></ul> |
| Heron Construction.   | <ul style="list-style-type: none"><li>➤ Ensure staff and sub-Contractors have an understanding and awareness of the existence of, and the requirement</li></ul>   |

|                               |   |   |  |
|-------------------------------|---|---|--|
| All vessels and<br>All crews. | to adhere to the requirements of the resource consent conditions and EMP; |   |  |
|                               | ➤   | Understand and comply with all instructions from Port Otago Ltd in regard to environmental compliance;                    |  |
|                               | ➤   | Undertake sufficient training of staff and sub-contractors to ensure compliance limits are known and adhered to;          |  |
|                               | ➤   | Maintain plant and dredging equipment in optimum condition to minimise impact on the marine environment;                  |  |
|                               | ➤   | Undertake regular inspections of all activities and project boundaries to ensure compliance with requirements of the EMP; |  |
|                               | ➤   | Carry out work in accordance with best practice to ensure compliance with the EMP;  |  |
|                               | ➤   | Report all environmental incidents to Port Otago Ltd within limits set in the EMP.  |  |

## 2.3 Key Personnel

As required by the EMP and consent conditions the following are key personnel for the project and contact details:

| Role                    | Company                | Name               | Phone                                 | Email  |
|-------------------------|------------------------|--------------------|---------------------------------------|--|
| GM Infrastructure       | Port Otago Ltd         | Lincoln Coe        | DDI 03 472-9884<br>Cell 021 2298884   | <a href="mailto:lcoe@portotago.co.nz">lcoe@portotago.co.nz</a>                     |
| Project Manager         | Port Otago Ltd         | Rebecca McGrouther | DDI: 03 472 9716<br>Cell 021 627 188  | <a href="mailto:rmcgrouther@portotago.co.nz">rmcgrouther@portotago.co.nz</a>       |
| Contract Manager        | Heron Construction Ltd | Greg Kroef         | Ph.: 09 299 9767<br>Cell 0274 787 942 | <a href="mailto:GregK@heronconstruction.co.nz">GregK@heronconstruction.co.nz</a>   |
| Harbour Control (24hrs) | Port Otago Ltd         |                    | DDI: 03 472 9882                      | <a href="mailto:harbourcontrol@portotago.co.nz">harbourcontrol@portotago.co.nz</a> |
| Otago Regional Council  | ORC                    | Pollution Hotline  | 0800 800 033                          | To report oil or fuel spills in the harbour.                                       |
|                         |                        |                    |                                       |  |
|                         |                        |                    |                                       |  |

### **3. Project Construction Activities**

#### **3.1 Introduction & Dredging Overview**

The backhoe dredging works will be undertaken using equipment that is all owned and operated by Heron Construction Ltd. The backhoe dredge Kimahia is supported by the tug Pacific Way which works the dumb barges Karaha & Kaheru alongside to load with dredging spoil, and when fully loaded, the Pacific Way tows a single barge to the disposal site and back again whilst the other is loaded. See Appendix 1 for a brief specification sheet for all of these pieces of equipment.

The Kimahia will do all of the dredging work and when positioned over the dredging site will work continuously excavating the material of the seas-bed, lifting it through the water column and filling the barge until it is full. The barges are not overloaded or overflowed. Once the barge is full it is moved away from the dredge with the second barge being brought alongside immediately. By the time the second barge is finished loading it is expected the first barge will be back empty from the disposal site.

The dredge is therefore working almost continuously, with the operation of the support tug intermittent at the dredging site.

#### **3.2 Dredging – locations, materials & methodology**

The backhoe dredging will target 3 specific and distinct areas, attached as Appendix 2 is drawing of the Lower Harbour which identifies these areas in priority order as follows.

- Rocky Point
- Acheron Head
- Port Chalmers Berths and Approaches
- Pulling Point
- Harington Bend

These areas have some material above the currently permitted 13m depth, however the majority of the material in these areas is currently between 13m and 14m depth.

Acheron Head, Rocky Point, and Pulling Point are outcrops of volcanic rock which intrude into the existing and proposed channel. The rock is weathered on the top and therefore softer and easier to dredge but below is very hard requiring the strong ripping forces of the backhoe. Overlying and surrounding the rock are the silts and clays which require stripping off to access that hard rock.

The material in the approaches and the Port Chalmers berths are likely to be mostly silt, with a slight chance of some rock. The material at Harington Bend is most likely to be sand.

The methodology or approach to dredging will be to remove the silts and clays from around the rocky points, this can be done with a larger bucket on the dredge therefore maximising the productivity. Once this stripping is complete, a small and stronger bucket is changed onto the backhoe to enable dredging of the hard rock.

The rock encountered at Acheron Head to date has proved to be very hard, and is expected to get harder the further towards the headland the dredge gets. To be able to continue dredging Heron Construction have purchased an xcentric rock ripper. The ripper is a hydraulic attachment that goes on the end of the excavator boom (in place of the bucket) and vibrates quickly whilst applying the force from the excavator arm.

Hydraulically it operates very similarly to the hydraulic vibrators used to drive/vibrate the sheet-piles in during the recent berth deepening works.

Using the xcentric ripper it is estimated approximately half the time will be spent ripping the rock, then when there is sufficient broken up rock to load, the mid-sized dredging bucket will be swapped in and used to load the barges. This loading will be very quick due to the broken nature of the roc. The overall duration of work to complete the work at Acheron Head with the ripper is expected to be 30-40 days.

The actual physical location of the dredging works will vary on a daily weekly basis; this is discussed in more detail below.



### 3.3 Disposal

Disposal of dredged material for the "Backhoe Dredging" will be undertaken in accordance with the relevant consents and their conditions, as follows:-

1. Disposal of ANY loads containing rock material or part loads of rock are to be disposed of at the northwestern end of the Heyward Point site (Consent RM11.153). In addition, the remaining loads of silt only, or silt / clay mix will be disposed of at this site.
2. No disposal to A0 offshore (Consent 2010.198). Note that no disposal is planned to occur at either the Shelley Beach site, or the Aramoana or Spit disposal site (Consent RM11.153).

Factors which will influence the choice of disposal site on a daily / weekly basis are:-

- Consent conditions
- Material type and suitability of material for that disposal site
- Sea state conditions and safety of vessels
- Vessel navigation

### 3.4 Dredging and Disposal Records

In accordance with condition 22 in 2010.193 and Condition c4 in App 1 for consent 2010.198, records of dredging and disposal activity are required.

The following information is collected and logged aboard Heron's vessels to enable reporting are:

- Vessel
- Source of dredge material (ie claim)
- Start point / location (GPS) of source material
- Start date and time of dredging
- End point / location (GPS) of source material
- End date and time of dredging
- Approximate volume of material
- Material splits (%age of silt, sand, rock)
- Date and time of disposal
- Disposal spoil ground (ie Heywards, Shelly, Spit, A0)
- Location (GPS) of disposal
- Vessel speed and heading during disposal (A0 only).

This information and these logs are the same as used for *New Era*, and also for any dredging equipment and/or Contractors who are used in the future.

### 3.5 Timing of Works

The majority backhoe dredging work is intended to be undertaken as a daytime operation, therefore not between the hours of 8:00pm to 6.30am.

#### January / February 2015 – 24/7 dredging activity

There will be a period of up to one month commencing at the earliest on the 5<sup>th</sup> January 2016 where Heron Construction will look to operate 24/7, therefore during night hours and on Sundays.

Night time work (all days of the week) is restricted by the 45dBA limit outlined in the Construction Noise standard, which will dictate where the dredging can occur. For work on Sunday's during the day (7.30am to 6.00pm) a limit of 55dBA is applicable.

Night-time and Sunday work will be possible at Pulling Point, Acheron Head and some areas of the approaches and berths at Port Chalmers at times during these night periods, depending on weather conditions, the dredging activity being undertaken and other activity occurring at the time.

### **3.6 Restrictions to Navigation**

There are no restrictions to navigation imposed on Herons during the Stage 1 Dredging Works.

### **3.7 Further general information - backhoe dredging**

A more detailed description of backhoe dredging, the advantages, disadvantages, causes of sediment release and management options is contained with the preliminary report that formed part of the consent applications. Pages 23 and 24 of the Dredging Methodology (Pullar & Hughes, Dec 2009) are included as Appendix 3.

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## **4. Construction Programme**

For the purposes of this D&DP, it is not intended to present a fully detailed program. The drawing Dwg 11514/1 (Appendix 2) attached shows works priorities for the backhoe dredging.

1. Rocky Point
2. Acheron Head
3. Berths and Approaches
4. Pulling Point
5. Harington Bend

The actual physical location of the dredging is unlikely to vary greatly due to the limited number of dredging locations. It will however, vary on a daily weekly basis dependent on a number of variables. These variables include:-

- Shipping schedules;
- Dredge material and productivity encountered;
- Environmental restrictions including noise and response to turbidity.
- Maintenance dredging commitments or demand.
- Vessel maintenance, breakdowns and/or repairs.

A more detailed schedule will be prepared on a monthly basis, showing the planned work and expected material types. These monthly schedules will be uploaded to the website and circulated to consultative group members.

Heron Construction work programme during January and February will vary depending on weather conditions, the dredging activity being undertaken and other activity occurring at the time.

It is intended that Herons day work will begin work at the Container Terminal Berth and then move to ripping rock/dredging at Acheron Head. It is intended that Herons night work will begin at Pulling Point then move to the PC Basin and Approaches It is worth noting, however, that Herons work locations may vary throughout the month, and that the schedule below is used as an indication only. Herons will also be dredging Harington Bend 0630-2000 hours

|                                      | JANUARY |    |    |    |    |    |    |    |    |    |    |    |    |   | FEBRUARY |   |    |   |    |    |   |   |    |    |    |    |    |    |    |
|--------------------------------------|---------|----|----|----|----|----|----|----|----|----|----|----|----|---|----------|---|----|---|----|----|---|---|----|----|----|----|----|----|----|
|                                      | T       | W  | Th | F  | SA | SN | M  | T  | W  | Th | F  | SA | SN | M | T        | W | Th | F | SA | SN | M | T | W  | Th | F  | SA | SN | M  |    |
| Heron Construction Dredging Schedule | 19      | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 1 | 2        | 3 | 4  | 5 | 6  | 7  | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| Out of Port                          |         |    |    |    |    |    |    |    |    |    |    |    |    |   |          |   |    |   |    |    |   |   |    |    |    |    |    |    |    |
| Container Terminal Dredging          |         |    |    |    |    |    |    |    |    |    |    |    |    |   |          |   |    |   |    |    |   |   |    |    |    |    |    |    |    |
| Port Chalmers Approaches             |         | 1  | 1  | 1  | 1  | 1  | 1  |    |    |    |    |    | 1  |   |          |   |    |   |    | 1  |   |   |    |    |    |    | 1  |    |    |
| Area off Beach St                    |         |    |    |    |    |    |    |    |    |    |    |    | 1  |   |          |   |    |   |    |    |   |   |    |    |    |    | 1  |    |    |
| Acheron Head                         | 1       | 1  | 1  | 1  | 1  | 1  |    |    |    |    |    |    |    |   |          |   |    |   |    |    |   |   |    |    |    |    |    |    |    |
| Area off Acheron Head                |         |    |    |    |    |    |    |    |    |    |    |    |    |   |          |   |    |   |    |    |   |   |    |    |    |    |    |    |    |
| Pulling Point                        |         |    |    |    |    |    |    |    |    |    |    |    |    |   |          |   |    |   |    |    |   |   |    |    |    |    |    |    |    |
| Harington Bend                       |         |    |    |    |    |    |    |    |    |    |    |    |    |   |          |   |    |   |    |    |   |   |    |    |    |    |    |    |    |

## 5. Environmental Aspects

### 5.1 Relevant Consents

The following consents are applicable to the backhoe dredging works.

- RM 11.153 – Disposal of material to inshore disposal sites
- RM2010.193 – Capital Dredging, disturbance of sea-bed.
- RM2010.195 – Capital Dredging, discharge and turbidity.
- RM2010.198 – Disposal of dredged material offshore at A0.

### 5.2 Environmental Restrictions

The applicability of the following conditions from Consent 2010.193 are as follows:-

- Conditions 7, 8 and 9 (Taiaroa Head & Godwits) - NOT APPLICABLE

None of the backhoe dredging is being undertaken in the locations relevant to these conditions. The support tug and barges are allowed to transit these areas, as in accordance with condition 1A(c) they are "vessels navigating the shipping channel to or from the dredging or disposal areas".

- Condition 10 (Construction Noise) - APPLICABLE

Compliance with the Construction Noise Standard will mean that works will not be able to be undertaken at Rocky Point and Acheron Head during night hours or on Sundays.

### 5.3 Turbidity

The purpose of the harbour turbidity monitoring at the six monitoring sites prescribed in consent 2010.195 condition 4 is to detect unexpected changes in the intensity and/or extent of turbidity caused by the capital dredging works.

Harbour turbidity monitoring for the "Backhoe Dredging Works" will be undertaken in accordance with consent 2010.195 and conditions 7, 8, and 8A. Pages 16-20 of the current EMP also contain the relevant information.

The actual turbidity limits vary depending on the site, however, the response levels are set as follows:

- Response Level 1 (6 hourly average)
- Response Level 2 (6 hourly average)
- Environmental Limit

Management actions are in place if the turbidity response limits set by the consent are exceeded, and will be strictly adhered to. This monitoring and management will continue for the duration of all the backhoe and other capital dredging.

During the dredging works, the data from the harbour turbidity monitors will show if the Response Levels have been exceeded, and hence whether dredging methods or locations need to be altered or changed.

Similarly the ETL at the offshore disposal site A0 will be monitored by Buoys A & B whilst disposal activity is being undertaken at that site. This is in accordance with consent 2010.198.

#### Specific discussion - backhoe dredging locations & relevant turbidity sites

The closest site to the location of the backhoe dredging is **Site E – Acheron Head**, with SSC/NTU Levels of 35, 50 and 70 mg/L respectively. The proximity of the monitoring site to the dredging at Acheron Head as well as Rocky Point, means this is the most likely turbidity monitor to show any elevated levels whilst dredging of silt or clays are underway.

The next most likely site to show any elevated levels will be **Site C – Quarantine Island**.

The approaches and the berth dredging areas are very sheltered and tucked into the approaches and out of the main tidal stream. This means it is very unlikely that dredging in the approaches will elevate turbidity at any of the monitoring sites.

#### Specific discussion – management actions

If dredging of silt is being undertaken at either Acheron Head or Rocky Point, and are contributing to the turbidity monitors response levels or Environmental limits being exceeded at either Site E or Site C, then all of the following management actions should be considered.

- Move to dredging rock
- Move to dredge approaches or berths
- Reduce dredging frequency
- Suspend dredging

No other monitoring, such as plume monitoring or mobile turbidity monitoring is proposed.

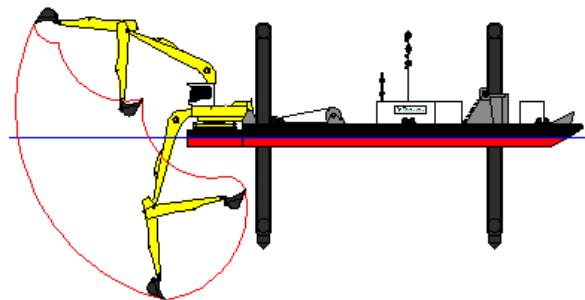
## **APPENDIX 1: DREDGING EQUIPMENT SPECIFICATIONS**

## Backhoe Dredger



Name: Kimahia  
Type: Backhoe Dredge  
Operators: Heron Construction Company Ltd  
Class: NZ Barge Safety Certificate  
Port of registry: Auckland, New Zealand  
Year built: 1995  
Gross tonnage: 291  
Displacement: 450 tonne  
Length overall: 42.0m  
Breadth: 13.3m

Excavator: Liebherr P984  
Monobloc (boom) length: 12.0m  
Stick (dipper) lengths: 4.6m, 6.6m and 7.8m  
Bucket sizes: 1.6, 2.6, 3.5, 4.0 & 5.0m<sup>3</sup>  
Clamshell size: 3.0m<sup>3</sup> Environmental  
Dredging control: DipMate v3 by Seatools  
Position and height control: Twin 5700 Trimble RTK GPS  
Aft spuds: Two @ 20m long x 26 tonne each  
Forward spud: One @ 24m long x 31 tonne  
Spud carrier stroke: Pendulum type walking spud  
Jack-up capacity: 200 tonnes



# Karaha and Kaheru

## Non-propelled Split Hopper Barges



Type: Non propelled, Selmer Split Hopper Barge  
Class: MNZ Barge Safety Certificate - Coastal  
Operators: Heron Construction Company Ltd  
Built: 2009  
Gross Tonnage: 209  
Nett Tonnage: 65  
Hopper capacity: 240m<sup>3</sup>  
Length overall: 38.2m  
Breadth moulded: 7.4m  
Draft loaded: 2.5m  
Draft lightships: 0.7m  
Displacement lightships: 143 tonne  
Hopper dimensions at coaming: 24.7m x 5.5m  
Hopper bottom opening: 2.5m (max.)



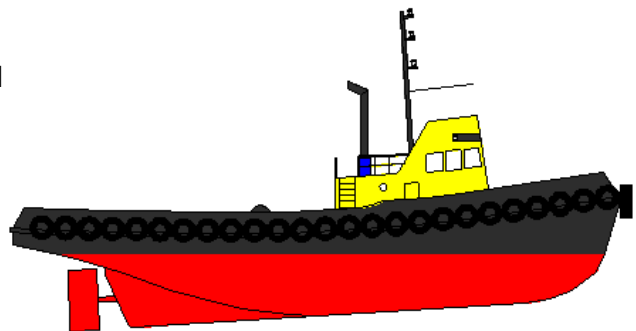
73 Boundary Road. Papakura 2110  
P.O. Box 72-561, Papakura 2244  
Auckland, New Zealand  
Telephone: +64 9 299 9767 Fax: +64 9 299 9510  
[www.heronconstruction.co.nz](http://www.heronconstruction.co.nz)



## Ocean Going Tug



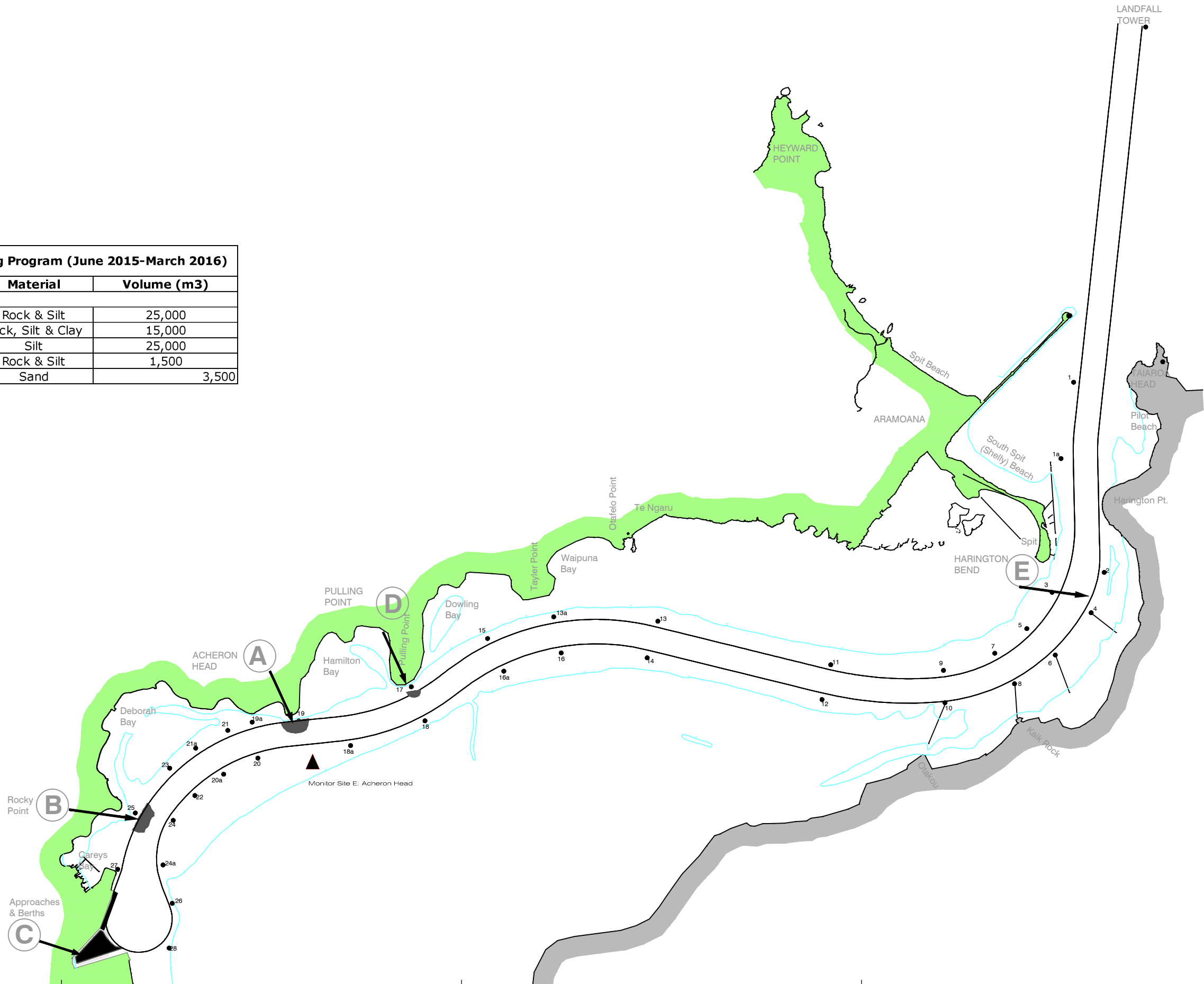
Name: Pacific Way  
Type: Ocean Going  
Official Number: 101700  
Class: MNZ, NZ Safe Ship Management  
Call Sign: ZM 2932  
Port of registry: Wellington, New Zealand  
Operators: Heron Construction Company Ltd  
Gross tonnage: 116  
Nett tonnage: 34  
Displacement: 214 tonne  
Length overall: 25.97m  
Breadth: 6.7m  
Max draft: 3.25m  
Main engines: 2 x Cummins KTA 19M3  
Power: 1200hp  
Auxiliaries: 2x Cummins 4BT, 1 x Cummins 6BT  
Propellers: Twin screw, 4 blade inside kort nozzles  
Bollard pull: 18 tonne  
Towing specifications: Tow winch 30 tonne brake capacity  
Tow wire – 400m x 28mm dia  
MF/HR Radio telephone  
with Watch Receiver: Sailor 5000 + DSC  
VHF Radio telephone: Sailor RT5022 + DSC and ICOM ICM402  
Inmarsat C: Sailor TT3000EB  
Radar: JRC JMA-2343  
GPS: Furuno GP 50  
Plotter: Windows XP based Nobeltec  
Echo sounder: Raymarine  
Compass: Kelvin Hughes (Magnetic)





## **APPENDIX 2: DREDGING PLAN & WORK PRIORITIES**

| Heron Construction - Backhoe Dredging Program (June 2015-March 2016) |                          |                   |             |
|--|--------------------------|-------------------|-------------|
| ID   | Claim/Area               | Material          | Volume (m3) |
| A  | Acheron Head             | Rock & Silt       | 25,000      |
| B  | Rocky Point              | Rock, Silt & Clay | 15,000      |
| C  | PC Berths and Approaches | Silt              | 25,000      |
| D  | Pulling Point            | Rock & Silt       | 1,500       |
| E  | Harington Bend           | Sand              | 3,500       |



## **APPENDIX 3:** Backhoe Portion of Dredging Methodology Report

## 5.4 Backhoe Dredger

The Backhoe Dredger (BHD) is similar to a land-based excavator mounted at one end of a pontoon. For smaller work, a land-based excavator is often simply mounted on a barge. For good leverage, the pontoon is fixed in position by spuds (support legs) pushed into the seabed. The size of the excavator and of the bucket varies with the nature of the material to be dredged and the maximum dredging depth. The excavator loads into hopper barges that are towed to the disposal location.

### i. Advantages:

- Large BHDs can excavate reasonably hard fractured rock avoiding the need to blast,
- Can dredge soil, especially cohesive soils, with little water added and hence load the barges efficiently without overflow,
- Can dredge effectively in confined areas,
- Can dredge by excavating a path forward when dredging shallow areas such as for widening the swinging basin,
- Position and excavation depth control is very accurate, reducing required over-depth to deliver accurate profiles,
- Can use bucket to level area after dredging,
- Suitable dredgers are available in New Zealand thereby minimising mobilisation costs.

### ii. Disadvantages:

- Dredging depth is limited to the length of the excavator dipper arm,
- Relatively low productivity rates (200 – 800 m<sup>3</sup>/hr depending on material and bucket size),
- Working on spuds cannot move easily out of shipping lanes,
- Can produce comparatively high turbidity in mud / silt materials, unless specific buckets are used which further reduce output.

### iii. Causes of Sediment Release:

- Impact of bucket on the seabed,
- Disturbance of the seabed when digging with bucket,
- Material spillage when lifting bucket,
- Spillage and overflow from barges,
- Washing of residual from bucket when lowering.

### iv. Management Options:

- Reduce spillage with water tight buckets,
- Skill of operator is important in reducing overflow,
- Using a silt screen around the work area although impractical in areas of high currents,
- Limit the swing of the bucket over water,
- Minimise levelling seabed by swinging bucket over the surface.

**v. Commentary:**

It is anticipated that a large BHD would be suitable for the excavation of the rock areas and thereby minimise the need to blast. It is anticipated that a BHD will not work in areas where there is a high percentage of silts thereby avoiding many of the effects and disadvantages discussed previously. This dredger may also be suitable for excavating sand at least for the top 5m of the Port Chalmers swinging basin but would need large barges in support to match productivity. The alternative is to use a smaller excavator over a longer period with smaller barges.

Photographs of typical large and small BHD follow:



**Figure 5.5** Heron Construction Ltd – 230 tonne *Machiavelli* excavator



**Figure 5.6** Small BHD and Barge Units