

**PORT OTAGO LIMITED**  
**PROJECT NEXT GENERATION**  
**ENVIRONMENTAL MANAGEMENT PLAN**

**Operable**

**3 December 2015**

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### **Revision History**

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3 December 2015	Operable	TG/MCG	18 Dec 2015	Yes
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Operable

## **SECTION A ENVIRONMENTAL MANAGEMENT PLAN OVERVIEW**

### **Introduction**

1. The dredging and disposal of materials generated through the Incremental as well as the Major Capital dredging programmes, the extension of the wharf and the fishing platform and the placement of rock will result in environmental effects of varying degrees.
2. These effects will either be short term and/or localised in terms of the site locations such as for the disposal sites or where in a particular part of the channel the widening and deepening is being carried out.
3. The Assessment of Environmental Effects documents dated May 2010 and the associated documentation describes the detailed analysis and the background to the deepening and disposal of materials and also indicates the nature, scale and extent of the predicted effects.
4. The resource consents with their conditions, issued by the Otago Regional Council, are attached as Appendix 1 and this plan is to be read in conjunction with those conditions. The plan has therefore been formulated to monitor the key environmental effects and establish steps to manage and where possible mitigate any significant effects that may arise from the intended works.
5. The scale of the effects will vary and will be differentiated by the two options (Incremental Capital and Major Capital) available to Port Otago to undertake the capital dredging. The type of operation has an effect on the level and intensity of turbidity and deposition both within the harbour and the disposal sites. It is noted that the large contract dredge used for Major Capital dredging will be confined to discharging at disposal Site A0 only.
6. For the maintenance and the Incremental Capital dredging programmes using the smaller item of dredging plant, generating volumes of 450,000 and 1 M cubic metres of materials per annum respectively, the impact on the suspended sediment concentrations and deposition rates has been assessed as being substantially lower, by an order of magnitude, to those related to the Major Capital dredging programme. This difference is a function of dredging capability including dredging rates and

hopper volumes, steaming time, rate of disposal and dispersal of sediments which tend to vary proportionally to the sediment discharge rates.

7. The New Era has a hopper capacity of 600 cubic metres as against a typical mid sized contract dredge with a hopper capacity of 10,800 cubic metres. This is covered in more detail by Bell (2010).
8. Irrespective of the level of effects Port Otago intends to actively manage the project activities thereby minimising any potential adverse environmental effects.

### **Outline of the Project**

9. The Project is comprehensively described in the following documents:
  - a. Project Next Generation Applications and Assessment of Environmental Effects.
  - b. The following Dredging & Disposal Plans or Construction Work Plans
    - i. New Era – Stage 1 Capital Dredging (May – Jan 2016)
    - ii. Heron Construction Ltd – Backhoe Dredging
    - iii. Daniel Smith Industries - Berth Sheetpiling Works
10. The Project can be divided into the following main components:
  - a. Deepening and widening the Otago Harbour channel, swinging areas and berths through dredging,
  - b. Disposal of dredge material at sea,
  - c. Construction of multipurpose wharf and fishing platform,
  - d. The placement of a rock revetment and toe support beneath the berths.
  - e. Sheetpiling works to enable deepening of the berths.

## **SECTION B ENVIRONMENTAL MANAGEMENT PLAN GENERAL**

### **CONSENT CONDITIONS**

11. As part of this Project Port Otago will be required to comply with consent conditions. This Environmental Management Plan ('EMP') describes the details of the general management approach to be taken during the delivery of this project. Otago Regional Council's consent conditions have informed the development of the adaptive management responses contained within this EMP. Both the EMP and consent conditions are integral to the Project. However it is an essential part of the

EMP that consent conditions must be followed. Consent conditions are attached in Appendix 1.

## **ADAPTIVE MANAGEMENT**

12. Port Otago will implement an adaptive management approach, the basis of which will be an EMP. The adaptive management approach involves monitoring the effects of the Project on key resources and implementing a management strategy, in response to the monitored effects that avoids, remedies or mitigates adverse effects that could become more than minor. There will be various types and scales of mitigation responses that can be implemented to address potential adverse effects. The exact type and mix of mitigation options to be utilised will be adapted to suit the circumstances that exist for each site specific issue.
13. Port Otago will adaptively manage the monitoring and mitigation that will be implemented as part of the Project. This EMP will identify how environmental 'trigger levels' will be defined and monitored, to ensure any adverse effects are identified, and will establish the mitigation measures to be investigated to minimise any adverse effects.
14. The primary goals of this EMP are to:
  - a. Describe what actions will be taken in the event of a range of events occurring during dredging and disposal operations as part of the Project Next Generation ("the Project")
  - b. Describe the methodology proposed for dredging and disposal operations and the programme scheduled for each component of the Project.
  - c. Provide a detailed Monitoring Plan describing the scale and intensity of monitoring of potential adverse effects on water quality, marine biota and coastal processes, and the management responses to that monitoring.
  - d. Provide a list of key positions and points of contact during the Project.
  - e. Describe how stakeholders will be kept informed during dredging and construction and how any complaints will be managed.
15. This EMP is now in an operable and final state for the current Stage 1 project. However, given the nature of Project Next Generation, more detail will be added once Contractors are selected to undertake portions of the works, with the Contractors using and developing specific methodologies and programmes for their

portion of work. Even after this stage, changes to the work programme during the Project will mean that the EMP will require updating. Therefore, this EMP document should be thought of as a 'live and dynamic document' that will be reviewed, updated and referred to throughout the Project. It is the responsibility of the reader to refer to the Revision History Box (located after the Table of Contents) to confirm its currency.

16. The environmental limits and monitoring programmes have been developed with a team of independent experts, and are based on industry best practice. The approach taken in the EMP is designed to identify and monitor the effects from the dredging and disposal operations when monitoring against the environmental limits.
17. An up to date copy of this EMP will be maintained at Port Otago Limited's main office throughout the Project. It will also be available in electronic form from the Project's public website : <http://www.nextgenerationportotago.nz/>

## PROJECT STAGING & WORK SCHEDULE

- 18A Detailed descriptions of the current Stage 1 works are contained within the individual dredging and disposal plan documents identified in paragraph 9b (page 2). These documents describe the work schedule, the type of activity occurring where and when, the volumes and type of material to be dredged, and the contractors and equipment to be used for the works. The key elements of the Stage 1 works, described in more detail in the dredging and disposal plan are:-

- Incremental Capital Works.
- Suction Dredging – Port Otago's dredge "New Era"
  - Works Period – May 2015 to January 2016
- Backhoe dredging – Heron Construction Ltd backhoe "Kimahia" & barges.
  - Works Period – June 2015 to March 2016.
- Berth Sheetpiling Work – Daniel Smith Industries.
  - Works Period – May 2015 to Dec 2015.
- Total volume of material for dredging and disposal is approx 440,000m<sup>3</sup>, with the majority of that being sand).

The Dredging & Disposal plans will be updated as necessary with any changes to plant and equipment used to undertake Stage 1 works, or any subsequent works.



18. Port Otago will:
- a. provide Maritime NZ and the Otago Harbourmaster copies of Dredging and Disposal Schedules prepared.
  - b. Make copies of all Dredging and Disposal Schedules prepared available on the Port Otago website; and
  - c. Place notices in the Otago Daily Times advising the availability of any Dredging and Disposal Schedule prepared.

## KEY POSITIONS AND POINTS OF CONTACT

### Introduction

19. As the project develops a number of key positions will be identified in terms of operating this EMP and for the life of the Project. Those roles, along with contact details for the specific person in that role, will be added into the EMP once known. These people will be first point of contact for the public, or other organisations, in each of the key areas identified.

### Port Otago – General Contact

20. The person with responsibility for the overall Project, including community consultation, technical matters and environmental compliance will respond to and manage the environmental aspects of issues during the Project. In doing this he must ensure that all environmental consent conditions are met and that the environmental requirements of the EMP are adhered to at all times during the Project.

Name	Lincoln Coe
Postal Address	c/- Port Otago Ltd, PO Box 8 , Beach St, Port Chalmers
e-mail:	lcoe@portotago.co.nz
Phone:	03 472 7890
Cell Phone:	021 229 8884

### Other Contacts Summary

- 20a The following table identifies and summarises the key personnel with various roles. More detailed information about the roles and further contact details are included within the individual Dredging and Disposal Plan documents

Person	Company	Role	Phone
Harbour Control Duty Officer (24hrs)	Port Otago		(03) 472 9882
Brian Corson	Port Otago	Community Relations contact	(03) 472 7890
Rebecca McGrouther	Port Otago	Manages <i>New Era</i> dredging operation.	(021) 627 188
Greg Kroef	Heron Construction	Manages <i>Kimahia</i> associated Heron Construction dredging equipment operation.	(027) 478 7942

### PROJECT CONSULTATION/COMMUNICATION

21. Effective communication with the community is essential during the project. Project consultation is to be maintained through the establishment of two consultation groups and a Technical Group.
22. These Consultative Groups have the role of ensuring effective communication actually takes place. The groups have representatives from the Dunedin City Council, Port Otago Limited, the Contractor, representatives from the local community, representatives of local hapu and iwi groups.

#### Project Consultative Group

23. The community Project Consultative Group ("PCG") has a range of roles associated with communication between the various project parties and the community.

#### Objectives of the Project Consultative Group

24. Within three months of the commencement of resource consent for the Project Port Otago will invite a cross section of the lower Harbour and Otago coastal communities and organisations, generally as described below, to form the PCG.
25. The purpose of the PCG is to facilitate consultation between the wider users of Otago Harbour and its surrounds and Port Otago during the Incremental Capital and Major Capital dredging and disposal works. The objectives of the PCG are, generally, to:
  - a. Build effective working relationships and mutual trust between the local community and Port Otago (and its Contractors) especially during the Project.

- b. Promote free flow of information in all directions between the local community and Port Otago, the Contractor and the Regional Council with an aim of anticipating and resolving any potential issues before they arise.
  - c. Discuss the results of monitoring activities on a periodic basis.
  - d. Receive information about any community complaints.
26. The PCG may include representatives from the following groups who participated in project pre-consultation and who may want to participate in the PCG:
- a. Aramoana League
  - b. Blue Water Products Limited
  - c. Careys Bay Residents Association
  - d. Chalmers Community Board
  - e. Department of Conservation
  - f. Dunedin City Council – Consents
  - g. Dunedin City Council – Planning Policy
  - h. Harbour Cycle Network
  - i. Harington Point Community Society (Inc)
  - j. Kati Huirapa Runaka ki Puketeraki
  - k. Monarch Wildlife Cruises
  - l. NZ Marine Studies Centre
  - m. Otago Chamber of Commerce
  - n. Otago Coast Guard
  - o. Otago Peninsula Community Board
  - p. Otago Regional Council
  - q. Otago Yacht Club
  - r. Otakou Runanga
  - s. Port Chalmers Fishermen's Co-op Society
  - t. Port Chalmers Yacht Club
  - u. Port Environment Liaison Committee
  - v. Port Otago Limited
  - w. Quarry Beach Surf Boards
  - x. Recreational Fishing
  - y. Residents of Port Chalmers, Blueskin Road, Dunedin and Harwood-as individuals
  - z. South Coast Board Riders
  - aa. Southern Clams Limited
  - bb. Surf Break Protection Society

- cc. University of Otago – Department of Marine Science
- dd. Yellow-Eyed Penguin Trust

27. Note that Community representative roles can be modified as appropriate.
28. The PCG shall meet on at least one occasion every twelve months during Incremental Capital Works and monthly during Major Capital Works.
29. The final copies of reports prepared in accordance with all reporting required under the resource consents shall be provided to the Consent Authority and such other PCG members as may express an interest in receiving them.

#### **Manawhenua Consultative Group**

30. The Manawhenua Consultative Group ("MCG") has responsibilities associated with communication between the various project parties and representatives of the local hapu and iwi.

#### **Objectives of the Manawhenua Consultative Group**

31. Within three months of the commencement of the resource consent, Port Otago shall invite representatives of the local hapu and iwi and Manawhenua representatives from the East Otago Taiapure Management Committee to join the MCG.
32. The purpose of the MCG, the meetings that will be held with the MCG, and Port Otago's obligations to the MCG are designed to:
  - a. Facilitate consultation between the MCG and Port Otago during the Incremental and Major Capital dredging and disposal works and present and future maintenance dredging.
  - b. Consult the MCG on the design of the cultural monitoring programmes, including the development of cultural health indicators for key species of importance to Kāi Tahu.
  - c. Receive and review monitoring data reports from the cultural, physical monitoring undertaken as part of Project Next Generation dredging, and maintenance dredging. If necessary, technical expertise will be made available by Port Otago to assist the MCG to interpret the monitoring data.
  - d. On an ongoing basis to evaluate the cultural impacts of Project Next Generation, and maintenance dredging, on Otago Harbour and Te Tai o Arai Te Uru (Otago Coastal Marine Area).

- e. To make recommendations to Port Otago on management options to avoid, remedy or mitigate any adverse effects of Project Next Generation, and maintenance dredging, on the cultural values, interests, and associations of Manawhenua with the Otago Harbour and the Te Tai o Arai Te Uru (Otago Coastal Marine Area); and
- f. To make recommendations to Port Otago on appropriate changes to the cultural monitoring framework to ensure that it delivers timely focused results for the improved management of the project.
- g. Proposed changes to the Environmental Management Plan in response to recommendations of the MCG shall be reasonably considered by Port Otago and implemented to the extent practicable.
- h. The MCG and TG shall be given an opportunity to comment on all proposed changes to the Environmental Management Plan before Port Otago finally considers them. Any change to the Environmental Management Plan shall be submitted to the consent authority to ensure that it complies with the conditions of consent.
- i. Port Otago shall, not less than three months before, and at least once every three months when Major Capital works are being undertaken invite the MCG to a meeting to discuss any matter relating to the exercise and monitoring of the consents.
- j. Port Otago shall, in complying with the notification requirements to the Consent Authority, or when monitoring or research activities are being planned, or when results are to be submitted invite the MCG to a meeting to discuss any matter and share this information prior to submitting the information to the Consent Authority. The information shall be provided to the MCG sufficiently in advance of the meeting so that the MCG has time to review and consider it.
- k. Port Otago shall, at least once per calendar year, invite representatives of the Consent Authority and the MCG to a meeting to discuss any matter relating to the exercise and monitoring of this consent. At this time Port Otago shall, in addition to any matters relating to the exercise and monitoring of this consent, use its best endeavours to inform the MCG of the likely dredging to be undertaken in the following year.
- l. Port Otago shall keep minutes of the MCG meetings and shall forward them to all attendees and to the TG.
- m. The MCG meetings need not occur if the MCG notifies Port Otago and the Consent Authority that the meeting is not required.

- n. Port Otago shall provide final copies of the reports prepared in accordance with these conditions to the MCG concurrently with them being submitted to the Consent Authority.
- o. The MCG shall be serviced by Port Otago.
- p. All members of the MCG shall use their best endeavours to resolve all issues before it. If any matter remains unresolved then Port Otago shall refer each unresolved matter to its Board immediately and the Board shall take all practicable steps to resolve any outstanding issues with Kaumātua including (if necessary) appointment of an independent mediator."

33. The MCG includes representatives from:

- a. Port Otago Limited
- b. Otakou Runanga,
- c. Kati Huirapa Runaka ki Puketeraki,
- d. Manawhenua Working Group
- e. Te Runanga o Moeraki
- f. East Otago Taiapure Management Committee (Manawhenua Representative)
- g. Karaitiana, RL Karaitiana & Taituha Trust
- h. Koraki Karetai Trust
- i. KTKO Consultancy Ltd
- j. Heron Construction Ltd
- k. Other Project Contractors (*insert name when available*)

34. Note that additional Maori representative roles can be added as necessary, following MCG input.

#### **Technical Group**

- 35. A Technical Group will be established to evaluate monitoring and to make recommendations on actions to improve monitoring and effects including changes to this EMP.
- 36. The Technical Group will be serviced by Port Otago and meet as often as necessary but at a minimum annually.

37. The functions of the Technical Group are:
  - a. Evaluation of received monitoring data and reports from the physical and biological monitoring required by this EMP;
  - b. To make recommendations on management actions to ameliorate the adverse effects of dredging and disposal as part of Project Next Generation;
  - c. To make recommendations on appropriate changes to the physical and biological monitoring framework to ensure that it delivers timely focussed results for the improve management of the project.
38. The Technical Group shall have but not be limited to the following membership:
  - a. representatives of Otakou and Puketeraki runanga;
  - b. a representative of the Department of Conservation;
  - c. a representative of Port Otago Limited;
  - d. a representative of Otago Regional Council;
  - e. a suitably qualified technical representative nominated by the local fishing industry shall be invited to be a member of the Technical Group;
  - f. a representative of the East Otago Taiapure Management Committee
39. The Technical Group may co-opt additional members to ensure that it has the requisite skills to be able to deliver on its brief. In exercising its powers of co-option the Technical Group shall ensure that it has access to sufficient expertise on fisheries in the Otago harbour and coastal waters including Blueskin Bay.
40. The Technical Group shall adopt a terms of reference that includes, but is not limited to, establishing the way in which it will receive monitoring data and reports, consider that information and resolve any issues that may arise within the group.

## **REPORTING REQUIREMENTS**

41. All technical reports will include a brief summary that is free of technical jargon and is written for a lay person.
42. Port Otago will meet with community groups about any of the reports upon request.
- 42A. Port Otago will upload turbidity data from the telemetered monitors at sites A and B (see condition 28(b) of consent 2010.198) on a daily basis to its website. This data will be held on the Port Otago website for one month. Port Otago will also provide

the reports on turbidity at sites A and B (required by condition 28(a) of consent 2010.198) on its website.

43. A summary and timetable of all reporting dates and the relevant periods they cover is included in Appendix 5.

## **COMPLAINTS PROCEDURE**

44. Port Otago will establish and operate a Community Complaints Procedure during Project Next Generation and operation of consented activities.
45. Port Otago will have a clearly nominated and publicly communicated contact person within its own organisation, or within one of its local agents, who will be known as the 'Community Relations' contact.
46. The Community Relations contact will be the point of contact between the community (or other public) and Port Otago. They will be responsible for receiving and responding to any complaints during the Project.
47. Port Otago will operate a 24 hour freephone number for the community to call if they have any concerns or complaints during the Project. The freephone number and complaints procedure will be advised to local residents within the area potentially affected by the Project and shall be advertised in the Otago Daily Times and on the Port Otago website within 1 month of commencement of consent, before any Major Capital works are commenced, before any blasting is commenced, and at regular periods during the Project.
48. Port Otago will maintain a log of all complaints received including the following:
  - a. date.
  - b. time.
  - c. complainant name and contact details (if provided).
  - d. nature of the complaint including the cause and effect if known.
  - e. record of action taken to address or mitigate the complaint.
49. Port Otago, via the Community Relations contact, will acknowledge receipt of complaints to the complainant and Otago Regional Council as soon as it is



practicable but no later than 2 working days and shall log the action that it intends to take in response to the complaint.

50. Port Otago will use best endeavours to take action in respect of a complaint, if any action is necessary, within one week of a complaint being received. The response time will depend upon the nature of the complaint, the scale of any investigation required, and the type of mitigation action undertaken. In many circumstances a response will be quicker than five working days/one week but in some circumstances it may necessarily be slower.
51. Port Otago, via the Community Relations contact, will communicate with the complainant about actions taken.
52. Port Otago will document any other longer term actions to be taken as a result of any complaint.
53. Once every twelve months Port Otago will present a complaints summary to the meetings of the PCG (in the event it is established), the MCG (in the event it is established) and to the Otago Regional Council for review.
54. Port Otago will make the Complaints log available to Otago Regional Council on request.

## **QUALITY ASSURANCE PROCEDURES**

55. The requirements for material and plant quality assurance procedures will be detailed in a construction specification. The Contractor will be required to prepare specific testing procedures to meet the specified requirements, and actions that will be taken if specified requirements are not achieved.

## **HEALTH AND SAFETY**

56. A health and safety plan will be prepared by the Contractor before the start of dredging and disposal operations. This will be written to fulfil the requirements of the Health and Safety in Employment Act (1992) and to ensure the safety of people working on the Project.

## **SECTION C MONITORING AND ADAPTIVE MANAGEMENT OF OTAGO HARBOUR RELATED ACTIVITIES**

57. This section of the EMP sets out the monitoring and adaptive management actions which will be undertaken by Port Otago prior to, during and following the Incremental Capital and Capital Dredging Works in Otago Harbour.

### **DREDGE MATERIAL CHARACTERISTICS** *(Refer to Condition 22 of consent 2010.193)*

#### **Purpose**

58. To document the characteristics and location of dredging activities.

#### **Monitoring**

59. For the duration of the project Port Otago will collect and record data on the characteristics of the material dredged and disposed including:
- a. Make up of each load (e.g. sand, silt, clay, rock),
  - b. Volumes of dredged material for each run,
  - c. Location of dredge sites (GPS or chart reference),
  - d. Cumulative total volumes of dredged material disposed.
  - e. Disposal ground used and location within the disposal ground.
  - f. Date and time of dredging and the associated disposal.

#### **Management Action**

60. The data collected will be included in annual reporting associated with the Incremental Capital and Major Capital dredging.

## **PLUME INTENSITY AND EXTENT**

#### **Purpose**

61. To detect unexpected changes in the intensity and / or extent of the dredging plume, and inform adaptive management of the dredging activities, to ensure the environmental limits specified in Table 1 (paragraph 73) and Table 2 (paragraph 74) are achieved.

## Monitoring

62. Port Otago will undertake monitoring of Incremental Capital and Major Capital dredge works within the Inner Harbour. The final methodology has yet to be developed but it is expected it will be generally as follows:
- a. Measure suspended sediment of dredge plume, once when the dredge is working a load of predominantly sand and once when the dredge is working a load of predominantly silt.
  - b. Measurements will include sampling using mobile turbidity meters, and also light attenuation along the centreline of the plume for up to 1km downstream.
  - c. Measurements will be compared to a control site so as to establish background turbidity and light attenuation levels.
  - d. Concurrently with the measurements, vertical aerial photographs may be taken to assist interpretation of results.

Stage 1 NOTE – no specific turbidity monitoring of the New Era or Heron Construction works (such as the 4 items above), are proposed due to the low intensity of the activities being carried out. Visual assessment, and then if necessary oblique or aerial photography should be considered.

As identified in the individual dredging and disposal documents for both New Era and Heron Construction, visual observation of the dredging activities within the first 4 weeks is recommended. This would confirm the nature and extent of the discharges, the anticipated effects as well as the appropriateness of the specific management action responses.

## Management Action

63. A report documenting and analysing the results of each of the four monitoring exercises outlined in paragraph 62 above, will be provided to the Consent Authority, PCG, MCG and Technical Group as soon as practicable, but no later than two weeks, following the completion of each monitoring exercise.
64. Should the results of monitoring undertaken in accordance with paragraph 62 be significantly different from those predicted, Port Otago will, as soon as practicable:
- a. Inform the Consent Authority.
  - b. Review the appropriateness of the turbidity monitoring, and identify and implement any additional monitoring required.

- c. Adapt its dredging practices to the extent necessary to avoid any significant adverse effects not predicted in the Project Next Generation AEE.
65. Notwithstanding paragraph 64, if following the receipt of a report prepared in accordance with paragraph 63 the Technical Group considers changes should be made to the dredging practices in order to avoid, remedy or mitigate the adverse effects of the dredging activities, and / or considers changes should be made to the plume intensity or water quality monitoring programme, Port Otago will implement those changes to the extent practicable.
66. Notwithstanding paragraphs 64 and 65, if following receipt of a report prepared in accordance with paragraph 63 the Consent Authority advises in writing that it considers that the effects of the disposal are:
- a. Significantly different from those predicted; and
  - b. Significantly adverse;
- Port Otago will immediately take all practicable steps to remedy or mitigate those effects, and will adapt its disposal practices to the extent necessary to avoid any continuation of those adverse effects.

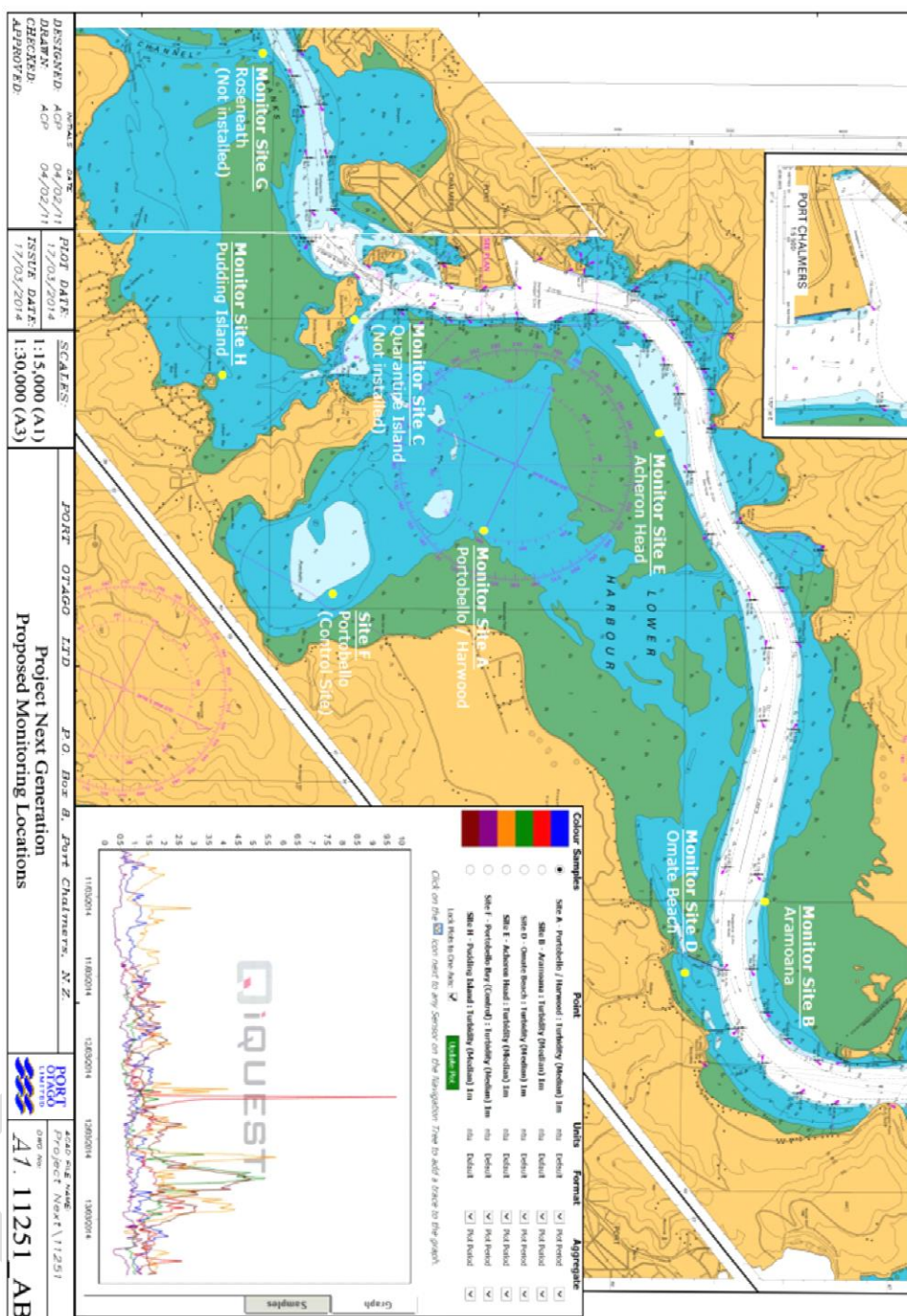
**TURBIDITY** (*Refer to Conditions 4 to 8, 10, 11 and 12 of consent 2010.195*)

**Purpose**

67. To detect unexpected changes in the intensity and / or extent of turbidity caused by Incremental Capital and Capital Dredging, and inform adaptive management of those dredging activities.

**Monitoring**

68. During Incremental Capital or Major Capital Works, a turbidity meter or meters will be placed near (within 20 m of the boundary of) or in the locations shown in Figure 1 and listed below:
- the Harbour Seagrass beds at Harwood (Sites A);
  - the Aramoana Ecological area (Site B);
  - Quarantine or Pudding Island (Sites C & H);
  - Wellers Rock/Omate Beach (Site D); and
  - the intertidal cockle beds opposite Acheron Head (Site E); and
  - a control meter in the Upper Harbour at Portobello Bay (Site F).



**Figure 1: Location of In-Harbour Fixed Turbidity Monitors.**

#### Description of Turbidity Monitoring Equipment

Cawthron Institute has installed seven standardised turbidity monitoring stations. Each contains a solar supply, batteries and a Wetlabs NTUSB turbidity sensor. A Campbell Scientific CR-800 datalogger is used, and programmed to both power the

turbidity sensor at set intervals, as well as collect and pre-process data prior to upload and transmission.

Cawthron's design includes the turbidity sensor being encapsulated inside a hollow tube which serves as an algae shield, but also enables easy hoisting to the surface for maintenance.

Two-monthly maintenance checks (maximum duration) of the turbidity sensors are required, involving in situ cleaning of the sensor by POL staff. This frequency may reduce depending on seasonality, due to bio-fouling in the monitoring area, and possibly be a bigger problem over spring and summer. A field check of the sensor will also be undertaken at this time to ensure accurate measurement and reporting.

The monitor at the Quarantine Island site is the "spare" harbour turbidity monitor, but in place at this location and operational. The contingency plan in the event of breakdown or extended outage at one of the other harbour turbidity meters, is to use the meter from the Quarantine Island site, and go without monitoring at this site whilst permanent repairs or replacement are undertaken.

69. Port Otago will undertake fixed turbidity monitoring at the locations specified in paragraph 68 in for a minimum of the first six months from commencement of any Incremental Capital works, and for a further period of at least six months, if determined appropriate in the report prepared in accordance with paragraph 76 below.
70. So as to obtain monitoring results that are representative of any effects resulting from the works, when the monitoring specified in paragraph 69 above is undertaken Port Otago will ensure that Incremental Capital Works are periodically undertaken within the vicinity of the monitoring areas identified in paragraph 68 of this consent.
71. Port Otago will undertake continuous fixed turbidity monitoring at the locations specified in paragraph 68 for a period beginning three months prior to the commencement of Major Capital dredging, and continuing, at minimum, until three months after the completion of all Major Capital works.
72. The relationship between turbidity (NTU) and suspended sediment concentrations (SSC) has been established by testing and analysis work undertaken by Paul Barter, Cawthron Institute. A detailed summary of the sampling protocol, test results and intended approach are included in Appendix 6, which also references a supporting technical report.

The outcome of that testing and the approach adopted is to apply a sensor specific correction factor of 2.5, to the raw NTU measured in the field by the Wetlabs® sensors. These adjusted NTU (i.e. NTU\_adj) results can be used to directly compare the data being collected in the field, to those SSC used in deriving the originally prescribed harbour turbidity limits and calculated off shore ETL, at these locations.

As a result of completing this confirmation of the SSC:NTU relationship for the sensors being used, and to ensure clarity and consistency with the wording of the consents document, a review of the original Condition 10(e) has been undertaken

### Management Actions

73. If the response limits set out in Table 1 are exceeded at the turbidity meters specified in paragraph 68 above, the associated management actions stipulated in Table 1 will be implemented. Note that equipment and activity specific management actions are included within the dredging and disposal documents for both the New Era and Herons Construction works.

**Table 1: Turbidity response limits and associated management actions.**

Note – the NTU values in this table are the same as those in Consent 2010.195. These were set originally on a 1:1 relationship basis with SSC. NTU in this table, can therefore can be viewed as directly interchangeable or substituted with SSC.

	Monitoring	Environmental Limit	Response Limits		Management Action	
			1	2	Response Limit 1 reached	Response Limit 2 reached
Site A	Turbidity meter placed in a location in the <b>Harbour seagrass beds</b> at Harwood in the location shown on Plan A1.11251 dated 11 February 2011 (attached).	25 NTU (6 hourly average)  15 NTU (2 week moving average)	12 NTU (6 hourly average)	17 NTU (6 hourly average)	Notify ORC within 24 hours of exceedance.  Check equipment/data accuracy to verify exceedance.	Undertake all actions as set out when Response 1 limit is reached  Undertake management of dredging process to reduce turbidity. This could include:
Site B	Turbidity meter placed in a location adjacent to the <b>Aramoana Ecological area</b> in the location shown on Plan A1.11251 dated 11 February 2011 (attached).	35 NTU (6 hourly average)	19 NTU (6 hourly average)	24 NTU (6 hourly average)	Review natural events and areas of dredging activity with	

Sites C, D and H	-Turbidity meters placed in locations shown on Map Plan A1.11251 dated 11 February 2011 (attached); at <ul style="list-style-type: none"> <li>▪ <b>Quarantine or Pudding Island</b></li> <li>▪ <b>Wellers Rock/ Omate Beach</b></li> </ul>	35 NTU (6 hourly average)	19 NTU (6 hourly average)	24 NTU (6 hourly average )	expert advisor. Assess impact of ongoing dredging operation.  Assess need for additional monitoring	<ul style="list-style-type: none"> <li>▪ Relocation of dredge</li> <li>▪ Reduce dredging frequency</li> <li>▪ Suspend dredging</li> <li>▪ Operate dredge in non overflow mode</li> </ul>
Site E	Turbidity meter placed in location as shown on Plan A1.11251 dated 11 February 2011 (attached) in <b>intertidal cockle beds</b> opposite Acheron Head.	70 NTU (6 hourly average)	35 NTU (6 hourly average)	50 NTU (6 hourly average )		
Site C	Turbidity meter placed at Quarantine Island	50 NTU (10 day average)			Dredging to cease between mid-flood tide and high tide in area of the swinging basin. Normal dredging in this area can restart once NTU values have fallen below 50 for a period of 1.5 times greater than the period of exceedance up to a maximum of 7 days.	
Site G	Turbidity meter placed in the cross-channel between Grassy Point and Roseneath.	50 NTU (10 day average)				

74. If the environmental limits specified in Table 2 are exceeded, Port Otago will immediately take the following steps:

- a. Inform the Consent Authority.
- b. Additional monitoring, investigation and / or analysis will be undertaken to confirm whether the dredging activities are responsible for the exceedance of the turbidity limit in Table 2 and whether the exceedance has caused a significant adverse effect.
- c. Should it be concluded that the dredging activities are the cause of the exceedance and it has caused a significant adverse effect, all practicable steps will be taken to remedy or mitigate those effects, and the dredging practices will be adapted to the extent necessary to avoid any continuation of those significant effects
- d. Should it be concluded that the dredging activities are the cause of the exceedance but it has not caused a significant adverse effect, the dredging practices will be adapted to the extent necessary to avoid any continuation of the exceedance.
- e. The biological monitoring programme will be reviewed, and amended as required.



**Table 2: Turbidity Limits**

Note – the NTU values in this table are the same as those in Consent 2010.195. These were set originally on a 1:1 relationship basis with SSC. NTU in this table can therefore be viewed as directly interchangeable or substituted with SSC.

<b>Monitoring Location</b>	<b>Environmental Limit</b>
Turbidity meter placed in a location in the Harbour seagrass beds	25NTU (6 hourly average) 15 NTU (2 week moving average)
Turbidity meter placed in a location adjacent to Aramoana Ecological area	35 NTU (6 hourly average)
Turbidity meters placed in the following Locations: <ul style="list-style-type: none"> <li>• Quarantine or Pudding Island</li> <li>• Wellers Rock/ Omate Beach</li> </ul>	35 NTU (6 hourly average)
Turbidity meter placed in location within the intertidal cockle beds opposite Acheron Head.	70 NTU (6 hourly average)

75. Data from fixed turbidity monitoring undertaken in accordance with paragraph 69, and any measurement or photographs undertaken will be reviewed by a suitably qualified expert to assess the need for continued monitoring during Incremental Capital works. A report will be prepared incorporating the results of the independent review and a discussion of future or continued monitoring requirements. This report will be submitted to the consent authority within two months of the end of the monitoring undertaken in accordance with paragraph 71.
76. On completion of turbidity monitoring undertaken in accordance with paragraphs 69 and 71, a report will be prepared summarising:
- the results of the turbidity data;
  - any photographs or additional monitoring results undertaken in accordance with the Environmental Management Plan;
  - the results of any surveys undertaken to verify the hydrodynamic modelling predictions associated with various items of dredging plant
  - and the schedule of works;
77. The purpose of the report specified in paragraph 76, is to determine the actual effects on water quality and on the coastal marine area including biota as a result of the Incremental and Major Capital works. This report shall also confirm the results of any

surveys undertaken to verify the hydrodynamic modelling predictions associated with various items of dredging plant.

78. Notwithstanding paragraphs 73 - 77, if the Technical Group considers changes should be made to the dredging practices in order to avoid, remedy or mitigate the adverse effects of the Incremental Capital or Capital Dredging Works, and / or considers changes should be made to the turbidity monitoring programme, Port Otago will implement those changes to the extent practicable.
79. Notwithstanding paragraphs 73 - 78, if the Consent Authority advises in writing that it considers that the effects of the dredging activities are:
- a. Significantly different from those predicted; and
  - b. Significantly adverse;
- Port Otago will immediately take all practicable steps to remedy or mitigate those effects, and will adapt its dredging practices to the extent necessary to avoid any continuation of those adverse effects.

#### **AQUATIC COMMUNITIES** (*refer to condition 13 of consent number 2010.195*)

##### **Purpose**

80. To detect changes in aquatic communities outside the “expected variability”. Expected variability includes both natural fluctuations, and anticipated Project Next Generation – related changes as predicted in the Project Next Generation AEE.

##### **Monitoring**

81. Port Otago will commission a suitably qualified person or organisation to undertake biological monitoring surveys of the foreshore, seabed and intertidal flats within the Lower Harbour and including the Port Chalmers swinging and berthing areas and the approach channel. The surveys will be undertaken at the following time periods:
- a. at least 3 months prior to the commencement of any Incremental Capital works as a baseline survey;
  - b. 3-yearly intervals during the Incremental Capital works;
  - c. a maximum of 36 months after the completion of Incremental Capital works;
  - d. at least three months prior to the commencement of Major Capital works;
  - e. 12-monthly during Major Capital works; and
  - f. 12-monthly for a maximum of three 12-month periods after the completion of Major Capital works.

82. The methodology for the biological monitoring surveys described in paragraph 81 is to include the following:
- a. Quarterly monitoring of seagrass beds (quarterly frequency) for one year with 4 transects off Harwood and 2 at a control or reference site (Papanui) . Aerial cover, distribution, blade length, shoot density, biomass and percentage cover will be used as indicators of health. Core samples for assessing depth of redox layer and sediment composition will be taken at the end of each transect off Harwood. Further larger scale distribution assessment will be based on aerial photography, ground truthing and the established transects above. This will include aerial photography at 2 additional sites in the outer harbour.
  - b. Monitoring of Aramoana salt marshes with quadrats along 4 randomly selected transects with measures of epifauna and percent cover of plants (photo-quadrats), infauna (cores), redox layer (cores) and aerial photographs for extent of salt marshes.
  - c. An assessment of cockle beds at a minimum of 4 sites (such as opposite Pulling Point, opposite Acheron Head, Te Ngaru and Te Rauone) and control site in Papanui Inlet. Surveys to include cockle population, density, size structure, biomass and condition.
  - d. Monitoring of Rocky Shores at a minimum of 2 locations.
  - e. Surveys of invasive species.

Further details of this monitoring programme are provided in Appendix 2.

### **Management Action**

83. Results and analysis from each biological monitoring survey described in paragraphs 81 - 82 will be compiled into a report and provided to the Consent Authority, the PCG, MCG and the Technical Group as soon as practicable, but no more than three months, following the completion of each monitoring exercise.
84. If the monitoring outlined in paragraphs 81 - 82 identifies changes in biological communities in excess of natural fluctuations, and which are significantly different from those predicted and significantly adverse, Port Otago will immediately take the following steps:
- a. Inform the Consent Authority.

- b. Additional monitoring, investigation and / or analysis will be undertaken to confirm whether the dredging activities are responsible for the significant adverse effect.
  - c. Should it be concluded that the dredging activities are the cause of the significant adverse effect, all practicable steps will be taken to remedy or mitigate those effects, and the dredging practices will be adapted to the extent necessary to avoid any continuation of those significant effects
  - d. The biological monitoring programme will be reviewed, and amended as required.
85. Notwithstanding paragraph 84, if following the receipt of a report prepared in accordance with paragraph 83 the Technical Group considers changes should be made to the dredging practices in order to avoid, remedy or mitigate the adverse effects of the dredging activities, and / or considers changes should be made to the biological monitoring programme, Port Otago will implement those changes to the extent practicable.
86. Notwithstanding paragraphs 84 and 85, if following receipt of a report prepared in accordance with paragraph 83 the Consent Authority advises in writing that it considers that the effects of the dredging activities are:
- a. Significantly different from those predicted; and
  - b. Significantly adverse;
- Port Otago will immediately take all practicable steps to remedy or mitigate those effects, and will adapt its dredging practices to the extent necessary to avoid any continuation of those significant effects.

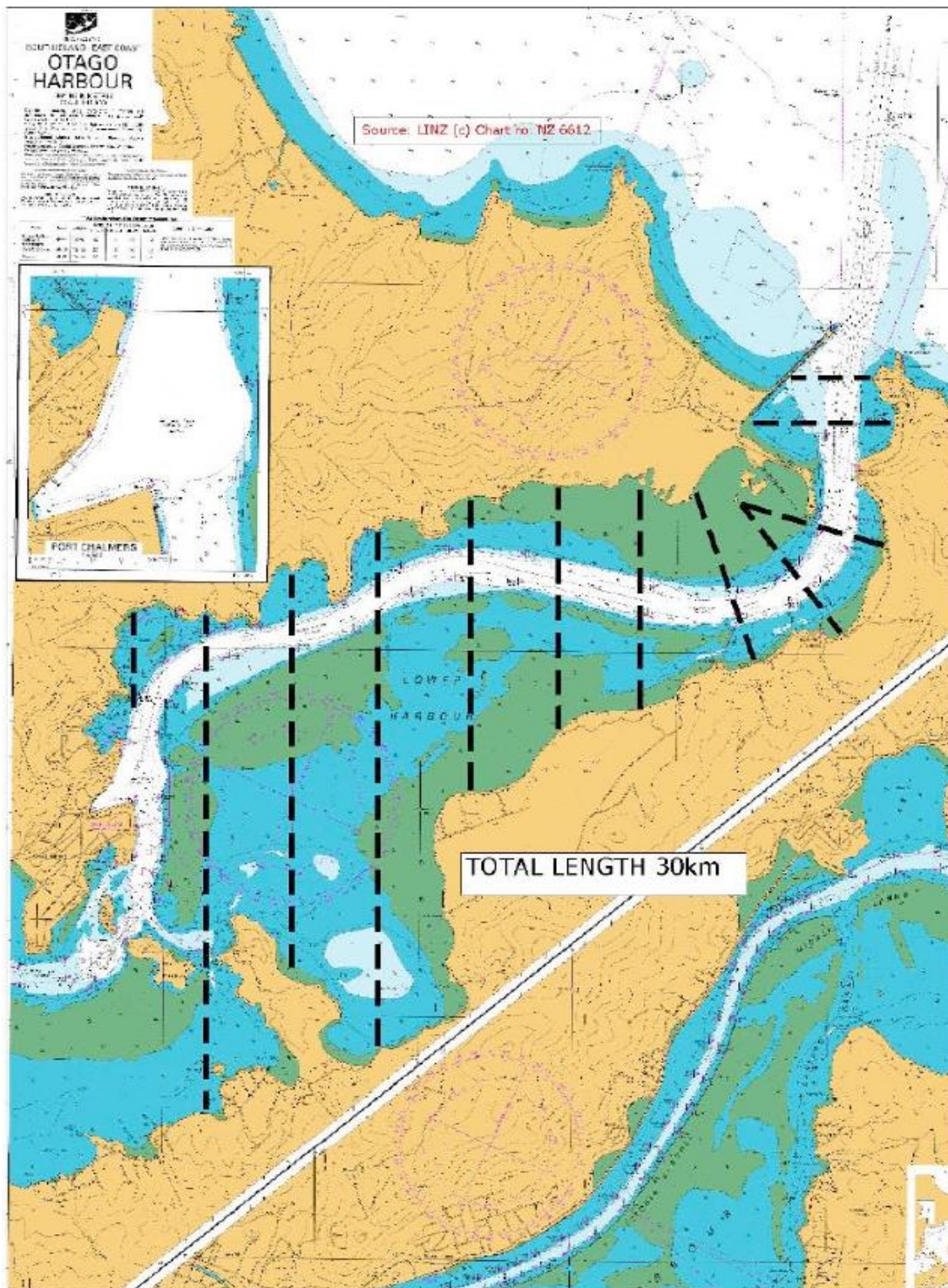
**BATHYMETRIC SURVEYS** *(Refer to Conditions 20 and 21 of Consent Number 2010.193, Conditions 11 and 12 of Consent Number 2010.194)*

### **Purpose**

87. To detect and document changes in bathymetry outside the “expected variability”. Expected variability includes both natural fluctuations, and anticipated Project Next Generation – related changes as predicted in the Project Next Generation AEE.

### **Monitoring**

88. Port Otago will undertake bathymetric surveys of the foreshore and seabed and intertidal flats within the Lower Harbour at the locations specified in Figure 2. All bathymetric surveys will have an accuracy of 0.1 metre vertically.
89. The bathymetric surveys will be undertaken at the following times:
- a. prior to the commencement of any Incremental Capital Works;
  - b. annually during Incremental Capital Works;
  - c. within six months of the completion of Incremental Capital Works;
  - d. within the period six months prior to the commencement of Major Capital Works;
  - e. every six months during the Major Capital Works; and
  - f. within six months of the completion of all Major Capital Works.
  - g. at three yearly intervals thereafter while resource consent 2010.194 authorising the disturbance of the bed for maintenance dredging is operative.
90. Port Otago will also undertake beach and nearshore profiling in the areas of Shelley Beach, Te Rauone, and the Aramoana Sand Flats at similar intervals to the bathymetric surveys described in paragraph 88 and 89 to determine any morphological change. The methodology for these surveys is contained within Appendix 7.



Project Next Generation  
 Scale 1:50000 In Harbour Bathymetric Survey Transects A4 11206/2

**Figure 2: In Harbour Bathymetric Survey Transects**

### Management Action

91. Results and analysis from each bathymetric survey and beach and nearshore profiling outlined in paragraphs 88 - 90 will be compiled into a report and provided to the Consent Authority, the PCG, MCG and the Technical Group as soon as practicable, but no more than three months, following the completion of each survey.
  
92. If the bathymetric surveys and nearshore profiling outlined in paragraphs 88 - 90 identifies changes in bathymetry or nearshore profiles in excess of natural fluctuations, and which are significantly different from those predicted and significantly adverse, Port Otago will immediately take the following steps:
  - a. Inform the Consent Authority.
  - b. Additional monitoring, investigation and / or analysis will be undertaken to confirm whether Port Otago dredging activities are responsible for the significant adverse effect.
  - c. Should it be concluded that the Port Otago dredging activities are the cause of the significant adverse effect, all practicable steps will be taken to remedy or mitigate those effects, and the dredging practices will be adapted to the extent necessary to avoid any continuation of those effects.
  - d. The bathymetric survey programme will be reviewed, and amended as required.
  
93. Notwithstanding paragraph 92, if following the receipt of a report prepared in accordance with paragraph 91 the Technical Group considers changes should be made to the dredging practices in order to avoid, remedy or mitigate the adverse effects of the dredging activities, and / or considers changes should be made to the bathymetric survey programme, Port Otago will implement those changes to the extent practicable.
  
94. Notwithstanding paragraphs 92 and 93, if following receipt of a report prepared in accordance with paragraph 91 the Consent Authority advises in writing that it considers that the effects of the dredging activities are:
  - a. Significantly different from those predicted; and
  - b. Significantly adverse;
 Port Otago will immediately take all practicable steps to remedy or mitigate those effects, and will adapt its dredging activities to the extent necessary to avoid any continuation of those significant effects.

95. In accordance with condition 21 of Resource Consent 2010.193 By 1 December 2030, Port Otago will submit a report to the Consent Authority that summarises the results of all in-harbour bathymetric surveys undertaken and shall clearly indicate the degree of change to the foreshore and seabed as a result of the dredging and detail the actual effects on the environment of the works.

**TIDE AND CURRENT MEASUREMENTS** *(Refer to Condition 12 of Consent Number 2010.193.)*

**Purpose**

96. To document changes in tidal height and associated currents

**Monitoring**

97. Port Otago will measure tidal height and associated currents in the following manner:
- a. For tidal height:
    - i. From existing gauging stations at Dunedin, Port Chalmers and Spit;
    - ii. These measurements will be taken continuously throughout the Incremental Capital and Major Capital Works, and for at least one year following completion of dredging; and
  - b. For current measurements:
    - i. At or near the Port Chalmers Swinging basin; and at Beacon Pile 1A opposite Harington Point.
    - ii. These measurements will be taken at the commencement of Incremental Capital Works, throughout Major Capital Works, and periodically for at least one year following completion of dredging.
    - iii. The duration of the measurement is yet to be determined but will be of sufficient time to accurately determine the tidal current regime.

**Management Action**

98. At no greater than five yearly intervals during Incremental Capital works, and within two years of completion of all Incremental and Major Capital works, Port Otago will submit to the consent authority a report outlining the results of the tidal height and currents monitored in accordance with paragraph 97, and discuss any trends in the data and any identifiable links to the capital works that were undertaken.
99. Port Otago will continue to provide tidal data to Land Information NZ Hydrographic Services.



100. Notwithstanding paragraph 98, the results of the tidal height and currents monitored in accordance with paragraphs 97 will be provided to the Otago Regional Council on request.

**MIGRATORY GODWITS** *(Refer to condition 9 of consent number 2010.193 and condition 19 of 2010.198)*

**Purpose**

101. To avoid effects on migratory godwits.

**Monitoring**

102. If Port Otago intends undertaking Major Capital Works in the vicinity of the Aramoana sand flats when the tidal height is above half-tide (>1.0 metre above Chart Datum) between 1 February and 31 March in any calendar year, the presence of the migratory godwit population will be monitored in conjunction with the Department of Conservation and/or a suitably qualified expert

**Management Action**

103. If the monitoring outlined in paragraph 102 identifies a migratory population of godwits are present in the immediate area of the Aramoana sand flats during the period 1 February to 31 March of each year, then Major Capital Works in the vicinity of the Aramoana sand flats will only be undertaken when the tidal height is above half-tide (>1.0 metre above Chart Datum) if the approval of the Consent Authority in consultation with the Department of Conservation is obtained.

## NOISE

STAGE 1 NOTE - The Stage 1 works as planned are incremental capital works.

**New Era** – The noise levels of New Era are well understood having been measured and assessed by both Port Otago Ltd and noise consultants Marshall Day Ltd. This involved taking measurements both on-board the vessel as well as around all points of the vessel at varying distances during different types of the dredging and vessel operation. The primary source of noise aboard the vessel is from engine and exhaust noise from the 5 different engines, with the main engines being on the aft deck of the vessel.

Marshall Day Ltd made a number of recommendations to reduce the noise emanating from the dredge, including acoustic lining of main engine enclosures, improved sealing of main engine enclosures and improved engine exhaust mufflers. Having completed this work, noise monitoring results showed a significant reduction (ie between 5 and 13dBA reduction) in noise both inside the workspaces and outside on deck areas.

Having reduced vessel noise New Era can now work at any time, unrestricted in all locations of the harbour channel without exceeding the noise limits prescribed by the consent.

No further specific monitoring of New Era noise is proposed.

Best practice equipment and management techniques, as identified in the bullets below under Management Action are incorporated within the on-board vessel specific vessel environmental management plan (VEMP)

**Backhoe Dredging Operation (Herons)** – 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. A duration of work less than 20 weeks means the daytime limits in the Construction Noise standard of between 60-75dBA measured at a residential dwelling would apply.

The primary source of noise from the backhoe dredge is the excavator working almost continuously on the barge, with some noise from the tug that services the dredging barge. Noise consultants Marshall Day Ltd have assessed Heron's dredging equipment and operation, and they are satisfied that the dredging operation will comply with the daytime noise limits. Therefore daytime dredging hours and locations for this operation are not restricted by the Construction Noise limits.

The small amount of work remaining at Rocky Point will be a daytime activity only.

#### January / February 2016 – 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.

Noise measurements of the backhoe *Kimahia* have been made and this information will be used to inform the locations where and at what times dredging operations can be undertaken. Spot checks of actual activity will be undertaken to confirm compliance with the noise limits.

Notification of neighbours in the immediate vicinity will be undertaken prior to any works proceeding in that particular dredging location.

***Backhoe Dredging Operation with xcentric 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.

**Specific xcentric ripper noise monitoring** - Airborne noise measurements will be taken whilst the xcentric ripping activity is being undertaken to confirm that the measured levels do not exceed the daytime noise limits imposed by the consents. If noise measurements did show exceedance of the limits imposed by the consents, avoidance of work during times when those low limits were in place would be necessary. Improvements, including noise shielding or absorption may be necessary to reduce noise below the imposed limits if it is not possible to avoid working in that location at times.

In addition to airborne noise measurements, underwater noise measurements will be taken while the xcentric ripper activity is being undertaken. Best practice equipment and management techniques, as identified in the bullets below under Management Action clause 106 below are to be provided by Heron Construction and kept aboard vessels as part of their contract.

### **Purpose**

104. To ensure activities comply with the following relevant noise standards set out in their respective Resource Consents:
- a. All activities other than Major Capital Works or the use of explosives - The NZS 6803:1999 Construction Noise Standard.
  - b. Major Capital Works between the hours of 7.30 am and 8.00 pm during weekdays and 7.30 am and 6.00 pm on Saturdays - The NZS 6803:1999 Construction Noise Standard.
  - c. Major Capital Works at other times - The dredge equipment shall operate such that the Construction Noise Standard night time level of 45 dBA Leq shall not be exceeded within 15 metres of a residential dwelling, except:
    - i. Where the residential dwelling has been acoustically treated; or
    - ii. Where the occupier of the residential dwelling has consented in writing to the work taking place.

### **Monitoring**

105. Prior to the commencement of the Major Capital dredging works Port Otago will establish a noise monitoring programme. This programme will confirm actual noise levels of dredging activities relative to the predictions contained in the acoustic evidence provided to the Otago Regional Council hearing. This will allow individual properties exposed to noise levels in excess of 45 dBA to be identified under certain conditions.

106. At a frequency to be specified in the Noise Management Plan which is addressed below, during Major Capital dredging works Port Otago will undertake periodic noise measurements at appropriate locations to verify compliance with NZS6803:1999 Construction Noise Standard.

### **Management Action**

*A Noise Management Plan would be required for Major Capital Works with details included in this Section. If and when complete it would be expected to include, but not necessarily be limited to, the following matters:*

- *The results of the noise monitoring programme outlined in paragraph 105.*
- *Identification of individual property owners, consultation with those property owners in respect of a range of mitigation options for their property.*
- *A 'Noise Restricted Operating Areas' plan prepared using soundpower level information matched to meteorological conditions, and in consultation with a noise expert. This will allocate areas to be dredged during specific times and under certain wind conditions so as to remain within the NZS6803:1999 Acoustics Construction Noise Standard.*
- *Best practice equipment and management techniques are employed to manage the noise emissions from the dredging and disposal vessels, including, but not limited to the following:*
  - *Ensuring that the dredging and disposal vessels are equipped in accordance with industry best practice to minimise noise from the machinery and its operation.*
  - *Ensuring all plant is maintained in accordance with industry best practice.*
  - *Regular monitoring of vessel noise to ensure noise levels remain at levels similar to those measured at the commencement of the operation.*
  - *Ongoing education and communication with staff to retain a high level of awareness as regards noise issues, particularly in relation to impact noises.*
  - *Foghorns or other warning devices used by dredging and disposal activities will only be used in instances of genuine maritime emergency in all areas of the lower harbour channel.*
- *Procedures for logging all noise measurements undertaken by monitoring described in paragraph 106.*

107. If any noise measurements exceed the relevant noise limit Port Otago will immediately:

- a. Report the exceedance to the Consent Authority.
- b. Alter work practices or machinery to the extent necessary to ensure that the relevant noise limit is achieved.

**USE OF EXPLOSIVES** *(Refer to Condition 14 of Consent Number 2010.193).*

STAGE 1 NOTE - The Stage 1 works as planned, does not anticipate or include the need to use explosives. Therefore at this point in time (Revision 3 Oct 2014) para's 108 – 113 are not relevant or applicable.

**Purpose**

108. To avoid, remedy or mitigate the adverse effects of blasting.

**Monitoring**

109. As required by the Blasting Plan developed in accordance with paragraph 110.

**Management Action**

110. Port Otago will prepare and implement a Blasting Plan, which shall be approved by a suitably qualified expert. The Blasting Plan will include details of the programme and include requirements to:

- a. Carry out an underwater survey of benthic community prior to blasting commencing in the immediate vicinity of the area to be blasted.
- b. Remove and relocate resident fish (crayfish) to the extent practicable.
- c. Undertake visual observations (mammal watch) prior to detonation of explosives. Where required, blasting to be delayed until mammals are outside an immediate blast area set at 1000 metres.
- d. Prior to detonating explosives deploy a noise generating device to scare fish away from the blast site.
- e. Carry out visual observation and keep records of fish mortality, and remove dead fish immediately post blast. Report results in annual report.

111. The Blasting Plan outlined in paragraph 110 will be submitted to the Consent Authority for review not less than one month prior to Port Otago commencing blasting activities.

112. In addition to submitting the Blasting Plan for review, at least one month prior to undertaking each campaign of blasting works, Port Otago will notify the Consent Authority of the intended works, including the expected blasting dates and duration.
113. Port Otago will adopt best practice in terms of the management and use of explosive materials.

## **LIGHT SPILL**

### **Purpose**

114. To minimise the effect of light spill from dredging and disposal operations Port Otago will adopt the following approach:

### **Monitoring**

115. None proposed.

### **Management Action**

116. Port Otago will (except where lighting is required for the health and safety of the vessel and/or personnel):
- a. Use best practice equipment and management techniques for lighting of all dredging and disposal vessels. This will include shielding of lights to minimise light spill away from the vessel.
  - b. Use only essential navigation lights when passing Taiaroa Heads.
117. Port Otago will include these management actions in specifications provided for all dredging plant, to ensure all dredging operators follow them.

### **Stage 1 NOTE**

Best practice equipment and management techniques, as described above are incorporated within the New Era's on-board vessel specific vessel environmental management plan (VEMP), and are required to be provided by Heron Construction and kept aboard vessels as part of their contract.

## **SECTION D MONITORING AND ADAPTIVE MANAGEMENT OF DISPOSAL ACTIVITIES**

118. This section of the EMP sets out the monitoring and adaptive management actions which will be undertaken by Port Otago prior to, during and following the disposal of material at Site A0.
119. The key aspects of the monitoring will be as follows:
- a. Documenting the characteristics and location of disposal events.
  - b. A turbidity monitoring programme to detect and interpret any unexpected increase in background turbidity in the vicinity of A0 and in the nearshore environment.
  - c. A biological monitoring programme to identify any unexpected change in aquatic communities and to document their recovery.
  - d. Periodic bathymetric surveys to identify any unexpected changes in bathymetry and to document changes in seabed profile.
120. With respect to the adaptive management of the disposal operation, the key determinant will be the continuous monitoring of turbidity at A0 and an inshore site for the entire period of Major Capital Works dredging and a minimum of 4 months for Incremental Capital Works. This information will provide timely feedback to capture any unexpected actual or potential adverse turbidity events which could arise, and allow determination of whether changes are needed in operational management to comply with the Environmental Limits set out in the consent.

### **DREDGE MATERIAL CHARACTERISTICS**

#### **Purpose**

121. To document the characteristics and location of disposal activities.

#### **Monitoring**

122. For the duration of the project Port Otago will collect and record data on the characteristics of the material dredged and disposed including:
- (a) the volume and nature (as defined by approximate proportion of silt and sand) of dredged material in each disposal event;
  - (b) the GPS location of chart reference of the event, and vessel speed and direction
  - (c) the date and time of disposal;



- (d) a cumulative total of the volumes of disposal from the commencement of the consent;
- (e) GPS location and chart reference of the area (including start and end points) of the dredging where the material is sourced; and
- (f) the date and time of dredging and the associated disposal.

### **Management Action**

- 123. The data will be collected by the master of the dredge and recorded by Port Otago who shall include this information in annual and other scheduled reporting associated with the Incremental Capital Works and Major Capital Works.
- 124. To ensure that hopper loads are classified correctly as a silt, sand or silt sand mix, sampling of the load will be undertaken at least weekly until Port Otago has confidence that the loads are correctly classified.

### **TURBIDITY AND CURRENT-METER MONITORING**

#### *Turbidity monitoring in the vicinity of A0 at sites A and B*

- 125. Port Otago will deploy two turbidity moorings at sites A and B defined in the consent condition in appendix 1 D6 for not less than 4 months for the purposes of establishing a baseline of turbidity levels for setting the Environmental Turbidity Limit in Condition 32 of the consent.
- 126. The period of deployment shall include a range of oceanographic/weather conditions that include but are not limited to the following:
  - i. Onshore winds
  - ii. Offshore winds
  - iii. Large waves
  - iv. Small waves ...
- 127. If a representative range of oceanographic/weather conditions has not been captured within four months then the deployment period may be extended at the discretion of the Technical Group.
- 128. Following commencement of disposal, the moorings at A (45 44.943S 170 47.910E) and B (45 43.560S 170 47.146E) shall be in place for the entire period of Major Capital Works and a minimum period of 4 months for Incremental Capital Works provided at least five loads of silt have been disposed.
- 129. Each mooring to comprise a self-cleansing turbidity sensor to measure NTU near the surface (at least 2 m depth below a surface float). Recording intervals will be 15 minutes. Measurements are to be telemetered to a base station and processed to compare with the Environmental Turbidity Limit. Back-up turbidity sensors are to be

on standby to enable replacement of lost or damaged sensors to occur as soon as practicable.

130. Calibration of the turbidity sensors will be performed prior to deployment and at least every two months thereafter. Further, at least 15 sets of water samples are to be collected from A and B at the sensor depth for a range of turbidity and weather conditions, and measured for suspended-sediment concentration (using the analytical method for marine waters), turbidity (NTU units) and 5-cm black disc (in a long water trough on land designed for viewing the visual distance). A relationship will be developed from these results between turbidity in NTU from each sensor with suspended-sediment concentration of adjacent waters.

*Turbidity monitoring 1-2 km north of Cornish Head at site C*

131. Port Otago will deploy and operate a non-telemetered turbidity mooring at site C (45 37.015S 170 42.990E) defined in the consent condition at appendix 1 D6 concurrent with the monitoring at A and B with the addition of four months at the completion of Major Capital Works.
132. The mooring at site C will consist of a turbidity logger at the same depth below the surface as for sites A and B. At least 2 additional PAR sensors will be attached to the mooring at different depths to measure underwater light attenuation. Recording intervals will be at 15 minutes coincident with measurements at A and B. Loggers are to be downloaded at least monthly for processing. Calibration of the turbidity sensors and collection of water samples on at least 15 occasions will be performed at the same time as outlined above in paragraph 130.
133. A PAR sensor above water level measuring the open air PAR light intensity is installed on buoy C, substituting the originally intended sensor to be deployed in the vicinity of Cornish Head..

*Deployment of a recording current meter at A0*

134. Port Otago will deploy a recording depth-profiling current meter with a wave measurement capability 750 metres west of the centre of A0 for the duration of the turbidity base line monitoring.
135. Currents are to be recorded at 15 minute intervals aligned with the turbidity measurements at A and B, with waves measured over at least 10 minute bursts every 1-2 hours. These data to be processed and used to interpret turbidity measurements from A and B during the baseline monitoring survey and inform any fine-tuning of the locations of A and B for the operational monitoring phase.

### *Ancillary Information*

136. To aid with the interpretation of the results from the turbidity moorings, the following ancillary information will be collected for the monitoring periods and archived:
- a. Wave heights, periods and direction relevant to A0 that can be obtained from reliable wave model hindcasts or forecasts, complemented by wave measurements from the current-meter deployment specified in paragraphs 134-135);
  - b. Winds and barometric pressure from the Taiaroa Head weather station, which is already routinely collected;
  - c. Suitable MODIS or Landsat satellite images for cloud-free passes to determine the occurrences of coastal and offshore plumes from both natural sources, wave resuspension activity and dredge disposal;
  - d. Suitable aerial photography of at least five disposal events to show the visual extent of any plume associated with disposal of dredged material;
  - e. Sea-level records from Spit Wharf (Otago Harbour Entrance) and Green Island (operated by NIWA for Otago Regional Council); and
  - f. Rainfall and river discharge data for local coastal catchments and the Clutha and Taieri Rivers where and when available in the public domain.

### **Management Action**

137. Should the results of turbidity monitoring undertaken during disposal exceed 75% of the Environmental Turbidity Limit then Port Otago will:
- a. Inform the Consent Authority;
  - b. Adapt its disposal practices to minimise the increases in turbidity. Actions may include but not be limited to:
    - i. modify sailing speed and direction;
    - ii. modify disposal methodology and rate of release;
    - iii. alter location of disposal within A0;
    - iv. consider cessation of disposal of silt-laden material;
    - v. assess turbidity at mooring site C (Cornish Head).
138. Should the results of turbidity monitoring undertaken during disposal exceed the Environmental Turbidity Limit then Port Otago will:
- a. Inform the Consent Authority;
  - b. Cease disposal of silt loads;

- c. Investigate modification of disposal practices to minimise the increases in turbidity. Actions may include but not be limited to those matters listed in 137 above;
- d. Report the findings of the investigations to the consent authority. The report will include a proposal for modified disposal methodology to ensure compliance with the consent.
- e. Recommence disposal of silt loads only when the consent authority authorises recommencement.

**AQUATIC COMMUNITIES** *(Refer to Conditions 9, 18, 25, 26, 36 of Consent Number 2010.198).*

### **Purpose**

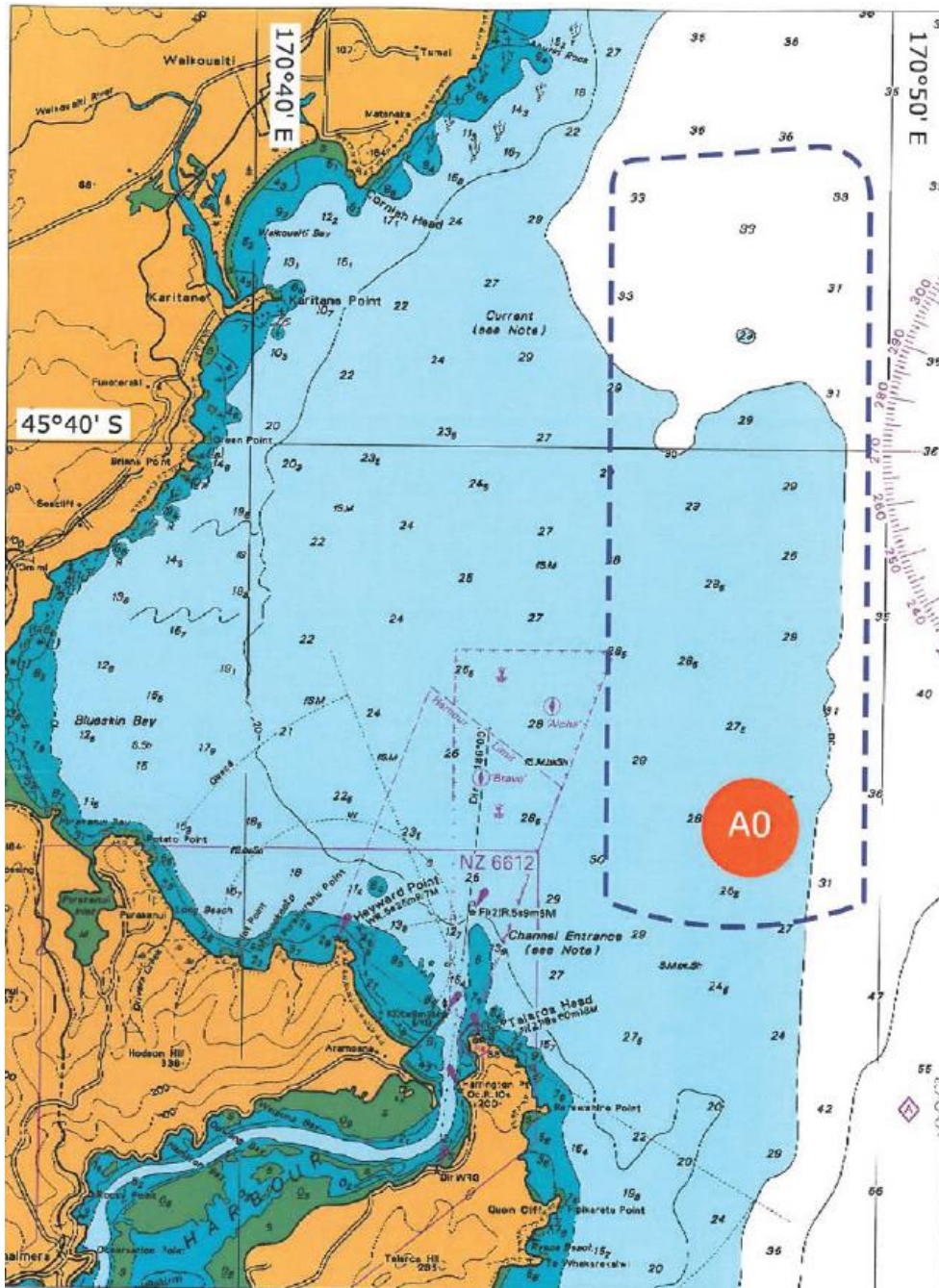
139. To detect changes in aquatic communities outside the “expected variability”. Expected variability includes both natural fluctuations, and anticipated Project Next Generation – related changes as predicted in the Project Next Generation AEE.

### **Monitoring**

140. A detailed baseline biological monitoring survey will be undertaken at least 3 months prior to the commencement of Incremental Capital Works and Major Capital Works. The specific details of the baseline survey will be developed in consultation with the Technical Group and specified in the EMP. The baseline survey will focus on the zone indicated in blue on Figure 3 but will also gather information about meaningful parameters at:
- (i) a representative area of shoreline and associated kelp forest between Shag Point and Cornish Head; and
  - (ii) sites near Shag Point and Pipikaretu Point (as control sites).
141. During Incremental Capital Dredging a biological monitoring survey will be completed at three yearly intervals. The survey will focus on the locations surveyed by the baseline biological monitoring survey and will be suitable to address effects on:
- a. species diversity;
  - b. abundance;
  - c. community composition; and
  - d. key physical parameters (e.g. sediment analyses).

142. Sampling methods will include use of sidescan to map seabed changes, bottom images from video or splashcam for sparse or elusive fauna (incl burrows), epibenthic sled to assess epifauna and grab sampling to assess infauna and sediment characteristics. The presence and establishment of invasive species offshore will be included in the surveys.
143. Following Major Capital Dredging, surveys described in paragraphs 140 – 142 will be undertaken annually for a period of at least three years.

Full details of the monitoring programme around the disposal site at A0 are provided in Appendix 3.



**Figure 3: Offshore biological monitoring zone.**

### Management Action

144. Results and analysis from each biological monitoring survey described in paragraphs 140 - 142 will be compiled into a report and provided to the Consent Authority, the PCG, MCG and the Technical Group as soon as practicable, but no more than three months, following the completion of each monitoring exercise.

145. If the monitoring outlined in paragraphs 140 - 142 identifies changes in biological communities in excess of natural fluctuations, and which are significantly different from those predicted and significantly adverse, Port Otago will immediately take the following steps:
- a. Inform the Consent Authority.
  - b. Additional monitoring, investigation and / or analysis will be undertaken to confirm whether the disposal of dredged material at Site A0 is responsible for the significant adverse effect.
  - c. Should it be concluded that the disposal of dredged material is the cause of the significant adverse effect, all practicable steps will be taken to remedy or mitigate those effects, and the disposal practices will be adapted to the extent necessary to avoid any continuation of those significant effects
  - d. The biological monitoring programme will be reviewed, and amended as required. This review should include consideration of the alternative monitoring instrumentation such as Photosynthetically Active Radiation.
146. Notwithstanding paragraph 145, if following the receipt of a report prepared in accordance with paragraph 144 the Technical Group considers changes should be made to the disposal practices in order to avoid, remedy or mitigate the adverse effects of the disposal at Site A0, and / or considers changes should be made to the biological monitoring programme, Port Otago will implement those changes to the extent practicable.
147. Notwithstanding paragraphs 145 and 146, if following receipt of a report prepared in accordance with paragraph 144 the Consent Authority advises in writing that it considers that the effects of the disposal are:
- a. Significantly different from those predicted; and
  - b. Significantly adverse;
- Port Otago will immediately take all practicable steps to remedy or mitigate those effects, and will adapt its disposal practices to the extent necessary to avoid any continuation of those significant effects.

## **BATHYMETRIC SURVEYS**

### **Purpose**

148. To detect and document changes in bathymetry.

**Monitoring**

149. Port Otago will undertake the required bathymetric surveys of seabed of the offshore disposal site at transects specified in Figure 4. All bathymetric surveys will have an accuracy of 0.25 metres vertically.
150. At a similar time to each of the bathymetric surveys, bed surface grab samples will be obtained at five locations within A0 for grain size analysis.

Operable



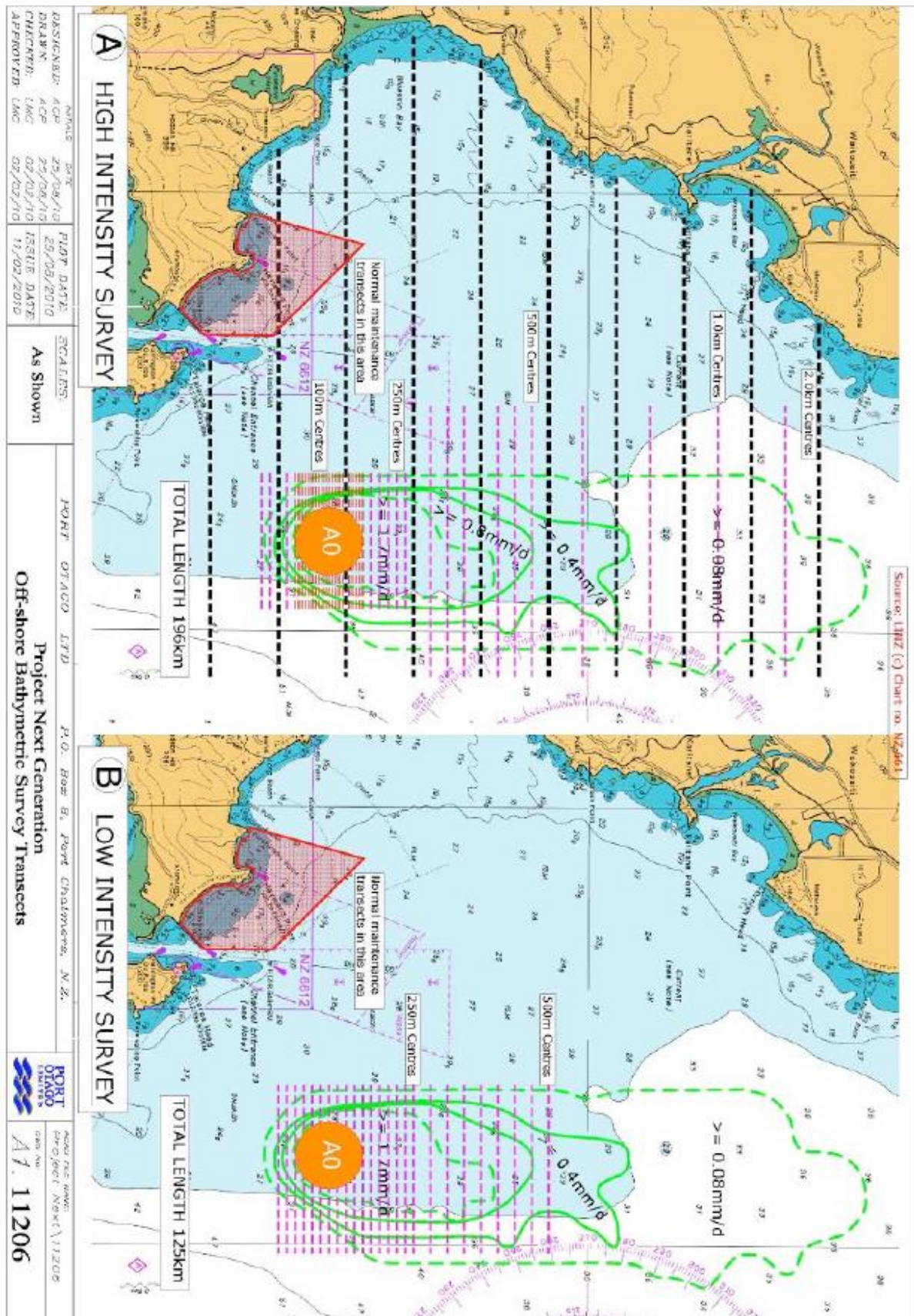


Figure 4: Off-shore Bathymetric Survey Transects

### Management Action

151. Results and analysis from each bathymetric survey and grab sampling will be compiled into a report and provided to the Consent Authority, the PCG, MCG and the Technical Group as soon as practicable, but no more than three months, following the completion of each survey.
  
152. If the bathymetric surveys and grab sampling identifies shoaling to a depth of less than 25 metres, or material coarser than 2.0 mm within A0, then Port Otago will immediately take the following steps:
  - a. Inform the Consent Authority.
  - b. Additional monitoring, investigation and / or analysis will be undertaken to confirm whether the disposal of dredged material at Site A0 is responsible for the observed effect.
  - c. Should it be concluded that the disposal of dredged material is the cause of the observed effect, all practicable steps will be taken to remedy or mitigate those effects, and the disposal practices will be adapted to the extent necessary to avoid any continuation of those effects.
  - d. The bathymetric survey programme will be reviewed, and amended as required.
  
153. Notwithstanding paragraph 152, if following the receipt of a report prepared in accordance with paragraph 151 the Technical Group considers changes should be made to the disposal practices in order to avoid, remedy or mitigate adverse effects of the disposal at Site A0, and / or considers changes should be made to the bathymetric survey programme, Port Otago will implement those changes to the extent practicable.
  
154. Notwithstanding paragraphs 152 and 153, if following receipt of a report prepared in accordance with paragraph 151 the Consent Authority advises in writing that it considers that the effects of the disposal are:
  - a. Different from those predicted; and
  - b. Adverse;
 Port Otago will immediately take all practicable steps to remedy or mitigate those effects, and will adapt its disposal practices to the extent necessary to avoid any continuation of those effects.

155. In accordance with condition 33 of Resource Consent 2010.198 within two years of completion of all Incremental Capital and Major Capital Works Port Otago will submit a report to the Consent Authority that summarises the results of all bathymetric surveys undertaken, and which clearly indicates the degree of change to the seabed in the surveyed areas. The report will also discuss the impacts of the deposition, and detail its actual effects on the environment.

**MARINE MAMMALS, FEEDING BIRDS AND SCHOOLING FISH** (*Refer to Condition 19 of Consent Number 2010.198*)

**Purpose**

156. To avoid harm to marine mammals, feeding birds or schooling fish during disposal operations.

**Monitoring**

157. A competent advisor will be on board the dredge, and will watch for any marine mammal, feeding birds or schooling fish within 300m of dredging equipment.  
For clarity and the purposes of the Stage 1 works for both New Era and Heron Construction vessels, the competent observer(s) are part of the normal crew who have been briefed and trained with respect to avoidance of marine mammals and logging of sightings of endangered species.
158. Additional steps should be taken in relation to lookout and sighting for marine mammals whilst ripping work is being undertaken by Herons dredge and tug crews. All dredge crews are to be particularly vigilant in maintaining lookout for marine mammals from the time of leaving the berth to reaching the worksite. As the backhoe dredge sets up on site, and commences work, the tug (Pacific Way) will continue around to Harington Bend maintaining lookout for marine mammals, returning to berth or to support dredge if no sightings made. In addition, coordinated communication with other Lower Harbour Users (tugs / pilot boats) will increase the chances of identifying and marine mammals within the harbour.
159. Heron Construction will undertake a “soft start” with the xcentric ripper to allow any fish or marine mammals in the area to vacate before the ripping work commences each day.

### Management Action

160. In the event feeding birds, or schooling fish are sighted the dredge will avoid those feeding birds and schooling fish as far as practicable, whilst not compromising the safety of vessels or personnel.
161. In respect to the use of the xcentric ripper, if marine mammals are sighted in the harbour west of Otakou Fisheries (Beacon 10), the xcentric ripping work should cease until such time as the area is clear. However, other dredging work such as loading broken rock or silt / clay material can continue.
162. In the event a marine mammal is sighted, whilst not compromising the safety of vessels or personnel, the following actions will be taken:
  - a. The dredge will avoid the mammal as far as practicable;
  - b. The dredge will avoid approaching the marine mammal head on;
  - c. The dredge will maintain a constant speed when within 300m of the mammal;
  - d. The dredge will avoiding sudden changes in direction;
  - e. The sighting, and any management actions undertaken will be recorded, and reported to the Consent Authority on an annual basis.
163. Port Otago will include the procedures and actions described in paragraphs 157 - 159 in specifications provided for all dredging plant, to ensure all dredging operators follow them. Training in regards the procedures and actions described in paragraphs 157 - 159 will be provided for all dredging equipment operators by a suitably qualified person.

## SECTION E BERTH SHEETPIILING WORKS

164. The Construction Work Plan (CWP) for this work contains a detailed outline of the works, the construction methodology as well as the environmental effects. The nature of the chosen methodology minimises the disturbance of the coastal marine area, with the only the area of the sheet-piling being affected.
165. The Environmental Aspects section of the CWP contains detailed outline of the following.
- (1)\_ Relevant Consents
  - (2) Environmental Restrictions
  - (3) Consent Condition 6 & EMP Performance Monitoring - Discussion which addresses the requirements of condition 6 of consent 2010.197.V1,
    - 6(a) describing disturbance.
    - 6(b) description of rock
    - 6(c) methods to minimise disturbance and associated plumes.
    - 6(d) relocate crustaceans, remove mammals, birds or fish
  - (4) Noise – including restricted work hours for pile driving.
  - (5) Operation of Machinery – fuel and oil, storage and spill response.

## **Appendix 2. Detailed design of monitoring programme for harbour aquatic communities.**

The methods proposed below are generally of a BACI (before, after, impact, control) design with the aim of addressing consent conditions and providing a robust assessment of any environmental effects within Otago Harbour that may be attributable to incremental or major capital works dredging carried out by Port Otago Ltd. The monitoring takes into account the extensive and comprehensive surveys undertaken for the consent application.

The main focus of the monitoring will be on habitats most likely to be at risk from any adverse effects; i.e. saltmarsh, seagrass beds, cockle beds and subtidal soft and hard bottom habitats removed from channels. Some of these are expected to be relatively stable over time (salt marsh, seagrass beds) and there is already information on their extent from previous surveys. Channels are expected to be at lower risk longer term with higher water velocities keeping fine sediments in suspension to a greater degree and reducing the likelihood of smothering of infauna and epifauna from this type of dredging. Additionally, the main channel is relatively species and abundance poor (Paavo *et al.* 2008) and will be dredged and subject to ongoing maintenance dredging. As such, monitoring of this area is designed more to gauge any re-colonisation and to compare post incremental capital dredging works with the present pre-dredging.

- **Seagrass Beds.** It is considered that the Seagrass beds off Harwood will be indicative of the health of the major beds in the area of the harbour likely to be affected by the capital works. Transects will also be surveyed at a control or reference site in Papanui Inlet.

Quarterly surveys (winter, spring, summer and autumn) of seagrass beds off Harwood and in Papanui Inlet will be undertaken (Figure 1) over one year before commencement of Major Capital Works. Results from at least the first three seasonal surveys will be included in baseline survey reports before Incremental Capital Works dredging (ICW) commences. Brief reports on subsequent surveys will be provided as they are completed.

The surveys will include areal cover, distribution, wet-weight biomass, blade length, and shoot density of seagrass as indicators of seagrass health. Core samples for assessing depth of redox discontinuity layer and sediment composition will be taken at the end of each transect off Harwood.



Fine scale assessment will comprise percentage cover at 20 x 1m<sup>2</sup> quadrats equidistant along the 4 transects across the seagrass beds (Figure 1). Biomass, blade length and shoot density will be determined by taking a single 75mm diameter core from a random location within each quadrat, returning cores to the laboratory, rinsing off sand and physically measuring blade length, number of plants per unit area, and biomass of plant material. Quadrat locations will be recorded using hand-help GPS so that sites may be revisited during future surveys for comparison. Two control transects will be surveyed in the same manner across seagrass beds in Papanui Inlet on Otago Peninsula (Figure 2).



**Figure 1.** Possible transects across seagrass beds off Harwood.

Broad scale assessment of the extent of seagrass beds off Harwood will be made using software such as Image J aerial photographs of the site, with appropriate ground truthing. Areal extent of the beds will be compared after 3 years of incremental capital dredging and also, as a control, with the areal extent of the seagrass beds in Papanui Inlet (Figure 2). Aerial photographs post-dredging will be taken at the same time of season each year as surface biomass of *Zostera* beds may change significantly with season (Norhadi 2001).

Additional aerial photos will be collected and digitized for seagrass beds at one or two additional locations further out in the harbour (following a reconnaissance Waipuna Bay near Aramoana and Poo Corner past Wellers Rock look suitable). The monitoring programme for seagrasses would be reassessed after the full year of surveying.

Statistical analyses to reveal changes in seagrass beds will include two-way analysis of variance, comparing effects of season, treatment, and season/treatment interactions. The analyses will treat the current design as a nested design using the two current transects at Papanui as one nest, the two at western Harwood as the second nest, and the two at northern Harwood as the third nest. Photographs will also be analysed for percent cover using appropriate “dots on rocks” type software and analysed using 2-way ANOVA.



**Figure 2.** Seagrass beds up-harbour of Papanui Inlet (circled).



- **Aramoana Salt Marsh.** A minimum of four transects will be established across the intertidal area at Aramoana from the saltmarsh habitat down to the low tide mark (Figure 3). Quadrat locations will be recorded using hand-help GPS so that sites may be revisited during future surveys for comparison. Assessments will be made of diversity and percentage cover of algae and other plants at five 1m<sup>2</sup> quadrats equidistant along each these transects. Within each quadrat two randomly located 150mm diameter cores will be obtained to a depth of 200mm. Cores will be sieved on site using a 0.5mm mesh and macro-invertebrates retained will be preserved and returned to the laboratory for identification and enumeration. An additional 75 mm core will be taken to 200 mm depth at each quadrat and photographed for assessment of the depth of the redox discontinuity layer (i.e depth that oxygen poor sediments are found).

Simple measures of species diversity (number of different ‘types’ of animals per sample) and animal abundance (number of animals per sample) will be calculated from the collected data. A diversity index will also be calculated using the Shannon-Weiner method (Zar 1996). Such indices provide a ready method for comparing diversity at sites from year to year and for comparing impact sites with control sites. For other community analyses the data will be transformed (fourth root) to meet the statistical requirements of the tests used.

Aerial photography with ground-truthing and transect lines will be used to map the broader scale distribution of salt-marsh habitats above MHWS. Aerial photography will be carried out by TL Survey Services of Dunedin who are able to produce high resolution aerial images of salt marsh and seagrass areas.

The methodology for seagrass and salt marsh monitoring incorporates elements of the methods recommended in the national estuary monitoring protocol (Robertson *et al.* (2002) and is consistent with methods used to map estuarine habitats on many occasions as part of the State of the Environment monitoring for the Otago Regional Council (e.g. Stewart 2007; 2008a,b; 2009a,b; 2012a).



**Figure 3.** Possible transects across Aramoana salt marsh.

- Cockle Beds.** Surveys of the cockle beds will be undertaken at 4 sites (Figure 4). Cockle density, size structure and biomass will be assessed for each site. Parts of the areas around Sites 1 and 2 are subject to experimental commercial harvesting so the sampling locations will be located in control areas for the Southern Clams Ltd programme.



**Figure 4.** Proposed sites for cockle surveys.

To assess the cockles, and the flora and fauna associated with the cockle population within the beds, two 10m x 10m quadrats would be sampled at each site and 4 in a

control area at Papanui Inlet. Three 150 mm diameter cores within each large quadrat will be excavated and cockles collected for measuring. If considered abundant a further two 0.1 m<sup>2</sup> quadrats will be excavated.

For other biota, two random 1 m<sup>2</sup> quadrats within each large quadrat will be photographed and percentage cover of macroalgae and seagrass estimated. One randomly placed 200mm deep core sample would be collected from within each large quadrat using an 85mm diameter coring device. Cores would be photographed to allow determination of the depth of the redox discontinuity layer if present. An additional 150mm core 200mm deep would be collected from within each 1m<sup>2</sup> quadrat then be sieved using a 500µm sieve and all animals retained preserved and returned to the laboratory. Animals would be identified to a minimum of family level in the laboratory and enumerated.

Simple measures of species diversity (number of different 'types' of animals per sample) and animal abundance (number of animals per sample) will be calculated from the collected data. A diversity index will also be calculated using the Shannon-Weiner method (Zar 1996). Such indices provide a ready method for comparing diversity at sites between years and for comparing impact sites with control sites. For other community analyses the data will be transformed (fourth root) to meet the statistical requirements of the tests used.

In addition variability among sites will be measured using the Index of Multivariate Dispersion (IMD) (Warwick & Clarke 1993), with IMD values to be calculated for the invertebrate samples at each location and compared visually. Ordination will be used to 'graph' the invertebrate communities. In such plots, how close the core values appear to each other reflects how similar they are in terms of species composition and abundance patterns.

The survey would be repeated again after 3 years of incremental capital dredging, at a similar time of year. Analysis of similarities (ANOSIM) will be used to test whether there were significant differences between the communities post-dredging. Finally, analysis of similarities will be used once more to test whether there is a significant difference between communities before and after impact and among impact and control sites.

These methods are consistent with those used for numerous similar surveys since 1992 for the Ministry for Primary Industries and Southern Clams Ltd. (e.g. Stewart et al. 1992, Stewart 2006; 2008c,d; 2009c; 2012b).

- **Rocky shore.** Two shore-normal transects will be surveyed at each of three sites, one at Pudding Island (where the brachiopod *Pumilus antiquates* has been recorded), one at Quarantine Island and one at Pulling Point, from MHWS down to at least 5m water depth across obvious sub-tidal habitat. Sampling will comprise 1 m<sup>2</sup> quadrats randomly placed at high tide, mid tide and low tide. The same sites selected for the baseline will be sampled post-dredging. Quadrats will be photographed and obvious fauna and flora identified and counted. Loose rock/cobbles will be turned over and concealed species will also be identified and counted. Subtidal sampling will use photo quadrats placed at 1 m depth intervals, where possible, or at roughly even intervals to assess the distribution and abundance of different invertebrate species and semi-quantitative observations of macro-algal distribution. Video transects will also be recorded along each transect.

One transect at each site has been added to the baseline surveys in more sheltered locations at each site, including one near where *Pumilis* has been found on Pudding Island (noting the need not to disturb the actual site). These extra transects will be surveyed before any backhoe dredging works begin. Quadrat locations will be fixed, if possible, and at least the same quadrats re-photographed at rocky shore intertidal sites using identifiable features or permanent markers. The subtidal ones are more problematic because of the patches of soft habitat and extensive macro-algae so random quadrats will be resurveyed along a GPS located transect.

The intertidal assessment methods used here are similar to those used in a variety of intertidal and sub-tidal assessments used for the Dunedin City Council and the Department of Conservation (e.g. Annual rocky shore monitoring carried out as a consent condition for Green Island and Tahuna wastewater treatment plants, pre and post construction monitoring for Harrington Point Road widening projects and sub-tidal video mapping for proposed marine reserve at The Nuggets).

- **Survey of infauna and epifauna.** Although not expressly required as part of consent conditions a single video transect will be swum within the swinging basin at Port

Chalmers and a second transect across the main channel off Pulling Point. Transects will be at least 100m long and at right angles to the channel at depths ranging from <2m to the channel bottom. Frequency will be once prior to incremental dredging commencing and with a follow-up survey at 3 yearly intervals and after the completion of incremental capital works dredging.

Three replicate core samples will be taken at six points, 20 m apart, along each of the two transects. Cores of 85 mm diameter will be taken to 200 mm depth using a custom built coring device dropped from a NZDS vessel. Cores will be sieved on site and retained animals preserved and returned to the laboratory for identification and enumeration. Substrate material obtained from cores collected for infaunal sampling will be kept and returned to the laboratory for particle size analysis.

- Samples from up to 6 representative sites (two in seagrass beds, two from soft bottom subtidal substrate and two from saltmarsh substrate) will be analysed for particle size analysis and heavy metals. The latter is so that comparisons can be made post-dredging to ensure there has been no build-up of heavy metals that can be attributed to dredging.
- **Invasive species.** NIWA have a contract to undertake surveys of invasive species around New Zealand ports for Biosecurity New Zealand. Surveys for Port Chalmers are planned for Aug/Sept 2013 and March 2014. This information will be publicly available and summarised for by Port Otago Ltd as a baseline for future surveys of the Port area following dredging.

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### **Appendix 3. Detailed design of monitoring programme for offshore aquatic communities.**

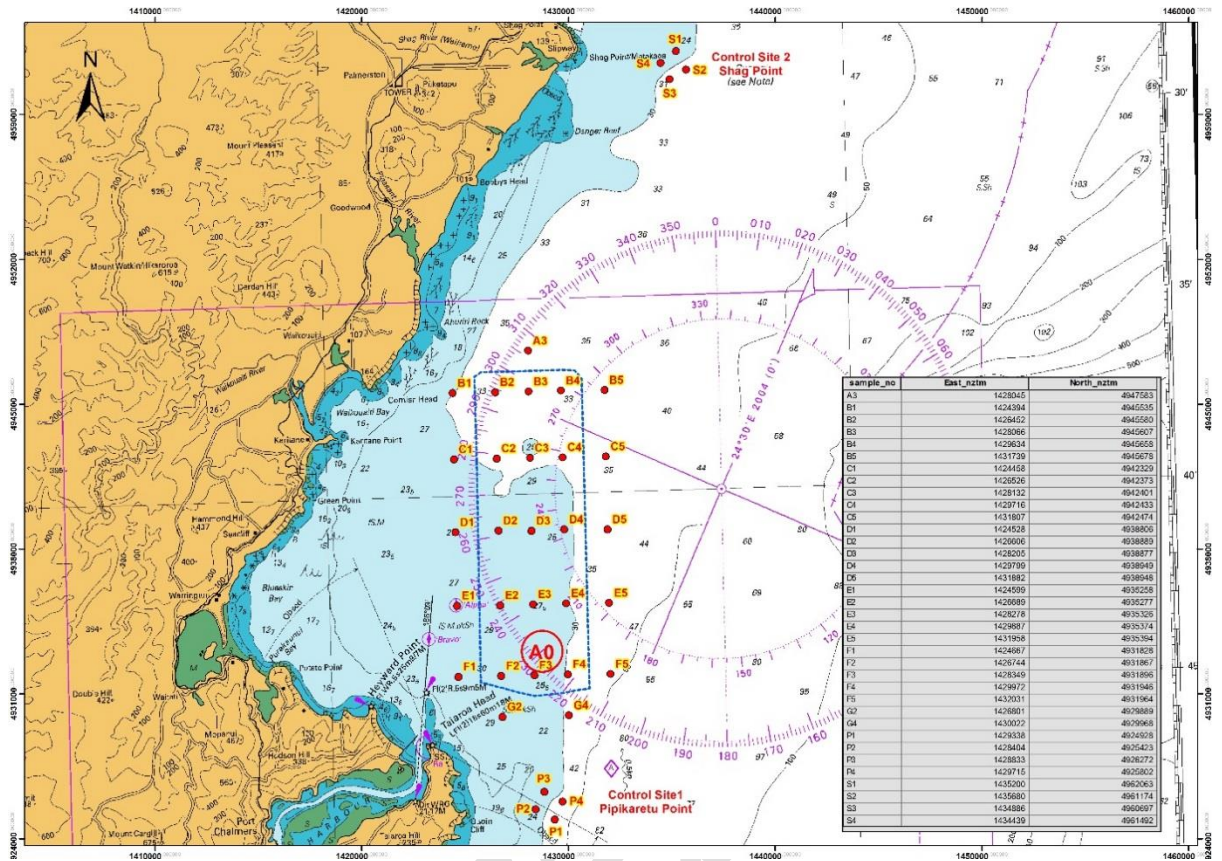
Previous surveys (notably Willis et al. 2008, Paavo 2011) reported that benthos across the proposed disposal site (Area A0) differed little (all >50% similarity in classification analysis), with the sites showing no clear differences in environmental variables or in benthos composition. This absence of marked differences across the site in both physicochemical factors (e.g., depth range c. 28-33 m) and biota means that it can be treated as a relatively uniform habitat and benthic community. From a sampling perspective, a single sample from any point within A0 essentially serves as a replicate for any other equivalent sample taken in the area. A single sample at each sampling station will be surveyed to maximise spatial coverage to detect change whilst minimising cost.

- Survey area - sampling will be on a 5 (north-south) x 5 (east-west) grid over the disposal site (A0) and monitoring area, comprising five north-south lines: one 1 km west, another 1 km east of A0, and three within the monitoring area (Figure 1, lines B-F). Additional sites (on lines A and G) lie north and south on the monitoring zone margins and, as with the north-south transects are intended to detect changes within and at the margins of the disposal ground. The lines for A and G will be extended from one and two sites respectively to 5 sites along Lines A and G for follow-up surveys, giving a full 7 x 5 grid. In addition, four randomly located stations will be sampled within each of Control Site 1 (Pipikaretu Point) and Control Site 2 (Shag Point).
- Sidescan - Sidescan sonar imagery will be surveyed over c. 400 m long and 60 m wide east-west at 17 stations within the monitoring zone as shown in Figure 2.
- Epifauna - Epifauna, including mobile species (e.g., portunid crabs, squid, shrimp, juvenile flatfishes), will be sampled using a small epibenthic sled (400 mm wide fitted with a 2 mm mesh bag) at selected stations (see Figure 2). Abundance will be standardised for area sampled. A minimum of 10 benthic images (still) will also be collected from at least 17 sites spread throughout the monitoring area. These images will be used to assess sparse or elusive fauna such as mantis shrimp burrows.
- Grab samples – The preferred benthos sampling device is an anchor-box dredge, a simple, rapidly deployed sampler that consistently collects replicable, quantitative samples (e.g., Probert, 1984 ) of diverse bottom sediments (0-100 mm deep) over 2-

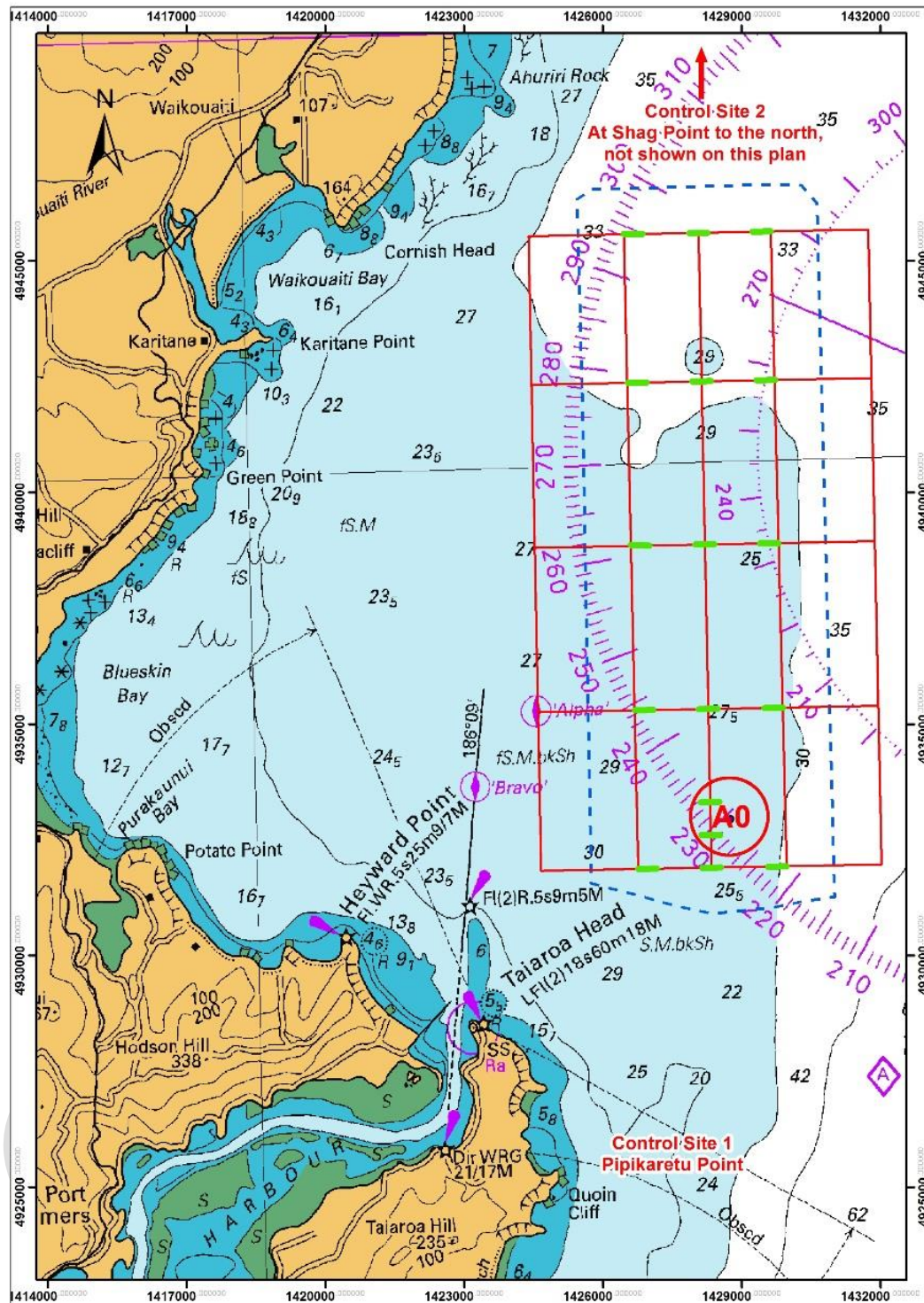


>50 m water depth. Live faunal samples will be washed through nested sieves (1.0, 0.5 mm mesh), and each fraction preserved separately. Past experience shows that a 1.0 mm sieve retains much of the macrofauna, but that important indicator species (e.g., capitellid polychaetes), often very abundant in disturbed sediments, may be lost. Thus, a separate finer fraction will be retained to ensure fully representative sampling, as well as facilitating subsampling of very abundant taxa. The extracted fauna will be labelled and preserved in the field. A small van Veen grab will be used in tandem with the anchor-box dredge to obtain an undisturbed profile of the upper 50 mm of bottom sediments. Three small samples of undisturbed surface (0-25 mm depth) sediments will be frozen for subsequent particle size frequency analysis, organic content (loss on ignition) and shell content.

- Faunal samples will be washed to remove preservative and any residual sediment before identification to the lowest practicable taxonomic level (family or genus for most taxa; common or well-known taxa to species). Identifications will be cross checked by taxonomic experts, a desk file/identification file and a collection of labelled voucher specimens will be established as work proceeds. All sorted collections will be retained for 12 months and voucher specimens added to collections for future reference.
- Abundance data will be standardised to numbers per m<sup>2</sup> before analysis using PRIMER routines. Analysis will focus on confirming the relative homogeneity of sediments and benthos within and about Area A0, as well as establishing whether the fauna and sediments at control sites 1 and 2 are similar to those within the disposal area. Faunal analyses will focus on species diversity, invertebrate abundance, community composition and any important or indicator species. Various univariate tests and multivariate statistical procedures will be used to assess variation between stations. There will need to be detailed statistical analyses carried out post-dredging to reveal changes. Analysis to check for differences between years will include cluster analysis and Multi-Dimensional Scaling (MDS), plus ANOVA, using community composition, plus both species density and diversity data. Further analyses will be used if there are significant indications of differences.



**Figure 1.** Spoil disposal area and monitoring area (Area A0, broken blue line) showing sampling stations including control sites.



**Figure 2.** Locations (green bars) of drop-camera and sidescan images across the monitoring zone off Blueskin Bay. Red circle shows spoil disposal area (A0); broken blue line encircles monitoring zone. No bottom imagery undertaken at either Shag Point or Pipikaretu Point.

**References**

Paavo, B. (2011). AO mapping – Benthic observations near the dredge spoil disposal site 'AO' proposed by Port Otago Ltd. Report produced by Benthic Sciences Ltd for Port Otago Ltd.

Probert, P.K. (1984). A comparison of macrofaunal samples taken by box corer and anchor-box dredge. NZOI Records 4(13):149-157.

Willis, T.J.; Bradley, A.; Handley, S.J.; Paavo, B.; Page, M.J.; James, M. (2008). Benthic offshore surveys of proposed dredge spoil disposal sites off Otago Peninsula. NIWA Client Report NEL2008-024, Project POL08401. 53 p.

## Appendix 4 – Monitoring proposed for kelp forest & shoreline

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### **Project Next Generation – Dredging Project** **Technical Brief – Kelp Forest Monitoring Program** **Revision 3 – 3 December 2015**

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## **1. Introduction**

Port Otago Ltd has applied for and been granted a resource consent (Resource Consent 2010.198) to dredge the approaches to Port Chalmers and dispose of the dredge material at a site referred to as A0. During the Environment Court appeal one of the remaining issues of concern to the appellants was the potential effects on the inshore coastal area, particularly the kelp forests between Shag Rock and Tairoa Head. It was recognised in the Environment Court decision that effects in the area of A0 will occur and in time recover. The risk of potential effects on the inshore area to the north was considered to be “highly unlikely” but if it did occur it could be high impact.

The kelp beds are sensitive to light levels and are recognised for their importance as a habitat for a wide variety of marine life and in particular paua, kina and fish species that are important taonga species for Ngai Tahu. It was thus considered important that baseline monitoring include the inshore area and kelp beds. The Environment Court Decision and revised Environmental Management Plan now includes, in addition to monitoring around the disposal area and to the north and two control sites, that information be gathered about meaningful parameters at:

“ ( i ) A representative area of shoreline and associated kelp forest between Shag Point and Cornish Head.”

The following brief has been revised following comments from the Technical Group, with additional feedback from Mark James of Aquatic Environmental Services. In addition, Technical Group member Chris Hepburn, including his detailed background document dated 2/2/2014 and circulated by email to Technical Group member on 3/2/2014. The aim of the work would be to:

“Provide a baseline monitoring regime that could detect changes in kelp beds during disposal of dredge sediments at site A0, if they were to occur.”

## **2. Scope of work required**

To address this condition the following surveys are required at locations between Shag Point and Warrington, including a location inshore of the turbidity mooring at Site C:



- Aerial photography to map the extent of the kelp beds (to be finalised in discussion with Jim Fyfe) but likely to cover the area between Warrington and Shag Point at a broadscale and low intensity.
- Eight sites will be established between Shag Point and Warrington at depths of at least 6-8 m depth (or deeper if appropriate) within kelp forest. This would be used to ground truth the aerial photography and to make the following measurements, sufficient to give a robust baseline of the community and factors that might impact on it. Methods should include:
  - Continuous monitoring of light attenuation using light loggers at the end of each permanent transect with one close to the kelp bed and one near the surface (fixed posts used to mark transects) and at four sites on land. This would be used to calculate downwelling attenuation and calibrated to PAR (Photosynthetically Available Radiation), (further details of analyses provided in background document by Chris Hepburn). The data should be cross-referenced with similar data being collected on buoy C
  - The light attenuation monitoring design proposed is expected to be low cost and considered to be easily achievable in less than 2 days by a team of two divers in a suitably sized boat. Set up of these moorings is not anticipated to require specialised equipment. Download will be every 6 weeks
  - The two onshore logger sites should be established near the kelp forest monitoring sites, and the data is expected to take less than half a day to download.
  - Measuring percentage cover, and density of encrusting organisms and density of juvenile macroalgae/kelp using 20 randomly placed photoquadrats (0.1 m<sup>2</sup>) along each 30m transect. Five larger quadrats (2x2 m) would be used to determine density and status (including size) of larger kelp species.
  - The three monthly monitoring will allow for seasonal changes in macroalgal communities, and to download and replace the light sensors.
- The aerial photography and transect sampling would be used to give an indication of the overall state and health of the kelp canopy.
- The output would be a brief baseline report covering the results of the field work and putting observations into a seasonal and spatial context using information from previous surveys of kelp beds and light/turbidity studies in the region.

Surveys should be carried out every three months initially for two years and then the study reassessed for future monitoring.

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## **APPENDIX 5 – Summary of Monitoring and Reporting**

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## APPENDIX 6 – SSC NTU Relationship – background & details of establishment

### MEMO

**To:** Project Next Generation  
Technical Group representatives

**From:** Lincoln Coe

**Date:** 20 April 2015

**Subject:** **Review of Condition 10(e) in 2010.195 referring to confirmation of SSC:NTU relationship**

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#### Background

The review of Condition 195(e) of Consent 2010.195 was deemed necessary by the ORC and the Technical Group as a result of the completion of the work to confirm the SSC:NTU relationship for the Wetlabs® sensors being used to measure turbidity.

The Technical Group memo of 17 December 2014 contains a detailed outline of the sampling protocol and the work undertaken to complete the confirmation of the relationship between SSC/NTU. It also references the supporting technical report prepared by Paul Barter of the Cawthron Institute.

#### Original Consent Wording

Condition 10(e) of Consent 2010.195 is as follows.

- (e) a confirmation of the relationship between turbidity and suspended solids concentrations established by a sampling protocol and programme, which is specified by the Technical Group. The NTU calculations are based on a ratio of NTU to Suspended Sediment Concentration of 1:1 plus or minus 25%. If the NTU is calibrated outside that range then the consent holder shall apply for a review of the NTU limits specified in these conditions.

#### Proposed Revised Wording of Condition 10(e)

The following wording of condition 10 (e) is proposed, shown as tracked changes for clarity.

- (e) a confirmation of the relationship between turbidity and suspended solids concentrations established by a sampling protocol and programme, which is specified by the Technical Group. The original NTU calculations and limits were based on a ratio of NTU to Suspended Sediment Concentration of 1:1 plus or minus 25%. The sampling protocol and program shall ensure that the NTU/SSC being reported and used are within this specified range.

This approach is technically accurate and consistent with the sampling protocol and programme, as well as the discussion at the Technical Group meeting of 12 Feb 2015.

### **Proposed alterations to text within the body of the EMP**

The reference in the body of the EMP is on para 72, page 18. The following alterations and additions are proposed, shown in track changes style.

- 72 The relationship between turbidity (NTU) and suspended sediment concentrations (SSC) has been established by testing and analysis work undertaken by Paul Barter, Cawthron Institute. A detailed summary of the sampling protocol, test results and intended approach are included in Appendix 6, which also references a supporting technical report.

The outcome of that testing and the approach adopted is to apply a sensor specific correction factor of 2.5, to the raw NTU measured in the field by the Wetlabs© sensors. These adjusted NTU (i.e. NTU\_adj) results can be used to directly compare the data being collected in the field, to those SSC used in deriving the originally prescribed harbour turbidity limits and calculated offshore ETL, at these locations.

As a result of completing this confirmation of the SSC:NTU relationship for the sensors being used, and to ensure clarity and consistency with the wording of the consents document, a review of the original Condition 10(e) has been undertaken.

### **Proposed addition to Appendix 6 of the EMP**

For clarity as to the process of how the review of condition 10(e) has occurred, and to retain visibility of that process it is proposed this memo be included at the start of Appendix 6.

Lincoln Coe  
**GM Infrastructure**

## MEMO

**To:** Project Next Generation  
Technical Group representatives

**From:** Lincoln Coe

**Date:** 17 December 2014

**Subject:** **Confirmation of SSC:NTU relationship and therefore confirming offshore "Environmental Turbidity Limit"**

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This memo follows on and supersedes the original dated 2 October 2014, which was the focus of discussion at the 16 October 2014 Technical Group meeting.

### Background

The confirmation of the Suspended Sediment:Turbidity (SSC:NTU) relationship was the final task in relation to both the harbour turbidity monitoring and confirmation of the offshore "Environmental Turbidity Limits" ETL.

This matter was discussed at meeting #5 (18<sup>th</sup> March) as part of my short \*.ppt presentation and minuted on pages 7 and 8.

Condition 10(e) of Consent 2010.195 is as follows.

- (e) a confirmation of the relationship between turbidity and suspended solids concentrations established by a sampling protocol and programme, which is specified by the Technical Group. The NTU calculations are based on a ratio of NTU to Suspended Sediment Concentration of 1:1 plus or minus 25%. If the NTU is calibrated outside that range then the consent holder shall apply for a review of the NTU limits specified in these conditions.

The lab testing and tabulation of results for this work has now been completed by Paul Barter (Cawthron Institute) in accordance with the methodology initially outlined at the 18<sup>th</sup> March meeting. This memo outlines that process and the results.

Paul Barter attended the 16 October 2014 Technical Group meeting and referring to a draft report he had prepared, presented his methodology and findings to the group. This report has been circulated to TG group members, with this memo.

### Original establishment of the 1:1 SSC:NTU relationship

It is important to remember that the turbidity monitoring sites (and the SSC limits at each site) were established after taking into account the various habitats and species present at that site. The purpose of the turbidity monitoring is therefore to report an NTU that corresponds to the SSC present at the time of measurement.

The original 1:1 relationship was established using the field data collected by NIWA in 2008, and reported in the "Turbidity monitoring in Otago Harbour Data Report", Evan Baddock, Dec 2008. This 2008 work used Seapoint<sup>®</sup> turbidity sensors to measure the NTU in the water column with laboratory testing to confirm the SSC for the same sample.

During the mediation process, Condition 10(e) above was agreed by all parties recognising that if the actual sensor being used in the field measured a different SSC:NTU relationship,

adjustment would be required to ensure that the correct SSC's at the sites of interest were being reported.

### Overview of lab testing & results

Laboratory tank testing of the SSC:NTU relationship was carried out at the Cawthron Institute in Nelson, and used four different sensors as follows:-

- Seapoint<sup>®</sup> STM sensor (NIWA – same as 2008 [0-750 NTU])
- Seapoint<sup>®</sup> STM sensor (Cawthron [0-500 NTU])
- Wetlabs<sup>®</sup> NTUS sensor (offshore [0-250 NTU])
- Wetlabs<sup>®</sup> NTUS sensor (harbour [0-400 NTU])

The tank test methodology was as follows:

1. Testing was done with various combinations of both Seapoint and Wetlabs sensors in the same test tank.
2. Tests were done at different times using two different silt samples of Otago harbour sediment.
3. Each test started with approximately 375 litres of filtered seawater in the tank.
4. The tank was continually stirred using a 12 volt submersible pump.
5. Silt was added to the tank in measured weight increments with turbidity measurements taken at each increment step.
6. One litre water samples for SSC testing were also taken at five of the incremental steps.

One of the key conclusions drawn from the work was that each manufacturer's sensor reported the linearity across all the ranges of turbidity. The NIWA and Cawthron Seapoint<sup>®</sup> sensors although configured differently (*i.e.* gain/range) reported the same linearity of results. Similarly the Wetlabs<sup>®</sup> sensors with different NTU ranges for either harbour or offshore sensors reported linearity across all ranges. This shows that, despite the gain or range being used, that there is comparability between each manufacturer (*i.e.* instrument model). And that, as long as the SSC:NTU relationship is established for any given instrument, then applying conversion or correction factors between different instruments is easily accomplished.

Analysis of the results for the two different meter types (and two different silt types) is as follows and shown on Figure 1 attached:-

1. The number of comparative samples (*i.e.* Seapoint<sup>®</sup> vs Wetlabs) reported was 220.
2. The turbidity range of samples was large, 0-800 SSC.
3. The linearity relationship for each sensor has a very strong correlation
  - a. Wetlabs –  $r^2 = 0.9943$
  - b. Seapoint –  $r^2 = 0.9761$ .
4. The linear relationships of NTU to SSC are :-
  - a. **Wetlabs – 2.5594**
  - b. Seapoint – 1.3264

Comparing the different types sensors directly, the Wetlabs<sup>®</sup> turbidity sensors that Port Otago have installed report approximately half (*i.e.*  $1.33/2.56 = 0.52$ ) the NTU of a Seapoint<sup>®</sup> sensor (and hence SSC) for the same sample.

### Proposed approach for correction & reporting of measured turbidity against limits in Consent 195.

All Port Otago's sensors are Wetlabs sensors. In order to correctly report the SSC present at the time of measurement in the field, it is necessary to adjust the raw measured NTU by a **correction factor of 2.5**. This correction factor will be applied to the raw sensor output so all data reported will then be as SSC / NTU on the original 1:1 basis.

This approach has the effect of reporting the "actual SSC" which is then directly used to measure compliance with the trigger levels and limits prescribed in the consent. In this way,

the reporting of NTU / SSC is on a 1:1 basis, and within the 25% prescribed by condition 10(e).

### **Proposed approach to establishing “Environmental Turbidity Limit” (ETL) offshore**

The proposed approach for the offshore ETL is exactly the same.

Rob Bell calculated 98mg/L (*ie* SSC) for the ETL limit at offshore monitoring Buoy B. This limit would remain the same, and the corrected or adjusted NTU relating to that 98mg/L limit.

### **Review of Approach**

This methodology, testing and approach has been reviewed by the scientific advisors identified below, all of whom support the robustness of the work and approach suggested.

- Paul Barter - Cawthron
- Dr Mark James – Aquatic Environmental Sciences
- Dr Rob Bell – NIWA

### **Summary**

In conclusion, the tank calibration tests undertaken by Cawthron have shown excellent repeatability between sensor types, using two different types of Otago Harbour sediments.

In order to comply with the consent conditions, and for reporting and compliance purposes under the existing consent conditions (*ie* within the consent on a 1:1 SSC / NTU basis), a correction factor of 2.5 is to be applied to all raw NTU measurements from the Wetlabs<sup>®</sup> sensors. This same approach applies for both the harbour and offshore turbidity sensors.

Reporting of the adjusted NTU will therefore comply with the SSC limits & original 1:1 basis, hence no review of those limits is necessary.

Lincoln Coe  
**GM Infrastructure**

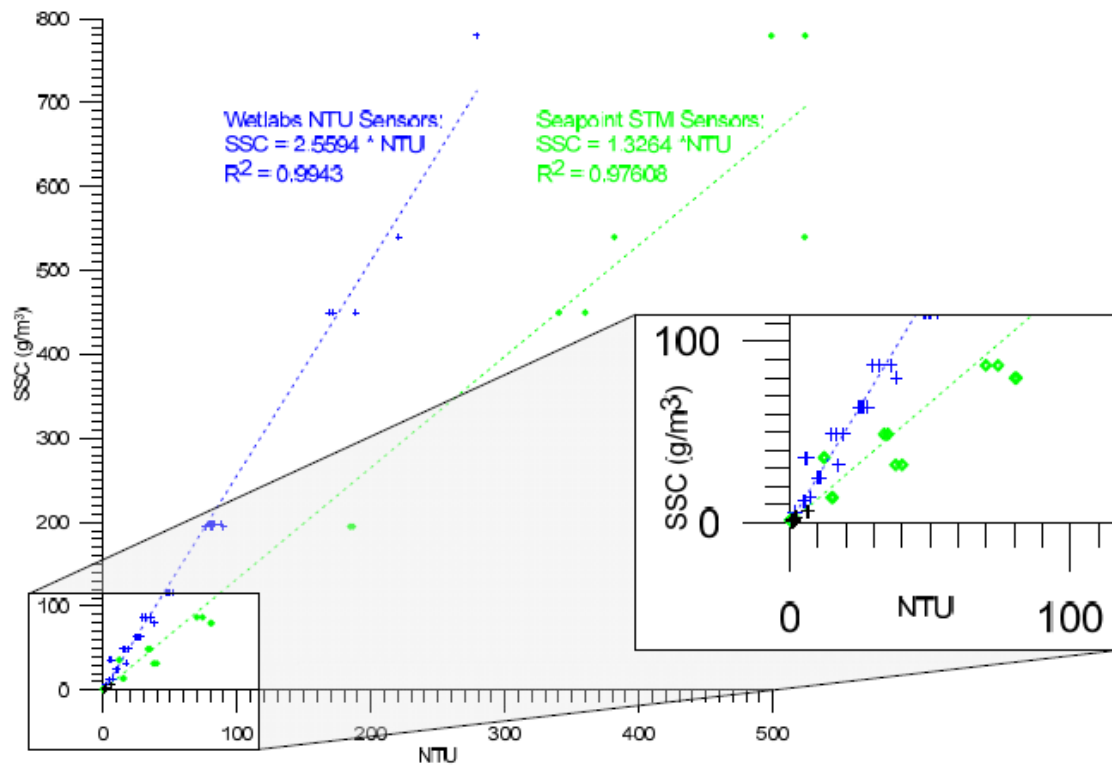


Figure 2. Comparison of nephelometric turbidity units (NTU) to suspended sediment concentration (SSC) for all three tank tests by manufacturer.

**Figure 1 – Tank testing results for both Seapoint® and Wetlabs sensors, from Cawthron Report 2602**

## APPENDIX 7 – Details of Beach & Nearshore Surveys

### Overview

The Beach and nearshore surveys for Shelly Beach, Te Rauone, and the Aramoana Sand flats are required to be undertaken as part of EMP Condition 90. The purpose of this condition was to determine if dredging contributed to any morphological change to these areas. The methodology for the surveys monitoring was not originally defined in the EMP, and therefore, the intent of this memo is to propose and define the survey methods for each of the sites.

EMP condition 90 is as follows:

Port Otago will also undertake beach and nearshore profiling in the areas of Shelly Beach, Te Rauone, and the Aramoana Sand Flats at similar intervals to the bathymetric surveys described in paragraph 88 and 89 to determine any morphological change

### Baseline Monitoring

Port Otago have carried out monitoring of the prescribed areas over many years as part of various projects that the port has undertaken. This monitoring therefore provides a pre-development dredging base line. It is therefore, Port Otago's view that continuing this monitoring will fulfill these requirements.

### Proposed Methodology

The methodology for the three sites varies due to the different morphological considerations at each site. The methodology for each site is detailed below:

- Shelly Beach
  - Bathymetric survey of Shelly Beach at 20m line spacing on a yearly basis (as per Maintenance disposal consent RM11.153.01)
  - Aerial photograph – shoreline change analysis at 2 yearly intervals
  - Beach morphology profiles 13 transects at 2 yearly intervals
- Te Rauone
  - Aerial photograph – shoreline profiles and survey of toe of beach at 4 yearly intervals
  - Two bathymetric survey transects as part of the Next Generation Harbour Survey plus two extra transects in front of Te Rauone Beach
- Aramoana Sand Flats
  - Three bathymetric survey transects as part of the Next Generation Harbour surveys
  - Four beach morphology transect lines that follow the transects in the biological baseline report.