BMT JFA Consultants

Pacific Harbour Long Term Maintenance Plan - 2016

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Limitations statement

The purpose of this report and the associated services performed by BMT JFA Consultants (BMT JFA) is to provide an updated Long-term Maintenance Plan and associated Maintenance Model for Pacific Harbour in accordance with the scope of services set out in the contract between BMT JFA and Moreton Bay Regional Council ('the Client'). That scope of services was defined by the requests of the Client, and by the time and budgetary constraints imposed by the Client.

In preparing this report, BMT JFA has relied upon and presumed accurate certain information (or absence thereof) relative to the site, provided by the Client and others identified herein. Except as otherwise stated in the report, BMT JFA has not attempted to verify the accuracy or completeness of such information.

No warranty or guarantee, whether express or implied, is made with respect to the data reported or to the findings, observations and conclusions expressed in this report. Further, such data, findings, observations and conclusions are based solely upon site conditions and information supplied by the Client in existence at the time of the study.

This Long-term Maintenance Plan has been prepared for the exclusive use of Moreton Bay Regional Council and is subject to and issued in connection with the provisions of the contract between BMT JFA Consultants and Moreton Bay Regional Council. BMT JFA excludes to the fullest extent lawfully permitted all liability whatsoever for any loss or damage howsoever arising from reliance on the contents of this report by any third party.

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1 Introduction

1.1 Background

Pacific Harbour is a residential canal estate and marina located on the western foreshore of Bribie Island, Queensland. The canal waterways provide access to Pumicestone Passage and Moreton Bay. Construction of the initial stages of the development commenced in the late 1980's, and the remaining areas of the development have been progressively developed since this time. While development of the final land stages is still ongoing, construction of the canals, including the marina, is understood to have been completed in the late 2000's. The canal estate currently has approximately 840 waterfront residential properties and a marina with a total of approximately 85 berths.

Moreton Bay Regional Council (MBRC) undertake regular maintenance works within the canal estate. These works include maintenance dredging, maintenance of canal batters, navigation aids and signage, and removal of marine plants and litter. Funding to support the delivery of these maintenance activities is generated through a special levy, paid by waterfront residential properties and commercial entities, together with a contribution from MBRC's general maintenance budget. The levy amount is calculated in consideration of forecast long-term maintenance costs, which are estimated based on a Long-term Maintenance Plan, and associated Maintenance Model.

The Long-term Maintenance Plan provides a high-level plan for forecast maintenance activities, and provides key inputs into the Maintenance Model. The Maintenance Model is a financial calculation tool which essentially comprises a list of maintenance activities, associated unit cost rates, and a forecast program of maintenance activities over the specified planning period. The estimated long-term maintenance costs are calculated in the Model based on the forecast program and estimated unit cost rates. The Long-term Maintenance Plan, including Maintenance Model, is subject to periodic review in order to ensure that the maintenance activities, unit cost rates, and program remain appropriate and up-to-date.

The initial Long-term Maintenance Plan, *Bribie Gardens and Pacific Harbour Canals – Long-term Maintenance Plan* was developed in 2011-12 (KBR 2012a) and formally adopted by MBRC on 1 July 2012. This plan identified siltation and subsequent maintenance dredging and dredged material disposal as the most significant maintenance issue within the canal estate. However, limited hydrographic survey datasets and other information was available at the time of the original study to inform estimated siltation rates and associated dredging requirements. Subsequently, and in line with the planned 3-5 year review cycle, MBRC commissioned a review and update of the existing Long-term Maintenance Plan for 2015-16.

1.2 Scope

1.2.1 Scope of services

BMT JFA Consultants Pty Ltd (BMT) were commissioned by MBRC in late 2015 to review and update the Pacific Harbour Long-term Maintenance Plan and associated Maintenance Model. Given that a significant proportion of the originally estimated maintenance costs are attributed to maintenance dredging and dredged material disposal (KBR 2012a), the review focussed on

siltation rates, dredging and material disposal strategies, and included an overall review and update of all unit cost rates in the Maintenance Model. BMT's proposal (Ref. *Q-P15.74-1 Rev.0*) incorporated the following scope of services:

- Review of siltation rates
- Assessment of dredging and material disposal options
- Development of a recommended dredging and material disposal strategy
- Development of a proposed dredging schedule for the purposes of informing the Maintenance Model
- Review and update of maintenance costs/rates
- Provision of updated:
  - Dredging schedule
  - Maintenance Model
  - Long-term Maintenance Plan

This Long-term Maintenance Plan (LTMP) documents the outcomes of the completed work, and provides a high-level plan for forecast maintenance activities, together with key inputs into the Maintenance Model. The document is structured as follows:

- Site description – brief description of the site including historical development of the canal estate, and summary of the maintenance activities.
- Maintenance dredging – summary of past dredging and disposal works, review of siltation rates, review of dredging and material disposal options, the recommended dredging and material disposal strategy, and discussion of environmental approval requirements.
- Other maintenance activities – discussion of the broad scope of general maintenance activities and forecast maintenance requirements.
- Maintenance costs – presentation of the estimated long-term maintenance costs, and discussion of key assumptions and sensitivities in the model, together with the accuracy of estimates.
- Conclusions – concise summary of the outcomes of the completed work and the estimated long-term maintenance costs.
- Recommendations – discussion of recommended additional studies and investigations identified during the review and update of the LTMP.

1.2.2 Scope of LTMP

The maintenance activities undertaken by MBRC, and subsequently considered in the LTMP, are limited to the maintenance of the canal waterways and entrance area, beyond the property boundaries. As outlined in the Project Brief (Ref. *RFQ VP0000000031743*) the following areas and maintenance activities are not included in the scope of the LTMP:

- All concrete revetment walls. These are the responsibility of the associated property owner.
- Bridges and retaining walls at causeway-type road crossings are part of the road network and therefore are not part of the LTMP.
- Pontoons. All pontoons are the responsibility of the associated property owner.
- Drainage outlets and associated infrastructure. These are part of the drainage network and therefore are not part of the LTMP.
- Parkland abutting the canals is part of the park network. Maintenance of these areas is therefore not part of the LTMP.
- The public pontoon located off Tradewinds Drive Park is not included in the LTMP.

Additionally, the end of the canal system terminates at the boundary of Skippers Canal and Pumicestone Passage (i.e. west of the shoreline). This boundary approximately coincides with the location of the navigation markers at the canal entrance.

The scope of the LTMP does include the following areas:

- Rock revetments/armouring within the waterways (i.e. beyond the property boundaries).
- Navigation aids associated with the canal entrance (i.e. those located immediately outside of the canal entrance) and those within the canal estate.
- Signage associated with the canals, including regulatory signs (e.g. vessel speed signs) and canal name signs.

1.2.3 Limitations

The following limitations apply to the LTMP, including the associated work completed by BMT:

- The LTMP is a high-level planning tool and should not be used for the detailed planning and execution of maintenance activities.
- No site-based condition inspections have been completed by BMT in completing this work. The condition of existing structures shall be assessed by others as part of regular inspections and maintenance activities.
- The contracted scope of services was limited to the review and update of the existing LTMP. As such, additional maintenance activities, beyond those included in the existing LTMP and specified in the Project Brief, have not been considered.
- The work completed by BMT has been largely based upon information provided by MBRC, including hydrographic surveys and costing information. While all care has been taken to apply the information appropriately, BMT have not independently verified the accuracy of the supplied information and shall not be liable for any errors in the supplied information including any subsequent calculations or assessments completed by BMT.

- All dollar amounts are presented in 2016 dollars and exclude the Goods and Services Tax (GST). Further, the time value of money and inflation is not taken into account, and therefore, financial modelling is required to be completed by others in order to determine appropriate levy amounts.

This LTMP, including the associated Maintenance Model, has been prepared for MBRC to assist in the long-term planning and funding of maintenance activities in the Pacific Harbour canal estate. While considerable detail is included within the LTMP, it is highlighted that it has been developed as a high-level, long-term planning and costing tool. As such, the LTMP should not be used for the detailed planning and execution of maintenance activities, which will generally require separate detailed planning and design. Further, the LTMP should be reviewed and updated periodically, notionally every 3-5 years, to ensure that the underlying assumptions and cost rates remain appropriate.

2 Site description

2.1 Location

Pacific Harbour is located on the western foreshore of Bribie Island, north of the Bribie Island Bridge, in the suburb of Banksia Beach, Queensland. The canal waterways provide access to Pumicestone Passage and Moreton Bay. The location and layout of the canal estate is provided in Figure 2-1.

2.2 Canal development

The canal estate has been progressively developed in stages following the original construction which began in the late 1980's. The original canal development consisted of two areas: the northern area *Solander Waters,* and southern area *Solander Quays*. Development of *Solander Waters* is understood to have commenced in the late 1980's. This was initially a tidal lake development until lower *Skippers Canal* and access to Pumicestone Passage was constructed in the early 1990's as part of the initial stages of *Solander Quays* (KBR 2012a).

Development of the northern stages, including *Voyagers Canal* and *Island Quays*, is understood to have been completed in about 2000. While development of the final land stages is still ongoing, construction of the canals in the southern parts of the development, including the marina, is understood to have been completed in the late 2000's. The historic development of the canal estate, based on available drawings supplied by MBRC, is broadly summarised in Table 2-1, and the known development stages are provided, in plan form, in Appendix A.

Table 2-1 Historic Development of Pacific Harbour

Year	Canal Stages	Canal Areas
-	H3, H4-H8, H11, H14	Skippers Canal, Voyagers Canal & Horseshoe Bay
1991	H3, H13a	Adjacent Cosmos Ave & Osprey Island
1994	P4, P6	Voyagers Canal & Chichester Inlet
1995	P9, P10, P12	Voyagers Canal, Bligh Cove & Flinders Inlet
1996	P15	Tasman Cove
1997	P20	Oxley inlet
1999	P16	Cook Inlet & Voyagers Canal
2000	P17	Dampier Cove
2003	6, 8, 13, 26, 14	Promontory, Peninsula & Osprey Island (Solander Quays)
2004	9, 10, 11	(Solander Quays)

Note – This table represents an incomplete history based upon the available As-Constructed drawings only.

The Pacific Harbour canal estate currently comprises approximately 840 waterfront residential properties. The Pacific Harbour Marina currently consists of 82 berths and has a planned future capacity of 150 berths (Pacific Harbour 2016).

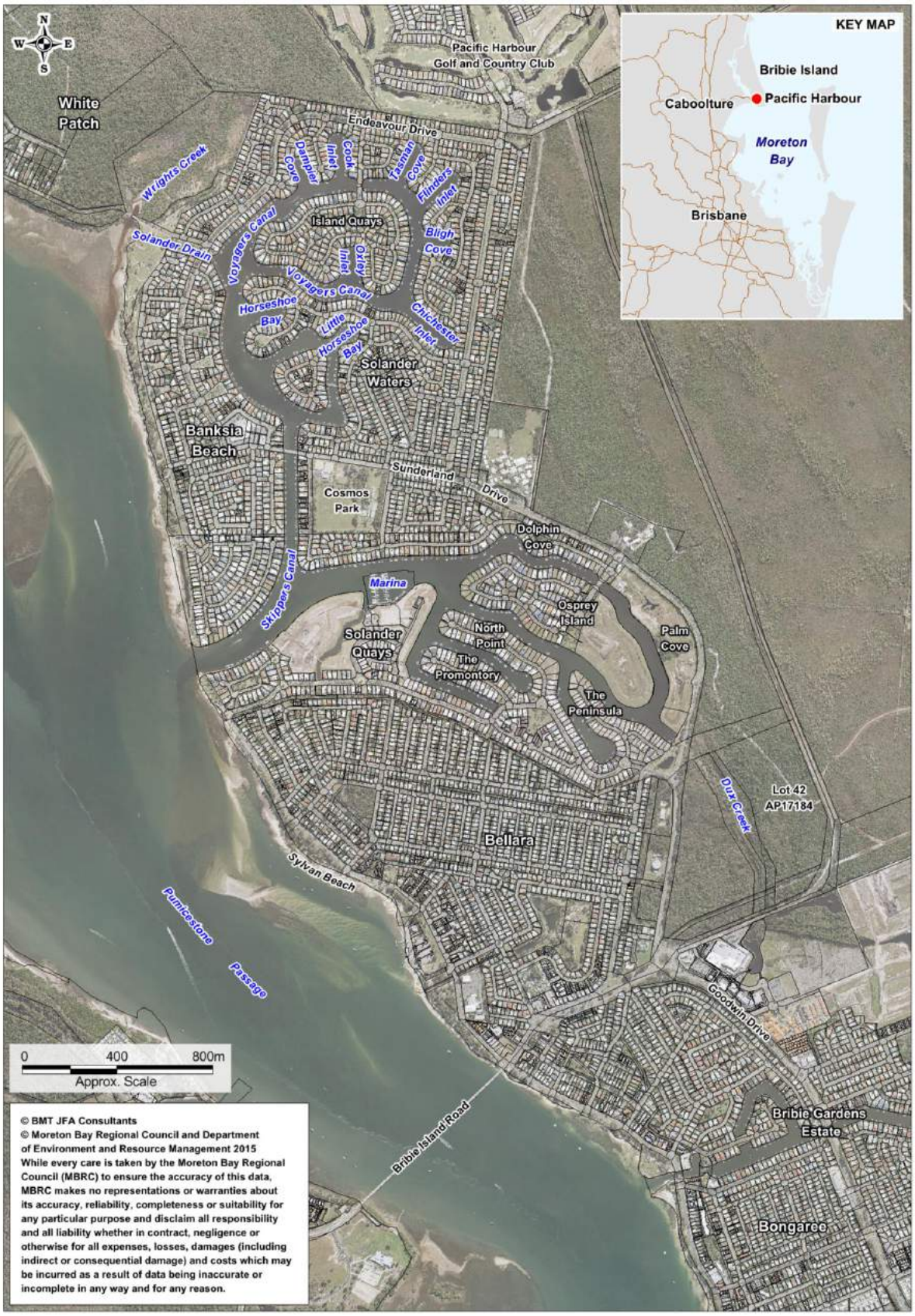

Figure 2-1 Pacific Harbour Locality Plan

2.2.1 Waterways and navigation

The canals within Pacific Harbour provide navigable access to Pumicestone Passage. The cross-section design of the canals is largely constant throughout the development and comprises a 2.3 metre high reinforced concrete revetment wall, upper rock-armoured embankment, lower-submerged embankment, and a flat canal bed as shown in Figure 2-2.

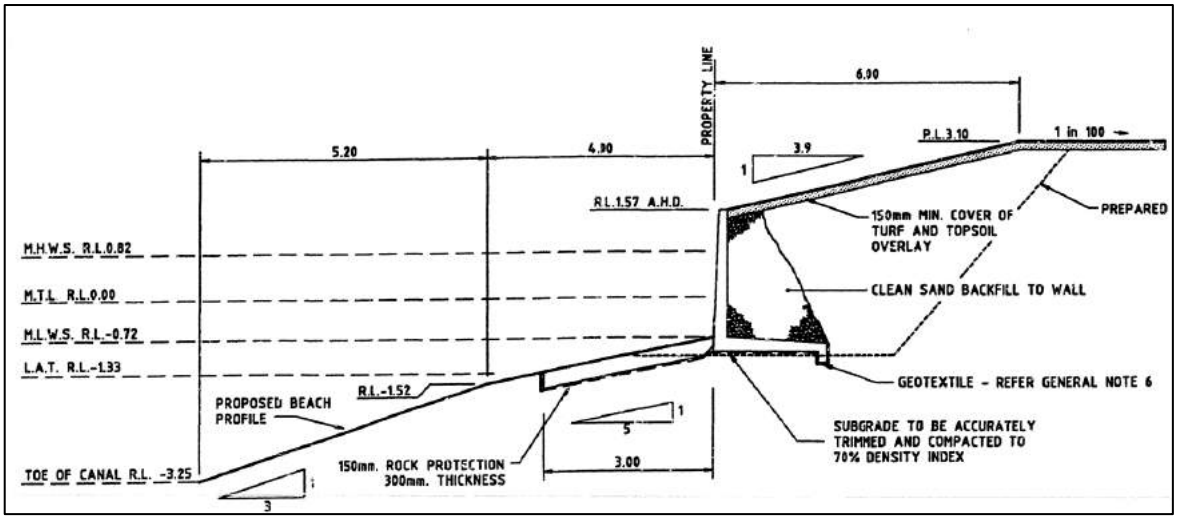

Figure 2-2 Pacific Harbour Typical Design Cross Section (MBRC Ref. A5976894 – Feb 1996)

While the general profile is largely constant, the width of the canal waterways varies appreciably throughout the estate. The lower areas of Skippers Canal and the entrance to Solander Quays (i.e. adjacent the Marina) measure approximately 110 metres in width (quay line to quay line), while the width of the other canals vary between approximately 40 metres, down to 25 metres in the narrower canals.

While the original design depth within the canal estate (-2.15 m LAT) would generally allow for small yachts to navigate safely, access for yachts is generally precluded due to the relatively low clearance heights of the Bribie Island Road Bridge and Sunderland Drive Bridge. These two bridges have nominated clearance heights of 5.0 and 3.22 metres respectively. As such, access to, and within, the Pacific Harbour canals is generally restricted to power boats.

2.2.2 Dredged material placement

A dedicated facility for placement, handling, and treatment of dredged material was not included as part of the Pacific Harbour development plans. Previous policy in Queensland required dedication of land for these purposes as part of all canal estate subdivisions; however this policy was not in place at the time of the Pacific Harbour subdivision. While this requirement is not currently captured in Queensland legislation it is reflected in the State Development Assessment Provisions (SDAP) (see Table 10.1.2 AO2.1).

Based on available records, maintenance dredging within the canal estate has been conducted on one occasion to-date. This small dredging campaign comprised dredging of less than 1000m^3 from

Skippers Canal, and was completed in early-2006. Due to the lack of a dedicated dredged material handling area, Cosmos Park (Lot 181 RP105698) was temporarily used for the initial placement and handling of dredged material.

The recommended dredging and material disposal strategy in the original LTMP included provision for a dedicated dredged material handling area to be constructed to facilitate future dredging campaigns. Initial site selection and planning studies have subsequently been undertaken by MBRC, together with preliminary construction cost estimates, and these are discussed in Section 3.7.3.

2.3 Marine environment

Water levels within the canal estate fluctuate daily as a result of the tidal movement of water within Pumicestone Passage and the wider Moreton Bay. While tidal records for the canal estate are not available, Maritime Safety Queensland (MSQ) publish tidal planes for Bongaree and Toorbul, which are located approximately 4 km to the south, and 4 km to the north-west, of Pacific Harbour respectively. While tidal planes for Bongaree were applied to Pacific Harbour in the previous LTMP, the tidal planes for Toorbul more closely align with the MHWS and MLWS levels noted in the canal design drawings (values of +0.82 and -0.72 m AHD respectively). The tidal planes for Toorbul have therefore been adopted in this study, and are presented in Table 2-2.

Table 2-2 Toorbul Tidal Planes

Tidal plane	Level (m LAT)	Level (m AHD)
HAT	2.46	1.36
MHWS	1.95	0.85
MHWN	1.60	0.50
MSL	1.13	0.03
AHD	1.10	0.00
MLWN	0.68	-0.42
MLWS	0.33	-0.77
LAT	0.00	-1.10

Source: MSQ 2016

The canal estate is located adjacent to marine and national parks, including the Moreton Bay Marine Park, and Bribie Island National Park. While the canal waterways are excised from the Marine Park, it is located directly adjacent to the *Pumicestone Channel* Conservation Park Zone (CPZ02) and Habitat Protection Zone (HPZ04). The canal estate is also located adjacent to the internationally important Moreton Bay RAMSAR wetlands, which extend throughout Pumicestone Passage. Areas of the Bribie Island National Park (Lot 105 NPW806) are also located immediately to the north and east of the development.

2.4 Maintenance activities

The maintenance activities included in the LTMP and associated Maintenance Model are summarised as follows:

- Maintenance dredging and dredged material disposal
- General maintenance, including:
  - Canal batter maintenance
  - Vegetation removal
  - Litter collection
  - Navigation aids and signage
- Other general and planning activities, including:
  - Water quality monitoring
  - Periodic review and update of the LTMP
  - Dredging design and planning
  - Environmental approval applications and renewals

The following sections further discuss these maintenance activities, and are arranged as follows:

- Maintenance Dredging
- Other Maintenance Activities (including general and planning activities).

3 Maintenance Dredging

3.1 Introduction

The completion of past maintenance dredging together with the findings of the original LTMP and review of hydrographic survey information indicate that the Pacific Harbour canals experience siltation. Subsequently, periodic maintenance dredging will be required to ensure that their function and amenity is maintained.

This section discusses maintenance dredging within the canals and marina basin, including discussion of historical dredging and material disposal activities, siltation rates, canal depths, dredging and material disposal options, the recommended dredging and material disposal strategy, and environmental approvals.

3.2 Historical activities

Records indicate that maintenance dredging has been undertaken on two occasions; the first comprised dredging within the canal estate in 2005-06, while the second comprised removal of accumulated sands from the entrance area in 2013.

The small dredging campaign conducted in 2005-06 comprised dredging within Skippers Canal, in the canal reach south of the Sunderland Drive Bridge. The reported volumes in environmental permits issued for the dredging totalled less than 1000 m^3 (KBR 2012a, Table 4.3 p.4-4). The material was dredged via small cutter suction dredge and, owing to the lack of a dedicated dredged material handling area within the development, Cosmos Park (Lot 181 RP105698) was temporarily used for the initial placement and handling of dredged material.

Removal of accumulated sand from the southern side of the entrance channel was undertaken in 2013, and again in 2016. In 2013, material was removed via land-based excavator and placed as beach nourishment at Bongaree. The estimated quantity of material removed during these works was 2,000 m^3. Works in 2016 were completed via excavator and barges and the dredged material was placed on the shoreline to the north of the entrance (i.e. Banksia Beach). An estimated 2,500 m^3 of material was removed during the 2016 works.

Dredging of the wider sections of the canal estate, including lower Skippers Canal and the main southern canal arm, was scheduled for 2013/14 in the original maintenance plan (KBR 2012a). The dredging was intended to be completed via grab dredge and attendant barges, with disposal of the dredged material at the Mud Island Dredged Material Placement Area (MIDMPA). This dredging and spoil disposal methodology was recommended as an interim solution prior to the construction of a dedicated dredged material handling area at the site. However, MBRC's application to conduct the dredging and spoil disposal was ultimately unsuccessful as the approval agencies would not approve the passage of barges beneath the Bribie Island Road Bridge, due to the risk of potential damage to the bridge.

3.3 Siltation

3.3.1 Siltation rates

Siltation rates within the Pacific Harbour canal estate have been previously assessed via direct comparison of hydrographic survey datasets. The results of previous assessments are documented in KBR (2012a) and KBR (2014a). An additional hydrographic survey dataset, collected since the original siltation assessment in KBR (2012a), have facilitated further assessment and updates to the estimated siltation rates. This section summarises BMT's completed assessment and outcomes.

The hydrographic survey datasets made available by MBRC for BMT's assessment are summarised in Table 3-1. Based upon the supplied hydrographic survey datasets, assessment of siltation rates between 2007 and 2014 was undertaken. These two surveys were selected as the 'bounds' for the comparison as both surveys were nominated Class A surveys with full coverage of accessible areas. Further, this approach removed any reliance upon the lower accuracy, Class C, areas of the 2011 survey, which had been identified as a possible source of error in earlier siltation assessments completed by KBR (KBR, 2014a).

The broad methodology for the completed assessment is summarised in Table 3-2. Given the lack of survey coverage in the Marina Village area (including the Marina basin) in the 2007 survey, siltation rates in this area were estimated via comparison of the 2011 and 2014 surveys and subsequently merged with the 2007-2014 comparison. The resulting long-term estimated siltation rates for the period 2007 to 2014 (i.e. Ref. G5 in Table 3-2) are presented in Figure 3-1 and summarised in Table 3-3.

The total siltation volumes above design levels, as at 2014, were also estimated using the developed design digital terrain model (Ref. Appendix A) and the 2014 survey, and are provided in Table 3-3.

Table 3-1 Summary of hydrographic survey datasets

Dates	Survey Description	Surveyor (Survey Plan Ref. No.)	Survey Class	Coverage
21/03/07 - 23/03/07	Investigation survey	PBPL (116697)	Class A	Full (excl. Marina area)
09/06/11 - 11/06/11	Investigation survey	PBPL (125468)	Class A - Zones A, B, C & D Class C - Zones E, F & G	Partial
16/07/14 - 18/07/14	Investigation survey	PBPL (130022)	Class A	Full

Table 3-2 Summary of siltation assessment methodology – 2007 to 2014

Ref.	Survey Grid Calculation	Applicable area
G1	2014 **minus** 2007	All areas excl. Marina and area adjacent Marina Village
G2	G1 ÷ 7.32 years (Estimated siltation rate 2007-2014)	All areas excl. Marina and area adjacent Marina Village
G3	2014 **minus** 2011	Marina and area adjacent Marina Village only
G4	G3 ÷ 3.10 years (Estimated siltation rate 2011-2014)	Marina and area adjacent Marina Village only
G5	Combine G2 **&** G4 (Mosaic) (Combined estimated siltation rate 2007-2014)	All areas

Table 3-3 Estimated siltation rates (2007-2014) and volumes above design (2014)

Canal Area	Description	Approx. age in 2014 (years)	Siltation rate 2007-2014 (m^3/annum)	Volume above design in 2007 (m^3)	Volume above design in 2014 (m^3)
A	Voyagers Canal & Horseshoe Bays	25	1,960	13,900	19,500
B	Skippers Canal (adj. Castaway Ct)	25	240	5,800	6,700
C	Skippers Canal – main entrance	22	†1,000	‡*27,200	‡34,600
D	Solander Canal and Marina (adj. Tradewinds Dr. and Cosmos Ave.)	22	1,040	*20,200	37,500
E	Voyagers Canal, Chichester Inlet, Bligh Cove, Flinders Inlet and Tasman Cove	20	1,320	8,600	13,600
F	Voyagers Canal and Dampier Cove (adj. Endeavour Dr.)	16	570	2,900	4,000
G	Dolphin Cove, Osprey Island, The Promontory, The Peninsula, North Point, Palm Cove	11	2,830	23,600	34,200
Totals			†8,960	102,200	150,100

**Note incomplete survey coverage in 2007 survey in Areas C and D (Skippers Canal and Marina)*

†Siltation rates within area C exclude 2013 campaign and entrance sand accumulation due to survey coverage limitations in the southern entrance area.

‡Volumes above design within area C are likely underestimated due to survey coverage limitations in the southern entrance area.

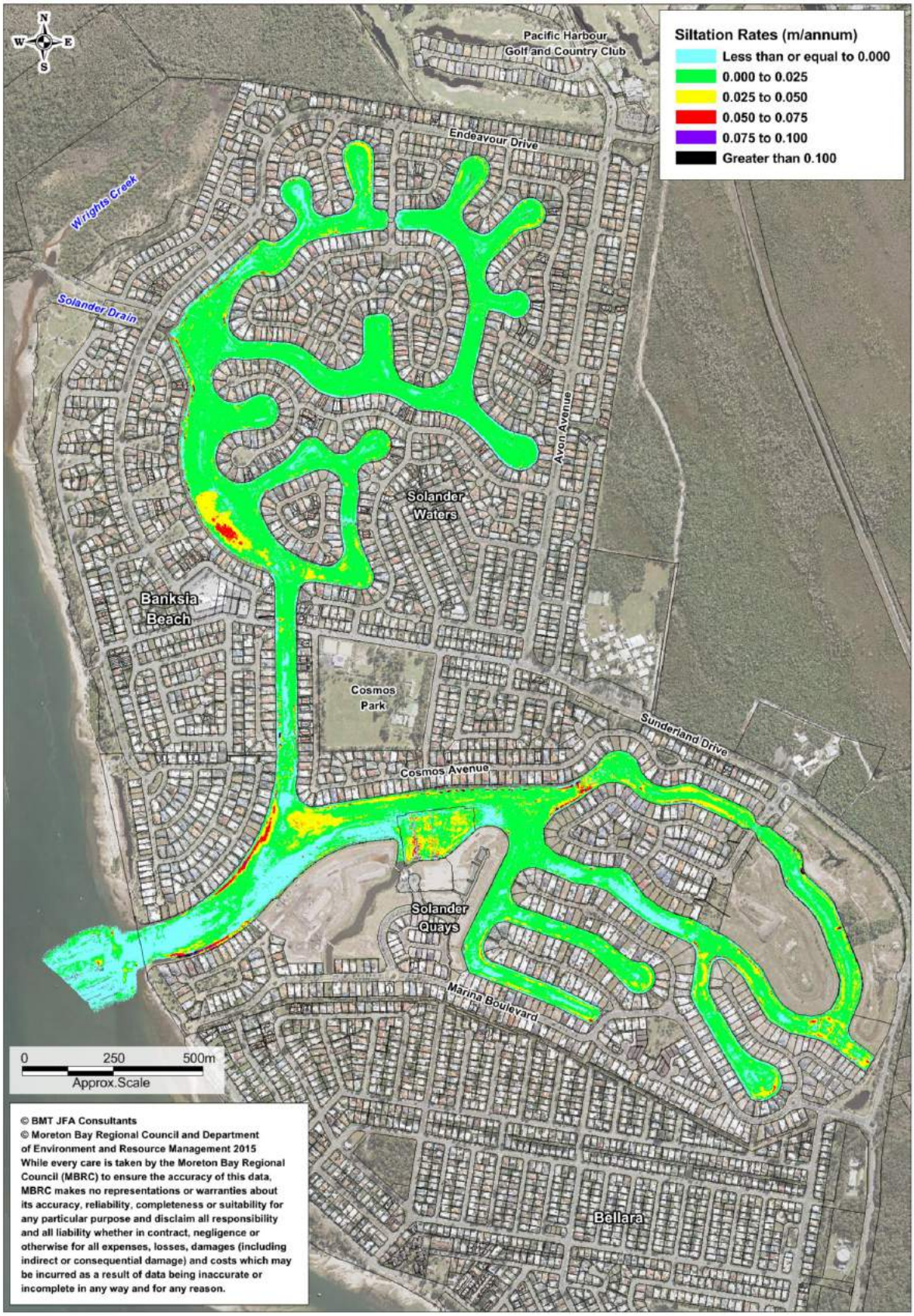

Figure 3-1 Estimated Siltation Rates 2007 to 2014

3.3.2 Causes of siltation

Basic theory

Siltation is the process of suspended fine sediment particles settling out of suspension and being deposited on the bed and banks of channels, rivers, and other areas. The rate of deposition of fine sediment is proportional to the near-bed suspended sediment concentration, the settling velocity of the material, the bed shear stress exerted by flowing water (proportional to current velocity) or waves, and the critical bed shear stress for deposition (bed shear stress above which the deposition rate reduces to zero), as per the following empirical equation (Whitehouse et. al. 2000):

$$\frac{dm}{dt} = -\left(1 - \frac{\tau_0}{\tau_d}\right) C_b w_{50} \qquad \text{for } \tau_0 < \tau_d$$

$$\frac{dm}{dt} = 0 \qquad \text{for } \tau_0 \geq \tau_d$$

Where:

$\frac{dm}{dt}$ *rate of change of mass on the bed per unit area (kg m^{-2} s^{-1})*

τ_0 *applied bed shear-stress exerted by the flowing water (N m^{-2})*

τ_d *critical shear-stress for deposition (N m^{-2})*

C_b *near-bed suspended sediment concentration by mass (kg m^{-3})*

w_{50} *median settling velocity (m s^{-1})*

This empirical equation broadly implies that the siltation rate increases with increasing suspended sediment concentrations and decreasing current velocities. As such, it is expected that siltation rates will be highest in quiescent areas which are near to the source of the suspended sediment (i.e. where the suspended sediment concentrations are highest).

If the material is not eroded following deposition, the generally loose fine sediments will undergo self-weight consolidation, a process whereby the trapped pore water is gradually expelled from the voids within the soil. This leads to the sediment density increasing as a function of time and depth below the bed level. The increase in density is generally associated with an increase in the strength of the material and an increased resistance to erosion (Whitehouse et. al. 2000). The settled density of fine marine clays can vary appreciably depending upon the depth of deposition and time since deposition (van Rijn 1993).

The average dry density of settled deposits of fine marine clays was previously estimated by KBR for the *Moreton Bay Dredge Material Placement Study* (KBR 2006 p.6-2) and subsequently applied in the Pacific Harbour Maintenance Model (KBR 2012a). The estimated *in situ* dry density of approximately 540 kg/m^3 compares relatively well with values published by van Rijn (1993) which indicate dry densities in the range 400-550 kg/m^3 and 550-650 kg/m^3 for 1 year old and 10 year old deposits respectively.

Suspended sediment sources

Investigation into the source of suspended sediments entering the Pacific Harbour canal estate was not part of BMT's scope. Further, no detailed investigations into suspended sediment sources have been commissioned to-date. Notwithstanding, the previous siltation assessments by KBR (2012a & 2014a) have included general discussion of the likely sources. The identified likely sources included natural settling of suspended sediments entering, via daily tidal movements, from Pumicestone Passage, together with eroded sediments from construction areas within the canal estate (i.e. construction related impacts) (KBR 2012a, KBR 2014a). A small proportion of the total material, comprising fine beach sands, also accumulates at the canal entrance as a result of natural long-shore sediment transport (KBR 2012a).

Whilst investigation into the source of suspended sediments was outside of the scope of BMT's study, it is considered that the spatial patterns of siltation within the canals (Ref. Figure 3-1) broadly support a combination of natural (i.e. from Pumicestone Passage) and construction related suspended sediment sources. However, without detailed investigation using more advanced analysis methods, such as hydrodynamic and morphological numerical simulation methods, it is not possible to confirm this, or to estimate the relative contributions from different sources.

As outlined in KBR (2012a), once the final stages of the canals have been developed, siltation resulting from local construction activities will reduce to zero. As such, hydrographic surveys after this time will enable more accurate determination of the expected long-term siltation rates.

Temporal variation

Siltation rates will vary naturally with time as a result of the inherent variability in the key controlling factors including the suspended sediment concentrations and tidal velocities. Periods of high rainfall and subsequent flooding are expected to result in sustained elevated suspended sediment concentrations within the waters of Pumicestone Passage, and therefore higher siltation rates within the quiescent waters of the canal estate. Conversely, periods of low rainfall and drought are expected to result in low suspended sediment concentrations within the waters of Pumicestone Passage, and subsequently lower siltation rates within the canal estate.

The assessed seven year period of 2007 to 2014 generally represents a period of higher than average rainfall, with average or above average rainfall in five out of the seven years. Given this, future investigation hydrographic surveys, at intervals of approximately 4-5 years, will be important in enabling assessment of temporal variability in siltation rates, and subsequent progressive refinement of the estimated long-term average siltation rates within the canal estate.

3.3.3 Entrance sand accumulation

In addition to siltation within the canals, the accumulation of relatively low volumes of sand within the entrance area also occurs at Pacific Harbour. Unlike the process of siltation, this accumulation is a result of long-shore sediment transport processes, also referred to as 'littoral drift' or 'long-shore drift', which result in a net 'drift' of granular sediment particles (i.e. beach sands) along the shoreline (i.e. long-shore direction).

The potential long-shore sediment transport rates in this area of the Bribie Island coastline were assessed as part of the *Shoreline Erosion Management Plan for Bongaree, Bellara, Banksia Beach*

and Sandstone Point (SEMP) (GHD 2011). The SEMP also included discussion of the accumulation of sand at the entrances to the Pacific Harbour and Bribie Gardens canal estates together with recommended management measures.

The reported long-term net average annual potential longshore sediment transport rate on the beaches adjacent to the Pacific Harbour entrance is approximately +3,000 m^3 in a northerly direction. 'Potential' long-shore transport rates represent the potential sand transport which will only be realised with a sufficient quantity of material available for transport (i.e. sufficiently nourished beaches). In areas where these conditions are not present, such as eroded beach areas where the shoreline is protected by a seawall, the actual transport rate will be much lower than the 'potential' rate.

On the basis of the predicted long-shore sediment transport rates, it is anticipated that accumulation of material will occur in the entrance areas of Pacific Harbour, principally on the southern side of the entrance. However, given the slightly under-nourished Sylvan Beach North, complexities of the offshore sand-bar system, and somewhat sporadic supply of sand to Sylvan Beach, the average annual accumulated volumes are likely to be appreciably less than the potential longshore transport rate. Direct assessment of the sand accumulation between the 2007 and 2014 surveys has not been possible as the hydrographic surveys do not extent above the waterline and therefore do not cover the necessary areas.

The recommended management measure in the SEMP to manage sand accumulation at the entrance is the periodic removal of the material via cutter suction dredge, and, subject to suitability of the material, placement as beach nourishment on the adjacent foreshore.

3.3.4 Future siltation rates

Given the natural variability and complexities in siltation processes, it is not possible to accurately forecast future siltation rates within the canal estate. Therefore, for the purpose of assessing the frequency and volumes of dredging and dredged material disposal campaigns over the specified 50 year planning horizon, a rate of 7,900 m^3/annum, determined from the 2007 to 2014 surveys, has been adopted as the estimated long-term average annual siltation volume. This rate has been reduced from the value of 8,960 m^3/annum presented in Table 3-3 to account for siltation which occurs within over-deepened areas of Voyagers Canal. Such siltation will not require removal within the 50 year planning horizon and was therefore not included in the assessment of dredging and dredged material disposal campaigns.

3.3.5 Future development

While development of the final land stages is currently ongoing, it is understood that there are no plans for the expansion of the Pacific Harbour canal estate beyond its current extent. As such, no allowance for additional siltation associated with future canal stages has been considered in BMT's assessment.

3.4 Sediment properties

Sediment sampling and analysis has been undertaken on two occasions within the Pacific Harbour canal estate; October 2010 and March 2012. A total of 13 boreholes were sampled between the

two sampling campaigns, with boreholes generally positioned in areas of inferred siltation. The 2010 sampling campaign was completed to provide a preliminary understanding of the physical characteristics of sediments, and therefore included only pH field-on-oxidation (pH_{fox}) and particle size distribution (PSD) testing in addition to standard field classifications. The 2012 sampling campaign was completed in accordance with the recommendations of the *National Assessment Guidelines for Dredging* (NAGD) (2009) and included a comprehensive suite of laboratory testing and analysis.

The results of general field classification and particle size distribution (PSD) tests indicate that the sediment profile is generally comprised of a surface layer of dark grey marine clays, of varying thickness, underlain by sandy clays and clayey sands (KBR 2012a, KBR 2012b). The results of physio-chemical testing of the sediments indicate the following (KBR 2012b):

- Potential Acid Sulfate Soils (PASS) are present throughout the canal estate.
- The deeper sediments generally have a much higher acid generating potential than the surface sediments.
- Mean contaminant concentrations were all below NAGD screening levels.

The sediments were subsequently deemed suitable for either unconfined ocean disposal, based on the assessment framework outlined in the NAGD, or land-based disposal. However, the presence of PASS, will likely necessitate additional management measures and treatment of the material if placed on-land.

3.5 Canal depths

3.5.1 Design bed levels

Maintenance dredging campaigns are planned to be conducted to restore canal bed levels to design bed levels to provide a period of immunity against ongoing siltation that may otherwise influence the safe navigation of vessels. Based on supplied design and as-constructed drawings, the design bed level throughout the Pacific Harbour canal estate is -3.25 m AHD (-2.15 m LAT), with the exception of the Marina, which has a design bed level of -4.0 m AHD (-2.9 m LAT).

In order to compare the 2015 surveyed depths against original design bed levels, and to provide a consistent basis for the design of future dredging works, BMT JFA developed a Digital Terrain Model (DTM) of the Pacific Harbour canals. This DTM was developed based upon supplied design drawings, and was developed to extend over the waterway areas only (i.e. between the cadastral boundaries). A depth-coloured plan of the DTM is provided in Appendix A.

3.5.2 Minimum desirable bed levels

Minimum desirable bed levels were established as part of the original Long-term Maintenance Plan and these have been reviewed by BMT. The minimum desirable bed levels, or ‘dredging trigger levels’, represent a level above the original design bed level, which triggers the need for dredging. The ‘dredging trigger levels’ have been established on the basis of the original canal design bed levels, the design vessel draughts, and a suitable allowance for under keel clearance at Lowest Astronomical Tide (LAT) (KBR 2012a).

The design vessel draught adopted for the canal estate is 1.5 m, and is based upon an anticipated maximum vessel length of 20m (power boat), together with guidance on vessel draughts for power boats provided in Table 3.1 of AS 3962-2001 (*Guidelines for Design of Marinas*) (KBR 2012a). An allowance of 100 mm for under keel clearance at LAT was also previously adopted in place of the recommended allowance of 300 mm provided in Section 3.2 of AS 3962-2001. It is understood that the relatively low value of 100 mm was adopted based on the very soft nature of the settled marine clays.

The adoption of the lower allowance for under keel clearance is considered a reasonable approach within the canal estate where settled material is comprised of settled fine marine clay. However, the recommended allowance of 300 mm should generally be adopted in areas where the settled material is comprised of sands. Notwithstanding, future siltation will be comprised of fine marine clays and silts, and therefore the value of 100 mm has been adopted in-line with the original LTMP.

As design levels for the Marina were not known at the time of the original LTMP, a separate trigger level for the Marina area was not previously specified. In the absence of information regarding the basis for the original design depths within the Marina, including design vessel draughts, BMT have defined a notional trigger level of -2.30 m LAT in the Marina. The adopted dredging trigger levels and original design bed levels values are presented in Table 3-4.

Table 3-4 Adopted design and minimum desirable bed levels

Canal Area	Original design bed level (m LAT)	Dredging trigger level (minimum desirable bed level) (m LAT)
All canals	-2.15	-1.60*
Marina	-2.90	-2.30

**As defined in the original LTMP by KBR 2012a*

3.6 Dredging and material disposal options

The cost of maintenance dredging and dredged material disposal represents a significant proportion of the total estimated maintenance costs in the Pacific Harbour Maintenance Model. As such, the identification and adoption of cost effective options is of key importance in minimising the total long-term costs of maintaining the waterways.

This section presents a discussion of dredging and dredged material disposal options, including the various constraints and results of a completed options assessment. The recommended dredging and material disposal strategy, including alternative options incorporated in the Maintenance Model, is presented in Section 3.7.

3.6.1 Constraints

A number of factors influence and constrain the available dredging and material disposal options available to MBRC. These include:

- Short-term vs. long-term dredging requirements.
- Physical and navigational constraints within the canal estate and Pumicestone Passage.

- Dredged material properties.
- Dredged material handling area.
- Environmental outcomes and approvals.
- Limited ultimate disposal / re-use options.
- Economic feasibility.

These are broadly discussed in the following sections.

3.6.2 Short and long-term dredging requirements

The estimated dredging volumes and frequency of dredging is a key consideration in assessing the suitability of dredging and dredged material disposal options. Based on the July 2014 survey and the estimated long-term average siltation rates, there is a degree of contrast between the short and long-term dredging requirements.

As of July 2014, large areas have reached the dredging trigger level, and dredging is subsequently needed in the short-term. Based on the July 2014 survey, it is estimated that an initial dredging campaign of approximately 80,000 m^3 is required to restore bed levels back to the design level, principally in areas of Skippers Canal and the main southern canal arm (i.e. adjacent the Marina).

The longer term dredging requirements are principally a function of the estimated long-term siltation rates, which govern the volume, and the design and trigger levels, which influence the frequency. Based on the estimated long-term average siltation rate and patterns presented in Section 3.3, and the design and dredging trigger levels presented in Section 3.5.2, the longer term dredging requirements are expected to comprise dredging of approximately 40,000 to 50,000 m^3 (*in situ* volume) every five to six years.

3.6.3 Physical and navigational constraints

The physical dimensions within the canal estate, including navigational depths, canal widths, and the presence of floating jetties and pontoons, limit the available dredging methodologies which can be successfully employed to remove accumulated sediments. Further, limitations on the movement of floating plant by regulatory authorities beneath the Sunderland Road and Bribie Island Road Bridges can also limit available dredging methodologies.

In general, it is considered that conventional small Cutter Suction Dredgers (CSDs) are most effective in dredging within the narrow confines of canals, and other methodologies such as Grab Dredgers (GDs) (incorporating Backhoe Dredgers and Clamshell Dredgers) have some limitations, particularly dredging around and beneath jetties and pontoons, and in safely navigating and mooring attendant barges. Notwithstanding, dredging is still possible with both CSDs and GDs, particularly in the wider canals within Pacific Harbour. Ultimately, the suitability of a given dredging methodology is subject to the specific plant and methodologies employed by contractors and subsequent effectiveness in removing material from areas which are difficult to access, together with general tolerance control.

As outlined in Section 3.2, MBRC previously lodged an application to dredge material from the wider areas of the canal estate using a grab dredge and dispose the material, via barges, to the

MIDMPA. This application was ultimately unsuccessful as the Department of Transport and Main Roads (DTMR) would not approve the passage of barges beneath the Bribie Island Road Bridge. Further, a subsequent proposal to provide piled protection to key areas of the bridge, in an effort to address DTMR's concerns regarding the potential for barges to collide with the bridge piers, was also rejected. Given this, disposal of material to MIDMPA, via direct barge shipment, has not been considered further for this study.

3.6.4 Dredged material physical properties

Review of historical sediment sampling and analysis results shows that the material to be dredged during maintenance dredging campaigns principally consists of unconsolidated fine marine clays (KBR 2012a, KBR 2012b). These sediments present a challenge in terms of drying the material, together with their suitability for beneficial re-use and other ultimate disposal options. The nature of the material also means that large volumetric and mass changes are likely to occur between its *in situ* state, initial placement in land-based ponds, drying, and disposal.

Material mass and volume changes

Estimates of the mass and volumetric properties of dredged fine marine clays were previously completed by KBR (2006 and 2012a). These estimates were completed based on a mix of geotechnical test results, including some from Newport Waterways, values provided from PBPL based on their experience, and reference values published in relevant literature, and are provided in Table 3-5 together with mass and volume conversion factors in Table 3-6. No additional geotechnical test results have been made available as part of this study, and therefore BMT have not critically reviewed or updated the previous estimates.

Table 3-5 Material mass and volume properties

Disposal phase	Volume (m^3)	Bulk density (t/m^3)	Solids fraction (t/m^3)	Water fraction (t/m^3)	M.C. (%)
In situ	1.00	1.350	0.537	0.813	152
CSD Dredge	2.96	1.135	0.182	0.953	525
Pond wet	0.89	1.391	0.605	0.786	130
Scraped crust	0.48	1.685	1.089	0.596	50
Spadeable	0.36	1.919	1.476	0.443	30
Pond Crust	0.36	1.920	1.600	0.320	20
Heaped Dry	0.34	1.760	1.600	0.160	10

Source: KBR 2012a and KBR 2006

Table 3-6 Volume and mass conversion factors from *in situ*

Material Location	*Volume conversion factor from *In situ*:	Mass conversion factor from *In situ*:
In situ	1.00	1.00
CSD Dredge	2.95	2.48
Pond wet	0.89	0.91
Pond Crust on Batter	0.36	0.52
Pond Crust in Truck - Bulked	0.44	0.48

** Source: KBR 2012a*

The values in Table 3-5 and Table 3-6 illustrate that the estimated volumes and mass of dredged material reduces appreciably if the material can be dried following initial placement (i.e. difference between 'Pond wet' and 'Pond Crust' values).

Drying and suitability for beneficial re-use

Dredged marine clays are difficult and more expensive to handle when wet (i.e. when the moisture content exceeds the Liquid Limit), and it is therefore desirable to dry the material. Drying of fine grained dredged material is most economically achieved through solar drying (USACE 1987, KBR 2006). Based on past dredging and material disposal projects in the region, solar drying of the material in layers not exceeding approximately 0.3m is possible and is estimated to take between seven and fourteen days (weather permitting). Solar drying of thicker layers is generally not feasible as a dried surface layer forms (crust), and the significantly reduced permeability of this crust effectively prevents further drying of the underlying material.

Without stabilisation or other treatment, dredged marine clays are generally considered to have poor engineering properties, including California Bearing Ratios (CBRs) of approximately zero (KBR 2013). This creates additional challenges when considering beneficial re-use of the material.

3.6.5 Dredged material handling area

Land-based disposal of the dredged material will require a dredged material handling area for dewatering, drying, and treatment of the material. The absence of a dedicated dredged material handling facility for the site potentially constrains the timing of the initial dredging campaign. Further, the capacity of a new facility will constrain the maximum volume dredged in any single dredging and material disposal campaign.

Should land-based disposal be the preferred option, the timing of the initial dredging campaign, to address the short-term dredging requirements, will be contingent on the approval and construction of a new dredged material handling facility. As outlined in the Project Brief, a preferred site for the facility has been identified and the estimated planning, approvals, and construction timeframes suggest that the facility could be ready for the first dredging campaign in 2019-2020.

To accommodate dredging via CSD, the dredged material handling area will be broadly comprised of two main areas; an initial placement and dewatering pond, and a treatment and drying area. The

initial placement and dewatering pond will need to have sufficient capacity to accommodate the expected upper limit dredging volumes of an individual campaign. Similarly, the treatment and drying area should be sufficiently large to allow spreading of the dredged material in layers of approximately 0.3m thick for drying and treatment. For the purpose of the completed options assessment and development of the recommended strategy, it has been assumed that the capacity of the new site will be sufficient to contain the planned dredging volumes outlined earlier in Section 3.6.2.

3.6.6 Environmental considerations

The assessment of dredging and material disposal options requires consideration of the surrounding environment and potential impacts, together with the regulatory constraints. These are broadly discussed in the following two sections.

Environmental context and impacts

Pacific Harbour is hydraulically connected to the Pumicestone Passage, both through Skippers Canal and Solander's Drain, via Wrights Creek. Freshwater inputs also flow into the site from Dux Creek, overland flow paths and stormwater drainage. Environmental values (EVs) and water quality objectives (WQOs) have been scheduled for each of these areas under the *Environment Protection (Water) Policy 2009*. In addition, nearshore waters of the Pumicestone Passage are within the Habitat Protection Zone (HPZ) of the Moreton Bay Marine Park (MBMP), while the waters further offshore are within the Conservation Park Zone (CPZ).

Water quality monitoring undertaken by MBRC within the canal estate has identified that the overall water quality is moderate to poor when compared with natural waterways (FRC Environmental, 2015). FRC Environmental (2015) identified that this is likely the result of algal blooms caused by nutrient enrichment and limited water exchange within the canals. In particular, water quality is poorest at Tasman Cove and Flinders Inlet which both experience very limited tidal flushing. By contrast, water quality in Pumicestone Passage[1] and Wrights Creek is good with some minor levels of nutrient enrichment.

Sediment within the canals is principally comprised of unconsolidated fine marine clays (KBR, 2012b). Previous testing of this material has not shown any contaminants of concern, with the exception of PASS (KBR, 2012b). PASS poses the risk of forming acidic runoff and mobilisation of other potential contaminants when exposed to the atmosphere for extended periods but can be effectively treated with lime or other neutralising agent.

Based on the physical properties of the sediment in the canal estate, dredging is expected to cause the generation of turbid plumes. These plumes have the potential to extend into Pumicestone Passage when dredging near the estate entrance, and may also extend into Solander's Drain, depending upon tidal influences. It is not expected that these plumes would cause long-lasting changes to the ambient quality of any waters that are subject to regular flushing, including in Pumicestone Passage. However, areas of the canal estate that currently experience limited tidal flushing are vulnerable to longer-term water quality impacts, especially where dredging occurs on a

[1] Measured at three locations: 500m offshore Freeman Road at Toorbul, 500m from Skippers Canal mouth, and mid-channel south of the Bribie Island Bridge

more frequent basis. The total volume of suspended sediments generated from dredging can be linked to dredging methodology, with much larger turbid plumes generated by grab dredging when compared to cutter suction dredgers (Nakai, 1978; cf. EPA Victoria, 2001).

Based on an investigation undertaken by KBR (2014b), Lot 42/AP17184 is the preferred site for the establishment of a dredged material rehandling facility for Pacific Harbour. This site is currently covered with remnant vegetation, including mangroves. Up to 8.24 ha of the site has been mapped as 'essential habitat' for acid frogs (i.e. *Crinia tinnula*, *Litoria freycineti*, *L. olongburensis*); however a study by Cardno (2014) has suggested the area actually used by frogs is 0.1 ha, suggesting that essential habitat mapping for the area could be altered. Clearing for the development of the site is expected to cause the loss of most of the vegetation on Lot 42, as well as on the adjoining Lot 16/USL26441 and road reserve. Earthworks would also be required in order to establish a rehandling facility.

Operation of a rehandling facility on the site would require discharge of tailwater generated during the dewatering of dredged material. Tailwater typically has high levels of turbidity associated with suspended sediments, depending upon the level of treatment. The discharge of this tailwater into the Pacific Harbour canals could cause temporarily elevated turbidity levels. Management of tailwater discharge will need to take into account the protection of environmental values in this area, particularly due to the poor flushing in canal ends (FRC Environmental, 2015).

Material taken from a rehandling facility will need to be placed at an ultimate disposal location. This is expected to be either an existing landfill (or otherwise approved) site or a new site, converted for disposal purposes. To the extent that environmental issues associated with dredged material (e.g. high salt content and PASS) can be managed and contained, an onshore placement facility may be feasible from an environmental perspective but would need to be subject to a separate study.

Environmental regulatory framework

The identification of dredging and material disposal options requires consideration of environmental regulatory constraints, including assessment and approval requirements for different activities. While there is an approval in place for dredging in the Pacific Harbour canals, this is due to expire at the end of 2016. In addition, there are no approvals currently in place for dredging or placement activities within the MBMP, or for a dredged material rehandling facility.

The regulation of the placement of dredged material is typically dependent upon two factors:

- Physico-chemical properties of sediment
- Environmental constraints and approvals at the disposal site.

Consistent with the London convention, the *National Assessment Guidelines for Dredging 2009* (NAGD) requires the adoption of the waste hierarchy for determining acceptable disposal solutions. Ultimately, however, the physico-chemical and associated geotechnical properties of sediment determine its suitability for beneficial reuse, recycling, land disposal or unconfined ocean disposal. Screening levels related to physico-chemical properties are set by the NAGD in relation to unconfined ocean disposal (i.e. placement at sea), and by the *National Environment Protection (Assessment of Site Contamination) Amendment Measure 1999* (NEPM) and *Queensland Acid Sulfate Soil Technical Manual* (QASSTM) for onshore placement.

As noted above, previous testing has shown material is suitable for both unconfined ocean disposal and onshore placement, as long as material is treated in accordance with the QASSTM. The only current location available for unconfined ocean disposal within Moreton Bay is the Mud Island dredged Material Placement Area (MIDMPA); however, the long-term use of this site beyond a 30 year planning timeframe is currently uncertain.

The development of a rehandling facility at Lot 42/AP17184 (and Lot 16/USL26441) would require a Development Permit for a material change of use (MCU) as well as permits for the construction of the facility. Discharge of tailwater is expected to be managed under a Development Permit through specific discharge limits. Development of this site would cause a 'significant residual impact' for the purposes of the *Environmental Offsets Act 2014*, thereby requiring an environmental offsets package to be approved prior to development.

3.6.7 Ultimate disposal and beneficial re-use options

There are a limited number of options available for the ultimate disposal and beneficial re-use of the dredged material, owing to the material's inherent properties, together with limited available land or established sites which can receive or store the material.

The *Moreton Bay Dredge Material Placement Study – Stage 2 Report* (KBR 2006) was commissioned by the Queensland Government, in conjunction with the Port of Brisbane, to investigate the future management of material dredged from within Moreton Bay. The study included detailed assessment of the environmental, social and economic issues associated with the options proposed for long-term dredged material disposal, and identification of the most viable options. The study identified a number of possible disposal options, including those applicable to small boat harbours and canal estates, and included (KBR 2006):

- Continued use of the existing Mud Island DMP area (MIDMPA).
- Filling of old mine sites, including Swanbank and Ipswich coal mines.
- Filling of old gravel extraction pits.
- Opportunistic filling of coastal developments.
- Stabilisation and use as controlled/engineered fill – via mixing with cement or lime.

The study provided an overall recommendation to continue the use of the MIDMPA for the disposal of uncontaminated dredged sediments. However, the study acknowledged that access and location issues dictate that some canals would require dredging by small Cutter Suction Dredge, and that this material would need to be pumped to a small local pond, subsequently dried, and then trucked to a land based placement area or disused mine.

The following options for disposal or re-use of material dredged from the Pacific Harbour canals have been identified:

Disposal:

- MBRC's Caboolture waste management facility (25 km)
- Veolia's Ti Tree BioEnergy site (125 km)

- Mud Island Dredged Material Placement Area (MIDMPA) (approximately 40 km via barge)
- PBPL's Future Port Expansion (FPE) site, Fisherman Islands (approximately 85 km)
- Short-term option for redistribution within deep 'holes' within the canal estate (limited capacity)

Rehabilitation and beneficial re-use:

- Potential rehabilitation of existing sand/gravel extraction sites/areas.
- Cement (or lime) stabilisation and re-use as general fill or controlled/engineered fill.
- Drying and leeching of salts, mixing with composted green waste, and re-use as garden mulch.

These options are each broadly discussed in the following sections.

MBRC waste management facilities

MBRC have advised that disposal of material at MBRC's Caboolture waste management facility is possible. However, advice provided from MBRC's waste management section has indicated that the salt content in the material is very likely to interfere with methane production from their landfill and it is therefore quite undesirable and costly to dispose of the dredged material at the Caboolture site. Further, initial trials have found that the material becomes quite dusty if used as day-cover, and relatively large areas of land are required to dry the material (J. Purcell, pers. comm., 7 March 2016).

Ti Tree BioEnergy Site

The Ti Tree BioEnergy site, located approximately 125 km (by road) from Pacific Harbour in Willowbank, is a waste disposal facility located on an existing open-cut coal mine. The site utilises "best practice" bioreactor technology to rapidly stabilise waste while capturing environmentally damaging methane and converting it into electricity (Ti Tree BioEnergy 2009). Initial advice provided by Veolia Environmental Services indicates that much of the material dredged from the canals could be accepted by this site, as either 'Contaminated Soils', or as 'Regulated Waste' (Kimber 2016).

MIDMPA

As noted in Section 3.6.6, the MIDMPA is the only area currently approved for unconfined ocean disposal in Moreton Bay, with the exception of beach nourishment locations near Bribie Island and inactive sites at St Helena Island and Raby Bay. It is designated as a material placement area within the Moreton Bay Marine Park and is managed by PBPL and DTMR. Only material that meets the NAGD requirements for unconfined ocean disposal is allowed to be placed at the site. The MIDMPA is located approximately 40 km by water from Pacific Harbour.

There is some uncertainty regarding the long-term capacity of the site, though at current rates the site is expected to reach capacity before 2050 (KBR 2006). Even with actions to expand the longevity of the site, the current MIDMPA has a finite capacity to receive material in the long-term.

PBPL Future Port Expansion

The Future Port Expansion (FPE) site is a land reclamation which will extend the existing port facilities. PBPL have advised that they would consider receipt of the dredged material for use as reclamation material in the FPE (P. Nella, pers. comm. 28/04/2016). However, the FPE site will have a finite life for receiving dredged material, which is currently estimated to reach capacity in approximately 2040.

Redistribution

A potential once-off short-term option for the disposal of dredged material is the dredging and placement (i.e. redistribution) in deep holes within the canal estate. Preliminary assessment of the volumetric capacity of the deeper areas within Voyagers Canal indicates a volume in the order of 30,000 to 40,000 m^3. Redistribution within the canal estate offers the advantage that the material is not double handled, and would therefore be significantly cheaper than disposal at land-based sites or the MIDMPA. However, the capacity is very limited and placement of material in these areas would require further environmental and engineering studies to protect against environmental impacts and to confirm the likely capacity.

Rehabilitation of existing sand/gravel extraction sites

As identified in the *Moreton Bay Dredge Material Placement Study*, there are likely to be opportunities to place the material for site rehabilitation within disused areas of sand/gravel extraction sites within the region. This would be similar in principal to the relatively recent filling of an existing extraction site along the North Pine River adjacent to the Gympie Arterial Road. Placement of dredged material would generally comprise sub-aqueous placement, but may extend above existing water levels. Known existing sand or gravel extraction operations in the region include sites in Lawnton, Ningi, Toorbul and Donnybrook.

The key advantage of disposal within existing sand/gravel pits, in addition to the obvious beneficial use of the material, is the likely significantly reduced disposal cost compared with other options. However, each site/pit will have a finite capacity, and therefore new sites will need to be identified as existing ones reach capacity. Given this, it is recommended that MBRC should be continually investigating opportunities for this overall option, and seek to establish contracts with the appropriate entities managing such sites.

Following enquiries made during the current study, it is understood that rehabilitation of a site in Lawnton, most likely adjacent the North Pine River, is planned or currently underway. This potential opportunity should be further investigated.

Stabilised fill material

The treated and dried material may be beneficially re-used as a general fill, or potentially as a controlled fill following stabilisation with cement or lime. Dried dredged material from the Newport Waterways canal estate has been previously utilised off-site for general fill. In 2009 approximately 40,000m^3 of material was removed from the Newport Waterways dredged material handling site (Griffith Road Pond) and placed as general fill in an adjacent development area (KBR 2013). Further, a total of approximately 65,000 m^3 of material was removed from the Griffith Road Pond

following maintenance dredging campaigns 2012 and 2014, and this material was placed as general fill on the Contractor's own site.

Preliminary stabilisation trials, undertaken by a Contractor on fine marine clays dredged from the Newport Waterways, have indicated that cement stabilisation significantly improves the bearing capacity of the material and can be economically feasible (Geldenhuys 2016). Cement stabilised material could potentially be beneficially re-used for controlled fill, subject to further testing and assessment (including engineering testing and environmental impact assessment).

BMT are also aware of the Trinity Park project, north of Cairns, in which approximately 300,000 m^3 of dredged fine material was successfully treated with lime and used for development fill. Beneficial re-use trials conducted for this project included stabilisation with agricultural lime as well as hydrated lime, and indicated increases in the soaked CBR of the material from approximately 3% (un-stabilised) to 5% and 10% once stabilised with agricultural lime and hydrated lime respectively.

Garden soil

Previous experiments by Kinhill Pty Ltd and PBPL (then Port of Brisbane Corporation) in 1999 have shown that dredged material can be dried and mixed with green waste to produce a soil in which salt tolerant upland plants can grow (KBR 2006). Further, advice from an external consultant has indicated that, subject to confirmation via laboratory scale tests, the material could be treated and subsequently sold as a garden soil which conforms to the requirements of AS 4419 *Soils for Landscaping and Garden Use*. Such treatment would broadly involve mixing the dried dredged material with a mixture of sand and green waste at a ratio of at least 1:1 (i.e. potentially more sand and green waste required for mixing), followed by addition of soil conditioners, fertilisers, and stabilisers (Blair 2016). The costs associated with treatment would be a function of the final treatment method, cost of the green waste, sand, mixing plant, etc., together with the potential sale price of, and demand for, the end-product.

It may be feasible for MBRC to undertake the treatment of the dredged material at existing waste facilities where green waste is already disposed. It is therefore recommended that MBRC further investigate the technical and economic feasibility of this overall beneficial re-use option.

3.6.8 Economic feasibility

The cost of the various dredging and material disposal options is a key consideration in the overall assessment of the options. In order to compare options, rates have been estimated for the various dredging and material disposal options on the basis of dollars per *in situ* cubic meter. Rates were estimated using a range of sources including quotes, historical rates for past projects, and typical industry rates. Estimated disposal only rates are provided in Table 3-7, and the estimated total combined rate for dredging and material disposal are provided in Table 3-8.

The conversion from 'Raw rates' to 'Per in situ m^3' rates requires mass and/or volumetric conversions between the disposed sediment mass and volume, and the estimated in situ volume. The estimates in Table 3-7 and the options incorporating the use of the Dredged Material Handling Facility in Table 3-8 assume that the in situ material and disposed material have Moisture Contents (MC) of 152% and 20% respectively, and bulk densities of 1.35 t/m^3 and 1.60 t/m^3 respectively. That is, the presented rates assume that the material is dried prior to disposal. The first three

options presented in Table 3-8 assume that the material is disposed at the in situ density (i.e. bulk density of 1.35t/m^3).

Table 3-7 Estimated disposal only rates

Disposal site/option	Raw rate	Estimated Disposal Only Rate ($ per in situ m^3)
MBRC Caboolture waste management facility	$125/tonne	$80
Ti Tree BioEnergy site	*$43/tonne	*$30
Future Port Expansion site	$40/$m^3$	$18
Sand/Gravel Extraction and General fill sites	$10/tonne	$7
Cement stabilisation (excl. site disposal fees)	$10/$m^3$	$5

** Applicable rate if final classification is 'Contaminated Soils'. Rate of $79.70/t applies if classified as 'Regulated Waste'*

Table 3-8 Estimated total dredging and disposal rates

Option	Estimated Dredging & Disposal Rate* ($ per in situ m^3)
†Grab dredge - MIDMPA	$75
Grab dredge - Skips - Rehabilitation of extraction sites	$100
CSD or Grab Dredge - Redistribution	$35
CSD - DMHF - MBRC Caboolture waste management facility	$105
CSD - DMHF - Ti Tree BioEnergy site	$80
CSD - DMHF - Future Port Expansion site	$60
CSD - DMHF - Rehabilitation of extraction sites	$45
CSD - DMHF - Cement stabilisation	$45
‡CSD - DMHF - Garden soil	$45

** Rates exclude contract execution costs (i.e. mobilisation/demobilisation, survey, project management etc.). Applied dredging rate for CSD - $15/$m^3$*

† Note this option is currently not available to MBRC (Ref. Section 3.6.3)

‡ Preliminary estimate only – includes cost recovery of soil at approx. $18/$m^3$

'CSD – DMHF' is Cutter Suction Dredge to Dredged Material Handling Facility

3.6.9 Options assessment

A broad assessment of dredging and dredged material disposal options was completed. The outcomes of the assessment are summarised in Appendix B. The recommended dredging and material disposal strategy was developed following the options assessment, and is presented in the next section.

3.7 Dredging and material disposal strategy

This section presents the recommended dredging and dredged material disposal strategy, together with proposed alternatives incorporated in the Maintenance Model.

3.7.1 Recommended strategy

The recommended dredging and dredged material disposal strategy comprises dredging campaigns every five to six years using a small CSD, with dredged sediments from the canals pumped into a new dredged material handling facility, treatment and solar drying of the material, and subsequent beneficial re-use of the material. The key factors leading to the selection of this methodology include:

- Small CSDs can best adapt to the narrow areas within Pacific Harbour, can dredge under pontoons, have relatively high manoeuvrability, and represent the cheapest dredging method.
- Dredging every five to six years is generally recommended to keep the estimated dredged material volumes for each campaign within the likely capacity constraints of the new dredged material handling facility.
- The combination of small CSD and beneficial re-use is estimated to represent the cheapest dredging and material disposal option, and, provided that PASS material can be effectively treated, is likely to also result in the most favourable environmental outcomes.
- This broad methodology has been successfully employed at other similar sites, including all past maintenance dredging campaigns at the Newport Waterways site.

A long-term opportunistic fill or beneficial re-use site (or sites) has not yet been secured by MBRC for future dredging and material disposal campaigns. However, as advised by MBRC, it has been assumed that a site (or sites) will be identified, and the necessary agreements established, prior to future dredging and material disposal campaigns.

It has been assumed in the Maintenance Model that the dredged material is treated and dried at the dredged material handling facility and subsequently disposed at a density corresponding to the '*Pond Crust in Truck - Bulked*' density (i.e. 1.6 t/m^3). This implies volumetric and mass conversions from *in situ* to disposed material of 0.44 and 0.48 respectively (Ref. Table 3-6, '*Pond Crust in Truck - Bulked*' density). As such, the estimated costs for material disposal assume that the material will be dried, and that the associated reductions in volume and mass are consistent with the adopted values in Table 3-6.

Entrance sand accumulation

In addition to the sediments dredged from within the canals, accumulated sands at the entrance will also require periodic removal. Whilst the volumes could not be estimated as part of this study, it is anticipated that removal of accumulated material each five to six years, in conjunction with the scheduled canal dredging campaigns, will be sufficient to manage the sediment accumulation.

As recommended in the SEMP (GHD 2011), removal should be completed via CSD and the preferred disposal method, subject to the suitability of the material, should be as beach nourishment on the adjacent beaches. The final placement area would need to be determined prior

to each campaign based on completed sediment sampling and analysis, and consideration of the condition of the adjacent beaches. Notwithstanding, given the net northerly transport direction, the recommended placement area is likely to be Banksia Beach to the north. However, consideration may also be given to back-passing the material to Sylvan Beach to the south.

3.7.2 Proposed dredging schedule

A proposed dredging schedule was developed on the basis of the recommended strategy. This proposed schedule was developed in order to inform predicted dredged material volumes applied in the Maintenance Model, together with the dredging areas for the next three dredging campaigns.

The proposed dredging schedule was generated using the existing Excel spreadsheet developed by KBR, with updates to reflect the revised predicted long-term siltation rates, updates to the original design and trigger levels, bed levels and volumes to design as at 2014, and the proposed dredging strategy. The existing spreadsheet tool utilises surveyed levels and volumes, predicted shoaling rates and siltation volumes, and the canal design and dredging trigger levels to estimate the timing and material volumes for future dredging campaigns within the nominated dredging 'zones'. The schedule was developed to cover a period of 50 years and dredging was scheduled to minimise the number of areas where bed levels exceeded the dredging trigger level.

It is important to note that the 'shoaling rates' applied in the tool/schedule correspond with the rate-of-rise in the area of highest siltation within each zone, not the average siltation rate within the zone, as it is the areas of higher siltation which will shoal more rapidly and cause potential impacts to navigation. Also, the 'siltation volumes' represent the average predicted annual siltation volume over the full dredging zone.

The proposed dredging schedule is provided in Appendix C, and a summary of the estimated dredged material volumes and areas for the next three campaigns is provided in Table 3-9 and in Figure 3-2.

Table 3-9 Proposed dredging schedule – Campaigns 1-3

Campaign	Dredging Areas	Estimated Volume (m^3)
1	Entrance area, lower Skippers Canal, and main southern arm (Zones 1-4 & 22)	80,000
2	Entrance area, lower Skippers Canal, Marina, and parts of Skippers Canal, Voyagers Canal, and high-spots around Osprey Island (Zones 1-2, 5-6, 11, 16, 18, 21, 23-25, 29)	60,000
3	Entrance area, lower Skippers Canal, and high-spots in Little Horseshoe Bay, Tasman Cove, Flinders Inlet, and parts of Voyagers Canal (Zones 1-3, 26-28, 30, 41-42)	45,000

While the proposed volumes and timing are considered appropriate for inclusion in the Maintenance Model (i.e. for the long-term planning of maintenance dredging requirements and costs), the actual timing and material volumes for future dredging campaigns will need to be determined via review and analysis of regularly scheduled hydrographic surveys.

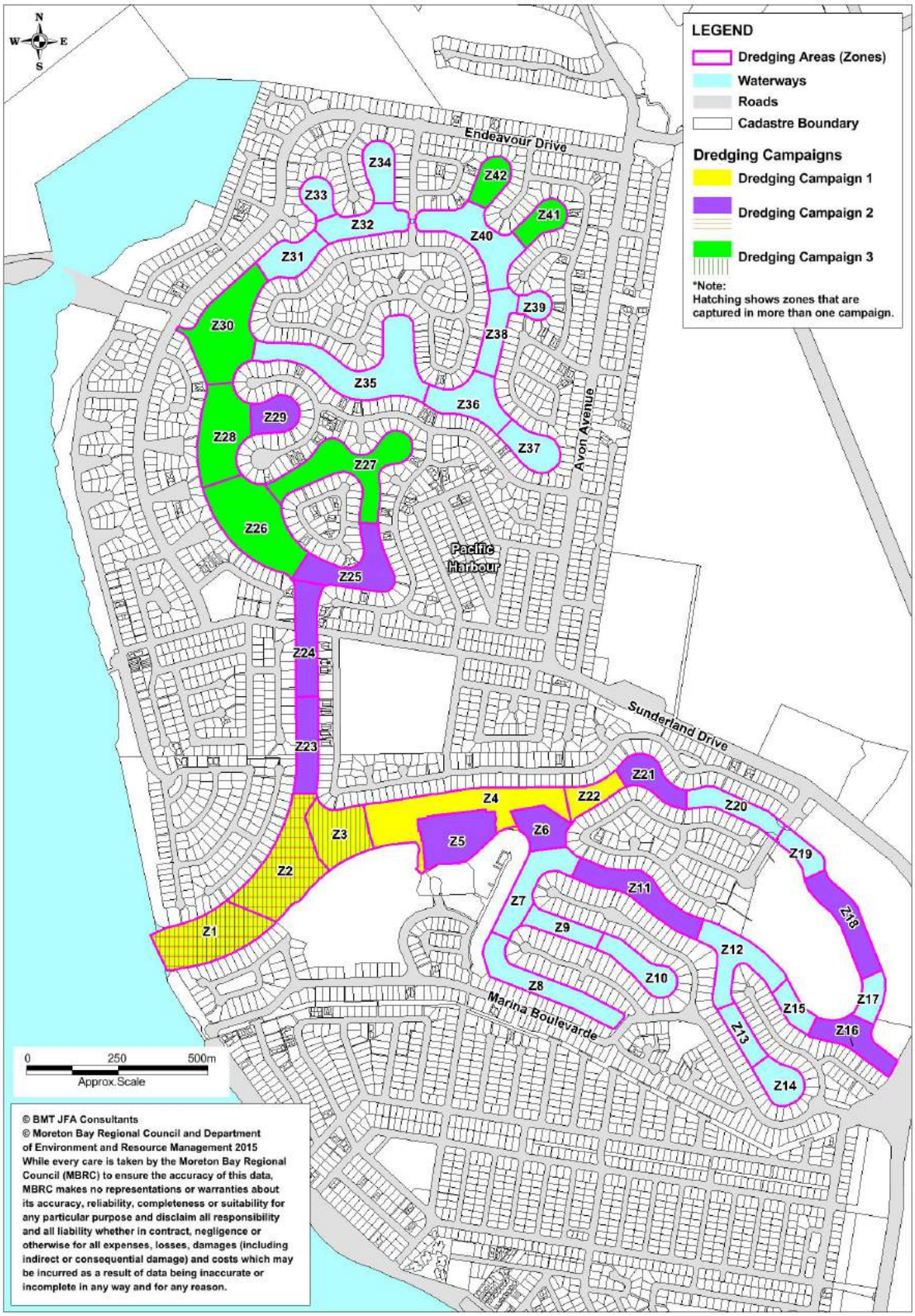

Figure 3-2 Proposed dredging schedule - dredging areas

3.7.3 Dredged material handling area

An integral part of the proposed dredging and dredged material disposal strategy is the planning, approval, and construction of a new dredged material handling area. The following sections summarise completed investigations into a new facility, together with a discussion of the potential to utilise mechanical dewatering technologies as part of the new facility.

Investigations into new facility

Following the recommendation for a permanent dredged material handling facility in the original LTMP, MBRC commissioned a site selection study for a new facility, and have also progressed initial environmental surveys, concept design, and cost estimates for the identified preferred site.

The objective of the site selection study was to identify a prioritised short-list of suitable sites. The study consisted of an initial identification of potential sites, followed by development of preliminary concepts and subsequent options assessment via multi-criteria analysis (MCA). The study identified three suitable sites which warranted further investigation (KBR 2014b). Subsequent work by MBRC resulted in the identification of a preferred site out of these three sites. This site, Lot 42 AP17184, covers approximately 17 ha and is located along Hornsby Parade, to the south-east of the Pacific Harbour development.

The preferred site is located on undeveloped State owned land zoned as 'Rural' adjacent to the Bribie Island National Park. This site is vegetated and therefore subject to a number of environmental constraints, namely: Category B vegetation and essential habitat (for acid frogs). The land is also within the erosion prone area and medium storm tide hazard area. Development of a facility would require a Material Change of Use (MCU) that would be impact assessable under the MBRC planning scheme. In addition, due to the presence of essential habitat, offsets would need to be provided for any loss in vegetation. Therefore, it is anticipated that the development of this site will broadly require the following tasks:

- Concept Design Refinement
- Community Engagement, including Cultural Heritage assessment.
- Preliminary Engineering Design (including Geotechnical Investigation) and Construction Cost Estimate, Environmental Impact Assessment,[2] Environmental Offsets Strategy and Development Applications.
- Approvals acquisition, including:
  - Development Permit for MCU – assessed by MBRC and State Government
  - Development Permit for Operational Works (for site clearing and construction) – assessed by MBRC and State Government
  - (potential) Environmental Authority (EA) for Environmental Relevant Activity – assessed by State Government

[2] The exact environmental assessment process adopted will be determined at this stage, in consultation with State Government agencies

- Land acquisition (from the State)
- Settlement of agreed Environmental Offsets
- Detailed Engineering Design
- Construction.

Initial environmental surveys have been undertaken at the site, principally to confirm the existing habitat mapping of the site and subsequently to estimate the applicable environmental offset amounts. The initial surveys indicate that the applicable environmental offsets may range between approximately $35,000 and $1,700,000. The larger of these amounts would apply if the full extent of mapped habitat was offset, while the lower amount would apply if a reduced offset obligation could be negotiated based on the findings of the initial completed surveys (Cardno 2015).

Preliminary cost estimates for construction of the facility and the land acquisition have also been completed by MBRC. These indicate that construction of the facility may range between approximately $2M to $3.5M, and land acquisition between $0.5M and $1.25M. In addition to these costs, an Indigenous Land Use agreement may also be required, which may incur appreciable additional costs. Given the above, MBRC have advised the following costs to be included in the Maintenance Model for development of the dredged material handling facility:

- $3,950,000 - Land acquisition, environmental offsets and other acquisition related costs
- $3,850,000 - Construction costs including engineering design and planning.

These costs, which total $7.8M are considered to represent the ‘upper-bound’ estimated cost. A ‘lower-bound’ estimate of the total cost, on the basis of the above provided information, is approximately $3M.

MBRC have also provided a broad implementation timeframe for the development of the site as follows:

- Land acquisition - 2017/18
- Facility construction - 2018/19
- First dredging campaign - 2019/20.

Mechanical dewatering technologies

As outlined earlier in Section 3.6.5, the dredged material handling area will be broadly comprised of two main areas; an initial placement and dewatering pond, and a treatment and drying area. Dewatering ponds utilise natural gravitational settling to dewater the dredged slurry. Dewatering may also be possible via mechanical means, which has the potential to reduce the required size of the initial placement and dewatering pond. Alternative dewatering and drying methods were considered and discussed as part of the *Moreton Bay Dredge Material Placement Study* (KBR 2006), and have also been further assessed by BMT as part of this study.

Initial drying of fine dredged material/slurry is generally possible using a combination of the following plant:

- Hydrocyclones – used 'upstream' of other plant to remove larger sediment particles prior to 'down-stream' processes.
- High rate thickening – regularly used in the mining industry, high rate thickening utilises specialised large conical tanks and raking systems, together with flocculants, to thicken the inflow slurry.
- Belt Press – also used throughout the mining industry, belt presses force water out of the material by squeezing a thin layer of sediment against a permeable belt.
- Centrifuge – mechanical cyclones, or centrifuges, spin the sediment slurry creating an internal pressure gradient which separates the sediment from the water.

Initial discussions with a designer of mechanical dewatering plant have indicated that the capital cost of a system capable of treating slurry from a small CSD at the Pacific Harbour site would be between approximately $2M and $3M (AUD). This cost would cover the supply and installation of equipment only, and excludes the costs of land acquisition, sludge ('output' material) handling/storage area, 3-phase power supply, water supply, and other associated site works including footings, base slabs, fencing and security, drainage and pipe-works. The estimated output concentration of the plant was approximately 300-350 kg/m^3 (i.e. MC 250-300%).

While the above listed mechanical drying methods will all reduce the moisture content of a dredged slurry from a CSD (i.e. MC 525%), the moisture content of the 'output' material will typically be greater than 100% (i.e. similar to the 'Pond Wet' state). This is largely due to the high proportion of fine sediment particles in dredged marine clays, and their associated very low permeability at relatively low densities, together with the practical limitations of the mechanical drying plant. Consequently, it is expected that only a limited reduction in the required total material handling area could be achieved through the use of mechanical dewatering methods. This, combined with the associated capital, operating, and maintenance costs, leads to the conclusion that mechanical dewatering methods are likely to be uneconomical compared with gravity settling.

3.7.4 Alternative options

Two alternative dredging and material disposal options have been included in the Maintenance Model. These options can be selected in the event that the recommended strategy of CSD and beneficial re-use is not available. The alternative options comprise:

- Small CSD, with dredged sediment pumped into the dredged material handling facility, subsequent treatment and drying, and loading into trucks for disposal at an approved landfill site (notionally the Ti Tree BioEnergy site).
- Grab dredging into barges and disposal at the MIDMPA (noting that this option is not currently available to MBRC due to limitations imposed by regulatory authorities).

These two options, are estimated to have higher cost rates for dredging and material disposal compared with the recommended option of CSD and beneficial re-use. However, they have been included in the model to provide alternatives in the event that a more cost effective beneficial re-

use option is not available to MBRC, or should approval be granted for the Grab dredge to MIDMPA option in the future.

3.8 Environmental approvals

3.8.1 Approvals Required

Preferred Option

MBRC currently hold a development permit for dredging and placement activities associated with the Pacific Harbour canals: SPDE04950512. This permit provides for the following activities:

- Maintenance dredging up to 90,000m^3/yr to design levels,
- Placement of material that is clean sands on beaches for nourishment purposes, and all other material at the MIDMPA or other approved area

This permit is due to expire 18th December 2016.

Based on the recommended strategy, the following approvals would be required:

- Renewal of SPDE04950512, with specific provision for use of the new material rehandling facility and ultimate beneficial reuse
- Development Permit for a MCU to use Lot 42 as a material rehandling facility
- Development Permit for operational works to construct a material rehandling facility at Lot 42
- (potential) Environmental Authority to conduct an ERA – this may be relevant to the operation of the rehandling facility but would need to be discussed with the Department of Environment and Heritage Protection (DEHP)
- Marine Parks Permit for any aspect of the works occurring in the MBMP (i.e. at the entrance channel).

Alternative Options

With the exception of the renewal of SPDE04950512 (discussed above) no additional approvals are required for the placement of dried dredged material within an approved landfill site.

Placement of the material at the MIDMPA will require a new Marine Parks Permit. This disposal option will also need to be provided for within the renewal of SPDE04950512.

3.8.2 Planning and Execution Requirements

Preferred Option

Prior to the commencement of a new dredging campaign, Lot 42 needs to be procured and developed, subsequent to detailed environmental and engineering investigations and approvals. This is expected to take up to 12 months, depending upon the requirements imposed during the approvals phase.

As part of each dredging campaign for the Pacific Harbour canals, the following actions are required:

- Preparation of a site-based management plan (SBMP) for the works or review and adaption of an existing SBMP, prior to commencement of works
- Sediment testing for acid sulfate soils (ASS) or other contaminants, prior to commencement of works
- Water quality monitoring during dredging, including monitoring of tailwater discharge from the rehandling facility.

Depending upon the beneficial re-use options available for each dredging campaign, additional approvals would also need to be sought in parallel. Assessments and testing for these approvals will depend upon the requirements of the relevant approval agencies.

Alternative Options

For placement at the MIDMPA an approval would need to be sought from the State Government prior to commencement of dredging. In addition, before each dredging campaign, testing of material would need to be undertaken to ensure it is suitable for unconfined ocean disposal in accordance with the NAGD.

No further tasks are required for placement at an approved landfill site or equivalent (e.g. Ti Tree BioEnergy site) unless required by the site operator.

3.8.3 Renewals

Renewal is required to SPDE04950512 at the end of 2016.

4 Other Maintenance Activities

4.1 Introduction

In addition to maintenance dredging, MBRC has an ongoing general maintenance program which consists of a number of maintenance activities, including:

- Canal batter maintenance
- Vegetation and litter removal
- Maintenance and replacement of signage and navigation aids
- Water quality monitoring

These maintenance activities are each briefly discussed in the following sections.

4.2 Canal batter maintenance

The canal batters, extending from the property boundaries to the navigation channel, require periodic maintenance to ensure that their function and amenity is maintained. Previous inspections completed for the original LTMP identified a number of areas where the canal batters required maintenance and remedial works. Additionally, the action of boat wakes, stormwater runoff, tidal flows, marine plants, and other factors have the potential to cause erosion and degradation of the canal batters, and maintenance of the batters may subsequently be required in the future.

The original LTMP identified the need for maintenance of the canal batters in a number of areas within the canal estate. MBRC subsequently implemented a works program to remediate these areas and the program is understood to be well progressed. MBRC have advised that remedial works are planned for the next three years, after which a standard maintenance regime will resume.

Assessment of the frequency and location of future canal batter maintenance activities was not part of BMT's scope. However, the condition of canal batters will be assessed periodically as part of MBRC's regular maintenance inspections, and maintenance activities will subsequently be carried out to address identified issues. In order to inform the Maintenance Model of the timing and estimated costs for canal batter maintenance, MBRC have advised an annual allowance for the next three years for the remedial works, together with an estimated allowance for subsequent maintenance based on a biennial works program. MBRC's estimates have been based upon previously completed maintenance works and the amounts have been included in the Maintenance Model by BMT.

4.3 Vegetation and litter removal

Marine vegetation is removed from canal batters and other areas within the canal estate on an as required basis. Removal of marine vegetation aims to maintain amenity of the canals, whilst also protecting against potential damage to the canal batters and structures caused by vegetation growth. MBRC have advised a notional annual allowance for vegetation removal based on the cost from previous years and this figure has been included in the Maintenance Model by BMT.

MBRC also collect and dispose of litter from within the canal estate on a regular basis, and have advised an annual allowance for inclusion in the Maintenance Model for this activity based upon the planned frequency of litter collection, and costs from previous years.

4.4 Navigation aids and signage

MBRC are responsible for maintaining navigation aids and signage for the canal estate. Existing navigation aids and signs include one set of fixed lateral markers at the entrance to the canal estate, together with various other signs. In order to inform the Maintenance Model of the timing and estimated costs for maintenance of navigation aids and signage, MBRC have advised an annual allowance based on historical expenditure records and this figure has been included in the Maintenance Model by BMT.

Identification and inspection of navigation aids and signage throughout the canal estate was not part of BMT's scope. As such, the actual timing for maintenance and replacement of navigation aids and signs shall be determined on the basis of routine condition inspections.

4.5 Water quality monitoring

MBRC undertake regular water quality monitoring within Pacific Harbour, as part of a regional water quality monitoring program. The water quality monitoring is an important activity as it provides an indication of water quality and an early warning system for potential environmental problems within the canals. This in turn helps to protect and maintain the amenity of the canal estate.

A critical review of the existing water quality monitoring program and monitoring results was undertaken in 2015 by FRC Environmental. Recommended refinements to the existing monitoring program included quarterly sampling in place of monthly, additional analysis parameters, and the preparation of an annual report card (or similar) summarising the monitoring results (FRC Environmental 2015). MBRC have subsequently advised an estimated annual allowance for a revised monitoring program and this figure has been included in the Maintenance Model by BMT.

4.6 Environmental approvals

Canal batter maintenance

Maintenance activities associated with canal batters are expected to be 'excluded works'[3] for the purposes of the *Sustainable Planning Act 2009* to the extent these works do not include replacing or rebuilding greater than 20% of the structure. Excluded works do not require environmental approvals.

Vegetation and litter removal

Removal of marine vegetation from structures is considered to be self-assessable to the extent it is reasonably necessary for the maintenance of existing structures. These works are required to comply with the Department of Agriculture and Fisheries (DAF) code for self-assessable development MPO2. This code places the following limitations of maintenance works:

[3] See DEHP guideline: https://www.ehp.qld.gov.au/coastal/development/pdf/gl-excluded-works-em2734.pdf

- Clearing limited to the footprint of the structure, an area 1m from this footprint and the associated airspace and substrate.
- Notification must be provided to DAF 5-20 days before commencement of works.
- Signage must be displayed at the works site for the duration of the works.

Where clearing is required to go beyond the area allowed for around a structure, a development permit will be required for the work. This is not expected to be the case for any of the proposed maintenance activities.

Navigation aids and signage

Any works involving interference with markers and aids to navigation should be checked with the Regional Harbour Master (RHM). No other approvals are required.

Water quality monitoring

No permits are required for water quality monitoring conducted within the canal estate. However, where water quality monitoring occurs within the MBMP, a marine parks permit is required.

4.7 Planning activities

Various design, planning, and support tasks are required in executing a number of the maintenance activities. Additionally, periodic review of the overall LTMP is required in order to ensure that the plan, including key assumptions and rates, remains up-to-date. These planning activities are briefly discussed in the following sections.

4.7.1 LTMP reviews

It is recommended that the LTMP, including the Maintenance Model, be reviewed and updated every 3-4 years, and that this work includes the following key tasks:

- Detailed assessment and updates to estimated siltation rates.
- Review and update/refinement the overall dredging and dredged material disposal strategy, including review of key sensitive parameters/assumptions.
- Review and update the Dredging Schedule.
- Detailed review of historical expenditure, including executed contract rates and costs.
- Update of the program and rates/costs in the Maintenance Model.

Allowance for periodic review of the LTMP, broadly encompassing these tasks, has been included in the Maintenance Model every 4 years.

4.7.2 Dredging design and planning

Various tasks are required in preparation of and during execution of maintenance dredging works. These include:

- Sediment sampling and analysis – as required by environmental approvals.
- Dredging design and preparation of contract specifications.

- Preparation of the dredging Environmental Management Plan – as required by environmental approvals.
- Tender inputs and assessment (specialist inputs as required to support MBRC).
- Contract support – including independent verification of dredged volumes.
- Environmental monitoring and reporting – as required by environmental approvals.

Accordingly, allowance for the completion of these tasks has been included in the Maintenance Model for each scheduled dredging campaign.

4.7.3 Approvals

With the exception of the previously obtained Marine Park Permit, which expired in 14 May 2015, none of MBRC's existing approvals require renewal. As such, no allowance for periodic renewal of approvals has been included in the Maintenance Model.

4.8 Potential effects of sea level rise

This sub-section has been prepared to briefly discuss the potential impacts of future sea level rise on MBRC's long term maintenance of the canal estate. Sea level rise projections provided in the SEMP are first summarised, followed by discussion of the potential effect on navigation (i.e. maintenance dredging) and general maintenance activities.

4.8.1 Sea level rise projections

Predicted sea level rise is discussed in Section 2.8 of the SEMP (GHD 2011, pp22-25), including projected 50 and 100 year sea level rise amounts and 1:100 year Average Recurrence Interval (ARI) storm tide water levels. The recommended values are summarised in Table 4-1.

Table 4-1 Predicted sea level rise – Bongaree

Year	Projected Sea Level Rise (m)	Mean Sea Level (mAHD)	Storm tide water levels (1:100 yr ARI event) (mAHD)
2000	0.0	-0.04	+1.34
2050	0.3	+0.26	+1.64
2100	0.8	+0.76	+2.14

Source: GHD 2011

On the basis of the projected sea level rise, the mean sea level within the canal estate is expected to rise an average of 6 mm/annum between 2000 and 2050, and 10 mm/annum between 2050 and 2100.

4.8.2 Effect on navigation

The potential effect of sea level rise on the full tidal range (i.e. highest and lowest astronomical tides – HAT and LAT), has not been previously assessed and therefore it is difficult to draw conclusions regarding the subsequent effect on navigation within the canal estate. Notwithstanding, assuming a linear shift of the tidal planes with the Mean Sea Level, LAT will rise at the same rates

and, on the basis of a static bed level, will act to increase navigable depths. As such, sea level rise has the potential to 'offset' siltation within the canal estate.

However, as eluded to above, navigability is principally a function of LAT, not the Mean Sea Level. Further, the sea level rise estimates are predictions only and therefore the actual sea level rise will vary from the predictions. As such, additional assessments would be required to confirm the potential effect of sea level rise on navigation within the canal estate.

4.8.3 Other maintenance activities

The potential effects of sea level rise on MBRC's general maintenance activities is expected to be limited providing existing infrastructure is not materially affected by the expected marginal increases in water levels. The increase in water levels is likely to further limit suitable areas for marine vegetation, and therefore may reduce the frequency and duration of this maintenance activity. No discernible difference in the other maintenance activities is expected as a result of sea level rise.

5 Maintenance Costs

5.1 Cost summary

The estimated annual cost of maintenance for the canal estate over a period of 50 years is $705,000. This cost represents an annual average amount over a 50 year period in 2016 dollars, where the time value of money and inflation is not taken into account. The breakdown of estimated annual maintenance costs into the key areas of dredging and material disposal, and general maintenance (including planning and administration, navigation aids and signage, and water quality monitoring), are summarised as follows:

- Dredging and material disposal - $630,000 /annum.
- General maintenance - $75,000 /annum.

The maintenance items and associated rates used in estimating the long-term maintenance costs are detailed in the updated Maintenance Model, which is discussed in the following section. The key assumptions in the Maintenance Model are also discussed in Section 5.2.1.

5.2 Maintenance Model

The previous Maintenance Model has been updated and is provided in Appendix D. The Maintenance Model includes details of the adopted cost-rates and their basis, a program of maintenance activities (including predicted dredging volumes over the defined 50 year planning period), estimated annual costs for each identified maintenance item, and summarised maintenance costs.

5.2.1 Key assumptions

A number of assumptions have been made in updating the Maintenance Model, and subsequently in estimating the long-term maintenance costs. The key assumptions which underpin the model are briefly discussed in this section.

The maintenance dredging and dredged material disposal costs are based on the proposed dredging schedule and adopted methodology presented in Section 3.7. This includes the outcomes of the completed siltation assessment. Additional key assumptions include:

- A dredged material handling facility will be constructed ready for the scheduled dredging campaign in 2019/20 (Ref. Section 3.7.3).
- Material removed from the dredged material handling area will be treated, and dried to a Moisture Content corresponding to the '*Pond Crust in Truck - Bulked*' material state (i.e. MC 20%) or better and the volumetric and mass conversions from *in situ* are 0.44 and 0.48 respectively.
- The dredged material will require treatment for Potential Acid Sulphate Soils (PASS) via addition of lime or cement stabilisation.
- Future dredged material has otherwise been assumed to be uncontaminated and suitable for land-based or unconfined ocean disposal.

- The applied rates for land-based dredged material disposal options include allowance for treatment, loading and haulage, and a disposal charge.
- A long-term opportunistic fill or beneficial re-use site (or sites) will be secured by MBRC, for the use of Contractors, prior to future dredging and material disposal campaigns (Ref. Section 3.7.1)
- As a specific site and strategy has not yet been secured, the applied rate for 'beneficial re-use site' in the Maintenance Model approximately represents an average rate of the specific options presented in Table 3-8.

5.2.2 Model sensitivity

A specific sensitivity analysis has not been completed on the Maintenance Model. However, based on the calculation methods and assumptions applied in the Model, it is considered that the estimated total long-term maintenance costs are most sensitive to the following parameters and inputs:

- Dredged material volumes – principally the long-term total quantity of material dredged and disposed, which is directly linked to the adopted average long-term siltation rate.
- Dredging technical parameters – specifically the volumetric and mass conversion rates from *in situ* to the material state at disposal, in conjunction with the adopted disposal methodology.
- Dredged material disposal cost rates – including the treatment, loading and haulage, and disposal charge components.

5.2.3 Accuracy of estimate

Inherent uncertainty in the future dredged material volumes, dredging and material disposal methodologies, and various unit cost rates, results in natural uncertainty in the estimated long term maintenance costs. While the original Maintenance Model incorporated a 'Confidence Factor Adjustment' tool to assess the possible range in long-term maintenance costs, BMT have recommended against the application of this existing facility to assess the possible range in cost estimates, owing to the lack of consideration of variability in material volumes and adoption of best practice probabilistic cost estimation methods.

Further, this tool was originally developed and applied as there was previously much greater uncertainty in the unit cost rates for various maintenance activities. The availability of actual costing information for the current LTMP update, via quotes, tendered rates, and expenditure records, has provided a greater degree of certainty in the adopted unit rates, and therefore the overall estimated maintenance costs.

In absence of an appropriate probabilistic cost estimation method, which considers uncertainty in the volumes together with the unit cost rates, and applies best practice methods, it is recommended that MBRC adopt an estimated long-term annual maintenance cost of $705,000.

6 Conclusions

BMT JFA Consultants were commissioned by MBRC in late 2015 to review and update the Pacific Harbour Long-term Maintenance Plan and associated Maintenance Model. The review and update included review of siltation rates, assessment of dredging and material disposal options, development of a recommended dredging and material disposal strategy, and review and update of maintenance cost rates.

Assessment of siltation rates was completed via analysis of hydrographic surveys. The completed assessment indicates an average annual siltation rate of approximately 8,960 m^3/annum within the canal estate. The estimated rate corresponds to the average annual rate determined from hydrographic surveys spanning the seven year period from 2007 to 2014. An estimated long-term average annual siltation volume of 7,900 m^3/annum, which takes into account siltation occurring within over-deepened areas of Voyagers Canal, was subsequently adopted for the purpose of assessing the frequency and volumes of dredging and dredged material disposal campaigns over the specified 50 year planning horizon.

An assessment of dredging and material disposal options was completed, including consideration of site-based constraints such as the narrow canals and navigational constraints of bridges in the area, plus environmental considerations, ultimate disposal and beneficial re-use options, and the economic feasibility of each option. The subsequent recommended dredging and material disposal strategy comprises dredging campaigns every five to six years using a small CSD, with dredged sediment pumped into a new dredged material handling area, treatment (for PASS) and drying of the material, and subsequent beneficial re-use of the material. This option was assessed to be the most cost effective long-term option, and has been successfully employed at similar sites in the region.

The existing Maintenance Model was subsequently updated with revised unit cost rates, dredged material volumes, dredging and material disposal strategies, and maintenance program. A detailed review of historical expenditure records, including review of contracted costs for recent dredging and material disposal contracts at similar sites, together with obtaining additional cost estimates, was undertaken as part of updating existing, and defining new, unit cost rates in the Model.

The estimated annual cost of maintenance for the canal estate over a period of 50 years, in 2016 dollars where the time value of money and inflation is not taken into account, is $705,000. Dredging and material disposal activities represent a significant proportion of the estimated maintenance costs. The breakdown of estimated annual maintenance costs into the areas of dredging and dredged material disposal, and general maintenance are $630,000 and $75,000 respectively.

7 Recommendations

In preparing the updated LTMP, BMT have identified a number of recommended actions. These cover the current shallow bed levels within the canal estate, design and construction of a dredged material handling area, plus additional work to enable better definition of the recommended dredged material ultimate disposal methodology (beneficial re-use) and reduced uncertainty of the estimated long-term maintenance costs. The recommended actions are summarised below:

- Effective communication of current elevated bed levels
- Planning, design and construction of the dredged material handling area
- Dredged material beneficial use and disposal study
- Critical review and update of the dredging technical parameters
- Revision of the uncertainty analysis function within the existing Maintenance Model.

These are each briefly discussed in the following sections.

7.1.1 Current bed levels

As outlined in Section 3.6.2, large areas of the canal estate have reached the dredging trigger level, and dredging is subsequently needed in the short-term. Based on the July 2014 survey, it is estimated that an initial dredging campaign of approximately 80,000 m^3 is required to restore bed levels back to the design level, principally in areas of Skippers Canal and the main southern canal arm (i.e. adjacent the Marina). However, without approval to transit barges beneath the Bribie Island Bridge, or the completion of the proposed dredged material handling area, there are no economically feasible and environmentally acceptable ways to remove the material, and MBRC are therefore unable to conduct maintenance dredging.

Given this, BMT recommend the following actions in the short-term:

- Provide hydrographic survey data to the residents and Harbour Master to ensure that they are informed of the shallow areas and can safely navigate within the canal estate. This may include provision of information regarding tidal levels and vessel draughts to enable tidal access constraints to be determined by residents.
- Consideration to the installation of additional navigation aids within the canal estate to identify shallow areas (or delineation of the deeper/safer areas).
- Expedite the planning, design, and construction of the proposed dredged material handling facility.

7.1.2 Dredged material handling facility

An integral part of the proposed dredging and dredged material disposal strategy is the planning, approval, and construction of a new dredged material handling facility. Further, based on limitations imposed by DTMR on the passage of barges beneath the Bribie Island Bridge, alleviation of the current elevated bed levels is contingent on the construction of this facility. As such, the necessary

planning and engineering design tasks to construct this facility should be conducted as soon as practicable.

As outlined in Section 3.7.3, it is anticipated that the following key tasks will be required (shown in expected chronological order):

- Review of existing studies and LTMP, and subsequent Concept Design Refinement.
- Preliminary liaison with approval agencies (i.e. pre-lodgement meetings).
- Community Engagement, including Cultural Heritage assessment.
- Preliminary Engineering Design (including Geotechnical Investigation) and Construction Cost Estimate, Environmental Assessment, and preparation of Development Applications.
- Approvals acquisition, including:
  - Development Permit for MCU
  - Development Permit for Operational Works (i.e. construction)
  - (potential) Environmental Authority for ERA
- Land acquisition (from the State).
- Settlement of agreed Environmental Offsets.
- Detailed Engineering Design and Specifications.
- Contractor Procurement and Construction.

This list of tasks is based upon development of the facility within the currently proposed site, Lot 42 AP17184.

Environmental and engineering aspects which should be considered in the concept and preliminary design phases include:

- A design basis report (or similar) should be prepared prior to refinement of the concept design.
- The facility should be designed in accordance with appropriate design guidelines, including EM 1110-2-5027 *Engineer Manual - Confined Disposal of Dredged Material* (USACE 1987)
- Sediment settling tests (as defined in EM 1110-2-5027), together with sediment drying tests, should be conducted to inform design calculations.
- Seepage from PASS should be assessed and an ASS Management Plan developed as part of the design.
- Potential impacts to Water (incl. seepage and runoff), Air (incl. dust from the dried fine dredged material), Noise (i.e. due to construction and operational plant operating at the site), should be considered, and appropriate management measures incorporated in the design.
- An Operations manual (or similar) should be developed in conjunction with the engineering design. This will incorporate a summary design basis, and key operational and environmental information for construction and operation of the facility.

7.1.3 Dredged material beneficial use and disposal

The recommended material disposal strategy of beneficial re-use is estimated to represent the most cost effective option. However, the specific details of any necessary material treatment or stabilisation, and final placement site(s) have not yet been determined. Given that the dredged material disposal costs are estimated to represent the single largest component of the total maintenance costs, and there is a large possible range in cost rates for this option, it is strongly recommended that MBRC commission a study to refine this broad option, with an aim of securing all required agreements for beneficial use/disposal of the material and, in doing so, obtaining greater certainty of the associated costs.

The study should consider two primary beneficial re-use options:

- Use as general fill or similar.
- Use for rehabilitation of disused areas of sand/gravel extraction sites or other suitable sites.

Additionally, the study could also consider the potential for treatment and use as garden soil.

Given beneficial use as general fill (either un-treated or cement stabilised) may offer the most economically viable option in the long-term, it is recommended that laboratory tests on the dredged material be undertaken to assess the potential for this use, including:

- Assessment of base engineering and physio-chemical properties
- Trials of material stabilisation using cement and lime

In parallel, it is recommended that MBRC progress the necessary enquiries and investigations to:

- Secure a long-term contract for placement in disused sand/gravel extraction sites as part of a long-term rehabilitation project (or similar); and / or to
- Secure their own specific ultimate dredged material placement site.

It is highlighted that a reliance upon contractors to identify and employ cost effective beneficial re-use strategies may not always yield desirable outcomes, and as such, MBRC should complete additional investigations and studies in order to secure long-term, cost effective options for land-based disposal of dredged material.

7.1.4 Dredging Technical Parameters

As outlined in Section 5.2.2, the estimated costs for disposal are sensitive to the volumetric and mass conversion rates from *in situ* to the material state at disposal. These parameters are applied in the calculation of the final quantities in the model. Additional site specific data was not made available to enable a critical review of these parameters as part of the current study. Given the sensitivity of the applied quantities in the Maintenance Model to these parameters, it is recommended that further investigations be conducted to provide greater certainty of these parameters and their application to various dredging and disposal methods.

Specific investigation and review of the following parameters is recommended:

- *In situ* material densities

- ‘Pond Wet’ densities (i.e. settled material from the Section 19 pond)
- Dried material properties (i.e. ‘Spadeable’ and ‘Pond Crust’)
- Appropriate bulking factors.

It is possible that testing of material to determine the material densities could be conducted in conjunction with the beneficial use laboratory testing and sediment settling testing discussed in Sections 7.1.3 and 7.1.2 respectively.

7.1.5 Model uncertainty

Should MBRC wish to adequately understand uncertainty in the estimated long-term maintenance costs, it is recommended that the existing ‘Confidence Factor Adjustment’ tool within the Maintenance Model be reviewed and updated such that it applies best practice probabilistic cost estimation methods, which consider the inherent uncertainty in the quantities and dredged material parameters as well as the unit cost rates.

8 References

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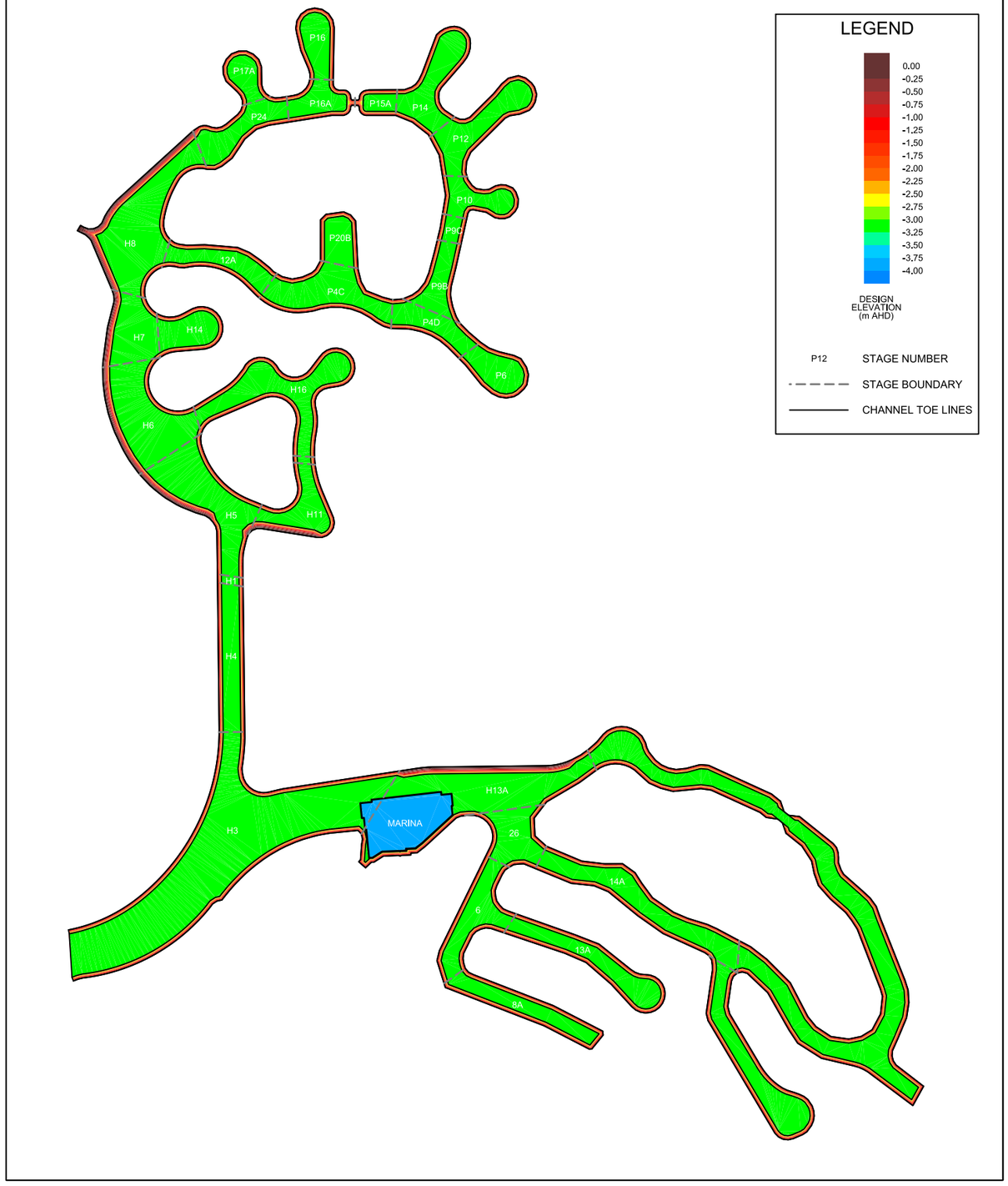
Appendix A Design DTM Plan

PACIFIC HARBOUR DESIGN DTM



LEGEND

DESIGN ELEVATION (m AHD)

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-0.25
-0.50
-0.75
-1.00
-1.25
-1.50
-1.75
-2.00
-2.25
-2.50
-2.75
-3.00
-3.25
-3.50
-3.75
-4.00

P12 STAGE NUMBER

STAGE BOUNDARY

CHANNEL TOE LINES

GENERAL NOTES:

THE DESIGN SURFACE MODEL HAS BEEN DEVELOPED BASED ON AVAILABLE DESIGN DRAWINGS SUPPLIED BY MORETON BAY REGIONAL COUNCIL (REFER TABLE 1 BELOW).
THE SUPPLIED DRAWING SET DOES NOT COVER THE FULL CANAL ESTATE AND THEREFORE ASSUMPTIONS HAVE BEEN MADE IN AREAS NOT COVERED BY THE SUPPLIED DRAWINGS (REFER ASSUMPTIONS BELOW).
IN PREPARING THE DESIGN SURFACE MODEL, BMT JFA CONSULTANTS HAVE NOT INDEPENDENTLY VERIFIED THE ACCURACY OF THE DESIGN DRAWINGS OR THE AS-CONSTRUCTED LEVELS.
THE DESIGN SURFACE MODEL DOES NOT INCLUDE THE LOCATION OF SERVICES, INCLUDING UNDERGROUND SERVICES AND DRAINAGE INFRASTRUCTURE.
THIS DRAWING HAS BEEN ISSUED IN CONNECTION WITH THE DIGITAL FILES NOTED IN TABLE 2. A COPY OF THIS DRAWING SHALL ALWAYS BE KEPT WITH THE DIGITAL FILES

TABLE 1 - MBRC SUPPLIED DESIGN DRAWINGS

PLAN NUMBERS	
6007-2 TO 6007-4	(93104-C2 E, C3 D, C4 C)
6007-10 TO 6007-18	(93104-C12 E, C13 D, C14 B, C15 A, C16 A, C17 A, C18 A, C19 A C20 A)
5245-1 TO 5245-7	(94216-?? A)
5245-8 TO 5245-13	(94253-?? A)
5245-14 & 5245-15	(93104-?? A)
5245-16 TO 5245-20	(95113-C48 1 TO 95113-C54 1)
5245-32 TO 5245-35	
5245-36	(96105-C14 A)
5245-48 TO 5245-52	(96272-C5 2, C51 1, C52 1, C53 1, C54 1)
13-891-001 TO 005	(JD 0311-06-005 SHEETS 1 - 5)
13-892-001 TO 011	(JD 0311-07-047 SHEETS 1 - 11)
13-893-001 TO 010	(JD 0311-07-048 SHEETS 1 - 10)
13-894-001 TO 019	(JD 0311-14-067 SHEETS 1 - 19)
13-896-001 TO 010	(JD 0311-26-029 SHEETS 1 - 10)
8688-C14 E	
8688-C15 E	
8688-C35 D	
8688-C77 A	

TABLE 2 - DIGITAL FILE SUMMARY

DATA	FILE
3D DXF FILE (CONTAINING DESIGN STRINGS, TRIANGLES AND GRID)	PACIFIC_HARBOUR_DESIGN_3D.dxf
0.5m GRIDDED DTM TEXT FILE	PACIFIC_HARBOUR_DESIGN_POINT5mGRIDDED.txt

ASSUMPTIONS:

IN GENERAL, THE STANDARD CROSS-SECTION DETAIL 'RW7' (DWG.REF. 8688-C77) APPLIES THROUGHOUT THE DEVELOPMENT, WITH THE EXCEPTION OF THE NORTHERN AREA OF STAGE H13A AND THE SOUTH AND WESTERN AREAS OF STAGES H5, H6, H7, H8 AND H11 WHERE CROSS-SECTION DETAIL 'RW3' (DWG. REF. 8688-C77) APPLIES.
THE DESIGN DEPTH OF THE MARINA HAS BEEN TAKEN FROM DRAWING JSP-SM-778 16.06.06, BUT THE EXTENT OF THE MARINA BASIN HAS BEEN TAKEN FROM THE CADASTRAL BOUNDARY OF LOT 100 SP214142.
FURTHER, IN PREPARING THE DESIGN SURFACE MODEL, A NUMBER OF ASSUMPTIONS HAVE BEEN NECESSARY, MOST COMMONLY AT THE BOUNDARY OF DEVELOPMENT STAGES AND TRANSITIONS BETWEEN AREAS. THESE ASSUMPTIONS ARE BROADLY OUTLINED BELOW:

- ALL BOUNDARIES NOTED ON THE PLANS WERE ASSUMED TO BE CADASTRAL BOUNDARIES UNLESS NOTED OTHERWISE.
- WHERE NOTED ON THE PLANS, DEPTHS, GRADIENTS, AND DISTANCES WERE MAINTAINED. WHERE THERE WERE DISCREPANCIES BETWEEN THESE CONSTRAINTS DEPTH AND GRADIENT WERE GENERALLY MAINTAINED IN FAVOUR OF DISTANCE.
- WHERE THERE WAS NO TRANSITION, OR THE TRANSITION WAS UNCLEAR ON THE PLANS, A CONSTANTANT GRADIENT WAS MAINTAINED BETWEEN KNOWN POINTS.

DATUMS:

HORIZONTAL DATUM - MAP GRID OF AUSTRALIA BASED ON GDA 94, ZONE 56
VERTICAL DATUM - AUSTRALIAN HEIGHT DATUM

DISCLAIMER:

THE DESIGN SURFACE MODEL HAS BEEN PREPARED FOR THE EXCLUSIVE USE OF MORETON BAY REGIONAL COUNCIL AND IS SUBJECT TO AND ISSUED IN CONNECTION WITH THE PROVISIONS OF THE CONTRACT BETWEEN BMT JFA CONSULTANTS AND MORETON BAY REGIONAL COUNCIL. MORETON BAY REGIONAL COUNCIL SHALL, PRIOR TO THE USE OR APPLICATION OF THE DESIGN SURFACE MODEL, CHECK THE MODEL AND CONFIRM THAT ALL ASSUMPTIONS ARE APPROPRIATE. BMT JFA CONSULTANTS ACCEPTS NO LIABILITY OR RESPONSIBILITY WHATSOEVER, INCLUDING CONSEQUENTIAL LOSSES, FOR OR IN RESPECT OF ANY USE OF OR RELIANCE UPON THE DESIGN SURFACE MODEL BY ANY THIRD PARTY.
THE LOCATION OF SERVICES AND DRAINAGE INFRASTRUCTURE, INCLUDING SUBMERGED DRAINAGE OUTLETS,ARE NOT INCLUDED IN THIS PLAN OR THE DIGITAL FILES. LOCATION OF ALL SUCH INFRASTRUCTURE SHALL BE DETERMINED AND CONFIRMED BY MORTON BAY REGIONAL COUNCIL.

REV	DATE	AMENDMENT	DRN	APP
0	15/08/16	ISSUE FOR USE	SM	
B	27/05/16	AMENDED NOTES	SM	
A	11/05/16	DRAFT ISSUE	SM	

ORIG SIZE A1 | ARCHIVE J15034-03-01_0.dgn

NOTES

SCALE 1 : 6000

50 0 250 500
METRES

DATUM
VERTICAL AHD

HORIZONTAL MAP GRID OF AUSTRALIA BASED ON GDA 94, ZONE 56

GDA

BebbCart

BMT JFA Consultants
"Where will our knowledge take you?"

ENGINEER	J.STEWART	11/05/2016
DRAWN	S.MOUCHEMORE	11/05/2016
DRAFTING CHECK	G.BEBBINGTON	11/05/2016
ENGINEERING CHECK	J.STEWART	11/05/2016
APPROVED PROJECT MGR	J.STEWART	11/05/2016

CLIENT MORETON BAY REGIONAL COUNCIL

PROJECT LONG TERM MAINTENANCE PLAN

TITLE PACIFIC HARBOUR DESIGN DIGITAL TERRAIN MODEL

DRAWING NUMBER J15034 - 03 - 01

REV 0

Appendix B Dredging and Material Disposal Options Assessment Summary

Given the number of potential dredging and material disposal options for maintenance dredging within the canal estate, a qualitative options assessment was conducted. The objective of the assessment was to identify the preferred options on the basis of nominated key factors. The nominated key factors included:

- Technical feasibility (inherent within the options identified), including availability
- Regulatory feasibility
- Timing, including frequency and time to commence option
- Economic feasibility, based on cost-rate for dredging, disposal and any necessary capital costs
- Environmental impact.

While these factors were all considered, no quantitative multi-criteria analysis or similar was undertaken. Notwithstanding, differing weights and preferences for each of the factors have been accounted for in the qualitative assessment.

The following sections summarise the completed assessment.

B.1.1 Preliminary List of Options

The identified options for maintenance dredging within the canal estate consist of three basic elements:

(1) Dredging

(2) Handling/interim storage

(3) Ultimate disposal.

The identified options for the canal estate are presented in Table B-1. This table also identifies the timeframe of the option, categorising all options as either short-term (i.e. ~1 year to commence), medium-term (1-5 years to commence) or long-term (>5 years to commence).

Table B-1 Dredging and material disposal options for Pacific Harbour canal estate

No.	Dredging	Handling/Interim Storage	Disposal	Timing
1	CSD	Dredged Material Handling Facility	Landfill site	Medium
2	CSD	Dredged Material Handling Facility	Other Filling or Rehabilitation site	Medium
3	CSD	Dredged Material Handling Facility	Converted sand/gravel extraction site	Long
4	CSD	Dredged Material Handling Facility	MIDMPA	Medium
5	Grab Dredge	-	MIDMPA	Short
6	Grab Dredge	-	Other placement site	Long
7	CSD	Mobile drying/processing plant (in conjunction with Dredged Material Handling Area for final drying)	Landfill site	Medium
8	CSD	Mobile drying/processing plant (in conjunction with Dredged Material Handling Area for final drying)	Other Filling or Rehabilitation site	Medium
9	CSD	Mobile drying/processing plant (in conjunction with Dredged Material Handling Area for final drying)	Converted sand/gravel extraction site	Medium
10	CSD or Grab Dredge	-	Redistribution within canal estate	Short
11	Grab Dredge	Barge-mounted skips	Landfill or other filling/rehabilitation site	Short
12	CSD	Dredged Material Handling Facility	Beneficial re-use (e.g. construction fill, mulch)	Medium

Of the options in Table B-1, the following were ruled out on the basis of being unfeasible, due to prohibitive cost, lack of availability and/or high regulatory constraint (i.e. highly unlikely to be approved):

- *Option 6: Grab dredging to other unconfined ocean disposal site*. Current regulatory framework in Queensland makes establishment of a new unconfined ocean disposal site unlikely. Existing studies and policy statements prefer the consolidation of unconfined ocean disposal at MIDMPA and do not provide a clear pathway for other sites. Changes in regulatory environment may make this a more viable option in the latter half of the planning period but this is uncertain.
- *Option 10: Redistribution within canal estate*. Redistribution provides a temporary solution but, ultimately, does not have long-term benefits as it does not actually remove the accumulated sediment from the canal system. This option may still be investigated by MBRC as a short-term measure in the future. However, for the purpose of the options assessment, which is focused on long-term options, it has not been considered further.

It is noted that Options 4 and 5 (CSD and Grab dredging to MIDMPA) have not been excluded in spite of the limitations imposed by DTMR on the transit of barges beneath the Bribie Island Bridge in the past. These have been retained in the event that approval is granted for the passage of barges beneath the bridge sometime in the future.

B.1.2 Options Assessment

The remaining options have been assessed in Table B-2 based on a number of key factors. Where necessary, notes have been made in regards to the weighting of particular factors. The factors considered include timing, environmental impact and economic feasibility. Each criteria is given a score of **High**, **Medium** or **Low** based on how suitable it is within the context of the criteria:

- *Timing: Assessment is based on a balance of the time to commence against the siltation rates, i.e. a measure of whether the option can be conducted within the timeframe necessary to dredge the canals. 'High' implies a high score as a result of an expectation that the preferred dredging schedule can be met; 'Low' implies a low score as a result of expected delays to the preferred dredging schedule.*
- *Environmental impact: Considers both environmental effects that not been considered by existing permits, and general environmental impacts. 'High' implies a high score as a result of a likely low environmental impact; 'Low' implies a low score as a result of a likely high environmental impact.*
- *Economic feasibility considers the cost, including capital cost, associated with each part of the dredging lifecycle. 'High' implies a high score due to expected lower relative costs. 'Low' implies a low score as a result of expected higher relative costs*

Based on the completed assessment, the preferred options identified for the Pacific Harbour canal estate are:

- *Most Preferred*: Dredging with a CSD, handling in Dredged Material Handling Facility, treatment and drying, and beneficial re-use of material or disposal for filling/rehabilitation. (Options 12 and 2)
- *Alternative*: Dredging with CSD, handling in Dredged Material Handling Facility, and disposal at landfill. (Options 1 and 7).
- *Alternative*: Dredging with a Grab Dredge, and disposal at MIDMPA (Option 5)

Beneficial re-use is preferred due to lower costs (with potential gain for beneficial re-use options) and low environmental impact. Placement at a landfill site is a suitable alternative option, but was rated lower than the preferred option primarily as a result of the appreciably higher costs associated with this option. The second alternative option of dredging with a grab dredge and disposal at MIDMPA is currently not available to MBRC, but has been retained in the Maintenance Model should approval for the transiting of barges beneath the Bribie Island Bridge be granted in the future.

Table B-2 Assessment of Pacific Harbour canal estate dredging and material disposal options

Option	Time to Commence	Economic Feasibility			Environmental Impact
		Dredging cost	Disposal cost	Capital cost	
1a. CSD to DMHF to Landfill Site (dry material)	**Medium** Option is contingent on the planning, design, and construction of the dredged material handling facility.	**High** Low cost	**Medium** Medium to high cost	**Medium** Construction of DMHF	**High** Activities not expected to cause impacts in excess of project approvals
1b. CSD to DMHF to Landfill Site (wet material)	**Medium** Option is contingent on the planning, design, and construction of the dredged material handling facility.	**High** Low cost	**Low** High cost	**Medium** Construction of DMHF	**High** Activities not expected to cause impacts in excess of project approvals
2. CSD to DMHF to Other Filling or Rehabilitation Site	**Medium** Subject to construction of the DMHF. Also, depends upon availability of re-use sites – rehabilitation or other fill sites are typically available, subject to negotiation.	**High** Low cost	**High** Expected to be low cost but site dependent	**Medium** Construction of DMHF plus possible re-use site costs.	**High** Provides for beneficial use of the material. Environmental management and engineering of external site by others.
3. CSD to DMHF to Converted Sand/Gravel Extraction Site	**Low** Depends upon availability of sites – disused or closing extraction sites are likely to require purchase and appreciable development time prior to use	**High** Low cost	**High** Low cost depending on proximity to Newport	**Low** High cost	**High** Provides for beneficial use of the material.
5. CSD to DMHF to MIDMPA	**Medium** Option is contingent on the planning, design, and construction of the dredged material handling facility, together with approval for the passage of barges beneath the Bribie Island Road Bridge. A Marine Park Permit for placement of material at MIDMPA is also required.	**Medium** Low to Medium dredging cost	**Medium** Medium to high cost to transport material	**Medium** Construction of DMHF plus possible re-use site costs.	**High** Activities not expected to cause impacts in excess of project approvals
5. Grab Dredge to MIDMPA	**Medium** Approval for the passage of barges beneath the Bribie Island Road Bridge is required, together with a Marine Park Permit for placement of material at MIDMPA.	**Medium** Low to Medium dredging cost	**Medium** Medium to high cost to transport material	**High** No cost	**High** Activities not expected to cause impacts in excess of project approvals
~~6. Grab Dredge to Other Offshore Placement Site~~					

Dredging and Material Disposal Options Assessment Summary

Option	Time to Commence	Economic Feasibility			Environmental Impact
		Dredging cost	Disposal cost	Capital cost	
7. CSD to Mobile Drying Plant to Landfill Site	**Medium** Expected to be available in the short to medium term – subject to availability of contractors with suitable mechanical de-watering equipment. No additional approvals, site identification or acquisition required	**Medium** Medium dredging cost to account for additional plant	**Medium** Medium to high cost	**Medium** Construction of Handling Area.	**High** Activities not expected to cause impacts in excess of project approvals
8. CSD to Mobile Drying Plant to Other Filling or Rehabilitation Site	**Medium** Expected to be available in the short to medium term – subject to availability of contractors with suitable mechanical de-watering equipment. No additional approvals, site identification or acquisition required	**Medium** Medium dredging cost to account for additional plant	**High** Expected to be low cost but site dependent	**Medium** Construction of Handling Area plus possible re-use site costs.	**High** Provides for beneficial use of the material. Environmental management and engineering of external site by others.
9. CSD to Mobile Drying Plant to Converted Sand/Grave Extraction Site	**Low** Depends upon availability of sites – disused or closing extraction sites are likely to require purchase and appreciable development time prior to use	**Medium** Medium dredging cost to account for additional plant	**High** Low cost depending on proximity to Newport	**Low** High cost	**High** Provides for beneficial use of the material.
~~10. Redistribution within Canal Estate~~					
11. Grab Dredge to Skip to Landfill Site	**Low** Expected to be available in the short term – subject to availability of contractors with suitable plant.	**Low** Very High dredging costs due to relatively low dredging production rates	**Low** High costs	**Medium** Some costs for establishing barge unloading area(s)	**High** Activities not expected to cause impacts in excess of project approvals
12. CSD to DMHF to Beneficial Re-use	**Medium** Option is contingent on the planning, design, and construction of the dredged material handling facility.	**High** Low costs	**High** Expected to be low cost but dependent on final option(s)	**Medium** Construction of DMHF plus possible re-use site costs.	**High** Activities not expected to cause environmental impacts; re-use is preferred within waste management hierarchy

NB – in regards to environmental impact, 'High' implies a high score as a result of a likely low environmental impact; 'Low' implies a low score as a result of a likely high environmental impact.

Appendix C Proposed Dredging Schedule

Proposed dredging schedule – Schedule

Index	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42			
Canal	Pacific Harbour	Pacific Harbour	Pacific Harbour	Pacific Harbour	Pacific Harbour	Pacific Harbour	Pacific Harbour	Pacific Harbour	Pacific Harbour	Pacific Harbour	Pacific Harbour	Pacific Harbour	Pacific Harbour	Pacific Harbour	Pacific Harbour	Pacific Harbour	Pacific Harbour	Pacific Harbour	Pacific Harbour	Pacific Harbour	Pacific Harbour	Pacific Harbour	Pacific Harbour	Pacific Harbour	Pacific Harbour	Pacific Harbour	Pacific Harbour	Pacific Harbour	Pacific Harbour	Pacific Harbour	Pacific Harbour	Pacific Harbour	Pacific Harbour	Pacific Harbour	Pacific Harbour	Pacific Harbour	Pacific Harbour	Pacific Harbour	Pacific Harbour	Pacific Harbour	Pacific Harbour	Pacific Harbour			
Zone	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	Grand Totals	Residential	Marina (Z5)
2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	392,200	370,700	21,500
2015	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2019	1	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	78,400	78,400	-
2020	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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2025	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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2031	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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2037	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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2043	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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2049	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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2054	1	1	1	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	40,000	40,000	-
2055	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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2060	1	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	53,900	53,900	-
2061	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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2065	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Proposed dredging schedule – Predicted Dredged Material Volumes

PREDICTED DREDGED MATERIAL VOLUMES																																												Totals	Residential	Marina (Z5)
Initial Volumes (m^3)	13,200	15,000	14,000	22,000	6,500	2,400	1,800	1,600	700	1,600	7,100	1,600	500	900	1,000	1,900	500	4,000	900	800	2,000	4,900	2,500	4,300	3,800	3,000	5,300	2,500	1,800	4,700	1,100	700	0	0	2,900	3,000	1,800	1,400	500	1,300	1,500	800	**147,800**	**141,300**	**6,500**
Est. Annual Siltation Vol (m^3)	290	440	420	470	440	130	130	200	90	170	30	310	70	110	80	250	130	240	100	260	180	210	90	140	310	240	270	270	110	160	120	120	30	130	370	120	50	130	40	210	120	120	**7,900**	**7,460**	**440**
2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2019	14,700	17,200	16,100	24,400	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	78,400	78,400	-
2020	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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2024	1,400	2,200	-	-	10,900	3,700	-	-	-	-	7,400	-	-	-	-	4,400	-	6,400	-	-	3,800	-	3,400	5,700	6,900	-	-	-	2,900	-	-	-	-	-	-	-	-	-	-	-	-	-	-	59,100	48,200	10,900
2025	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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2029	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2030	1,700	2,600	4,600	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6,800	9,600	6,800	-	7,300	-	-	-	-	-	-	-	-	-	-	3,400	2,700	45,500	45,500	-
2031	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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2035	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2036	1,800	2,700	-	7,900	-	-	-	-	-	5,300	-	8,400	-	-	-	-	3,400	-	-	6,500	-	3,500	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4,300	-	-	-	-	43,800	43,800	-
2037	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2038	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2039	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2040	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2041	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2042	1,700	2,600	5,100	-	-	-	-	7,200	-	-	-	-	-	4,000	3,200	4,500	-	-	3,700	-	-	-	-	-	-	-	-	-	-	-	4,500	-	-	-	-	6,400	3,200	-	-	-	-	-	46,100	46,100	-
2043	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2044	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2045	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2046	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2047	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2048	1,800	2,700	-	-	10,600	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1,900	8,400	-	-	25,400	14,800	10,600
2049	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2050	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2051	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2052	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2053	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2054	1,700	2,600	5,000	-	-	-	7,000	-	4,300	-	-	-	-	-	-	-	-	-	-	4,700	5,400	3,800	-	-	-	-	-	-	-	-	-	5,500	-	-	-	-	-	-	-	-	-	-	40,000	40,000	-
2055	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2056	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2057	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2058	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2059	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2060	1,700	2,600	-	11,300	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11,200	7,200	-	-	-	-	-	-	-	-	19,900	-	-	-	-	-	-	53,900	53,900	-
2061	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2062	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2063	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2064	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2065	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
																																											392,200	370,700	21,500

Appendix D Maintenance Model

PACIFIC HARBOUR MAINTENANCE MODEL

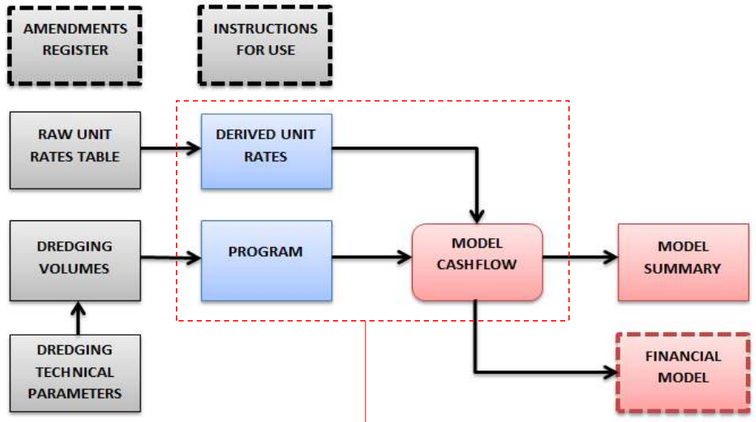
AMENDMENTS REGISTER

DATE	REV No.	BY	DETAILS
04/04/2016	0	BMT JFA	Revised and Updated Maintenance Model - Issued for Use
05/04/2016	1	BMT JFA	Revision to Dredging Volumes - Issued for Use

PACIFIC HARBOUR MAINTENANCE MODEL

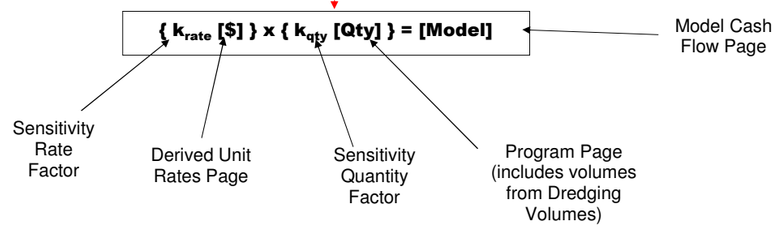
Guidelines on the Use of this Model

Worksheet Data Flow



Note: Worksheet is ordered such that data flows from RIGHT to LEFT. This results in the SUMMARY data being on tabs to the LEFT and INPUT data on tabs to the RIGHT

Governing Equation



Instructions For Use

Prepare the Model and Data Entry

The Spreadsheet is structured so that general input occurs on **RAW UNIT RATES TABLE** and **PROGRAM** pages. Additionally, the **DERIVED UNIT RATES** and **DREDGING VOLUMES** page has adjustable sensitivity factors to model the change of costs and quantities. Otherwise, worksheets show output.

Review **PROGRAM** and **RAW UNIT RATES TABLE** and populate with relevant schedule and costing data respectively. When using the **PROGRAM** worksheet **please note the units** for each item. Only unit-less items may be entered here, as volumes (m^3) are linked to **DREDGING VOLUMES.**

DREDGING TECHNICAL PARAMETERS and **DREDGING VOLUMES** contain information with regards to the major cost item of dredging and spoil disposal. These pages should not be edited without additional geotechnical information, a new dredging schedule, or new spoil disposal systems (except where shown).

Run & Refine Model

The **MODEL CASH FLOW** page is essentially **DERIVED UNIT RATES** x **PROGRAM**, with the addition of subtotals for each section.

The Model may be refined by breaking sections down further or adding new cost items. **This must be done with the care** as data is linked across multiple worksheets to provide relevant output.

Use adjustable sensitivity factor on **DERIVED UNIT RATES** and **DREDGING VOLUMES** pages

Update **AMENDMENTS REGISTER** upon updating model.

Output

MODEL CASH FLOW and **MODEL SUMMARY** pages are output pages, showing a breakdown of costs for given cost items.

It should be noted that all costs shown are 2016 dollars and exclude GST, with no consideration given for inflation

Financial Model Instructions

Instructions for the use of this section are to be written by MBRC as it is developed

Assumptions & Limitations

General

This Maintenance Model has been developed for Moreton Bay Regional Council (MBRC) to assist in the long-term planning and funding of maintenance activities in the Pacific Harbour Canal Estate (Pacific Harbour). While considerable detail is included within the Maintenance Model, it is highlighted that it has been developed as a broad-scale, long-term planning and costing tool. As such, the Maintenance Model should not be used for the detailed planning and execution of maintenance activities - which will generally require separate planning, design, and execution. Further, the Maintenance Model should be reviewed and updated periodically (notionally every 3-4 years) to ensure that the underlying assumptions and rates remain appropriate.

The Maintenance Model should be read and used in conjunction with the associated Long-Term Maintenance Plan report, which documents the key assumptions and parameters that underpin the Model. Additional comments and instructions are also provided within the Maintenance Model worksheets.

PACIFIC HARBOUR MAINTENANCE MODEL

MODEL SUMMARY

			1	2	3	4	5	6	7	8	9	10	11	12	13	14
Budget No.	Component No.	ITEM / DESCRIPTION	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
		1. Residential Canals														
20647	000	1.1 General Maintenance	$ 121,090.00	$ 121,090.00	$ 121,090.00	$ 21,090.00	$ 49,590.00	$ 21,090.00	$ 49,590.00	$ 21,090.00	$ 49,590.00	$ 21,090.00	$ 49,590.00	$ 21,090.00	$ 49,590.00	$ 21,090.00
20788	105	1.2 Dredging	$ -	$ -	$ -	$ 1,451,000.00	$ -	$ -	$ -	$ -	$ 947,280.88	$ -	$ -	$ -	$ -	$ -
20788	107	1.3 Spoil Disposal	$ -	$ 3,752,500.00	$ 3,657,500.00	$ 3,061,200.00	$ -	$ -	$ -	$ -	$ 1,907,447.72	$ -	$ -	$ -	$ -	$ -
20788	106	1.4 Water Quality	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00
20788	104	1.5 Administration	$ -	$ 52,250.00	$ -	$ 33,250.00	$ -	$ -	$ 52,250.00	$ 33,250.00	$ -	$ -	$ -	$ 52,250.00	$ 33,250.00	$ -
		TOTAL	$ 135,340.00	$ 3,940,090.00	$ 3,792,840.00	$ 4,580,790.00	$ 63,840.00	$ 35,340.00	$ 116,090.00	$ 68,590.00	$ 2,918,568.60	$ 35,340.00	$ 63,840.00	$ 87,590.00	$ 97,090.00	$ 35,340.00
		2. Marina														
20647	000	2.1 General Maintenance	$ 2,610.00	$ 1,110.00	$ 2,610.00	$ 1,110.00	$ 2,610.00	$ 1,110.00	$ 2,610.00	$ 1,110.00	$ 2,610.00	$ 1,110.00	$ 2,610.00	$ 1,110.00	$ 2,610.00	$ 1,110.00
20788	105	2.2 Dredging	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 214,219.12	$ -	$ -	$ -	$ -	$ -
20788	107	2.3 Spoil Disposal	$ -	$ 197,500.00	$ 192,500.00	$ -	$ -	$ -	$ -	$ -	$ 431,352.28	$ -	$ -	$ -	$ -	$ -
20788	106	2.4 Water Quality Monitoring	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00
20788	104	2.5 Administration	$ -	$ 2,750.00	$ -	$ 1,750.00	$ -	$ -	$ 2,750.00	$ 1,750.00	$ -	$ -	$ -	$ 2,750.00	$ 1,750.00	$ -
		TOTAL	$ 3,360.00	$ 202,110.00	$ 195,860.00	$ 3,610.00	$ 3,360.00	$ 1,860.00	$ 6,110.00	$ 3,610.00	$ 648,931.40	$ 1,860.00	$ 3,360.00	$ 4,610.00	$ 5,110.00	$ 1,860.00
		3. Canal Walls														
20788	108	3.1 Canal Wall Repairs	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
20788	109	3.2 Canal Wall Replacement	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		TOTAL	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		4. Canal Infrastructure														
20788	110	4.1 Public Pontoon Replacement	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		GRAND TOTAL	$ 138,700.00	$ 4,142,200.00	$ 3,988,700.00	$ 4,584,400.00	$ 67,200.00	$ 37,200.00	$ 122,200.00	$ 72,200.00	$ 3,567,500.00	$ 37,200.00	$ 67,200.00	$ 92,200.00	$ 102,200.00	$ 37,200.00
		ACCUMULATIVE TOTAL	$ 138,700.00	$ 4,280,900.00	$ 8,269,600.00	$ 12,854,000.00	$ 12,921,200.00	$ 12,958,400.00	$ 13,080,600.00	$ 13,152,800.00	$ 16,720,300.00	$ 16,757,500.00	$ 16,824,700.00	$ 16,916,900.00	$ 17,019,100.00	$ 17,056,300.00
		RUNNING AVERAGE FROM 2012	$ 138,700.00	$ 2,140,450.00	$ 2,756,533.33	$ 3,213,500.00	$ 2,584,240.00	$ 2,159,733.33	$ 1,868,657.14	$ 1,644,100.00	$ 1,857,811.11	$ 1,675,750.00	$ 1,529,518.18	$ 1,409,741.67	$ 1,309,161.54	$ 1,218,307.14

Instructions for Model Summary Worksheet
DO NOT MODIFY CELL CONTENTS DIRECTLY
MODIFY RAW UNIT RATES AND PROGRAM SHEETS TO UPDATE DATA.
TO SIMULATE EFFECTS OF COST VARIATION, USE SENSITIVITY FACTORS ON DERIVED UNIT RATES AND DREDGING VOLUMES PAGES (FOR RATES AND QUANTITIES RESPECTIVELY)

PACIFIC HARBOUR MAINTENANCE MODEL

MODEL SUMMARY

			15	16	17	18	19	20	21	22	23	24	25	26	27	28
Budget No.	Component No.	ITEM / DESCRIPTION	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043
		1. Residential Canals														
20647	000	1.1 General Maintenance	$ 49,590.00	$ 21,090.00	$ 49,590.00	$ 21,090.00	$ 49,590.00	$ 21,090.00	$ 49,590.00	$ 21,090.00	$ 49,590.00	$ 21,090.00	$ 49,590.00	$ 21,090.00	$ 49,590.00	$ 21,090.00
20788	105	1.2 Dredging	$ 957,500.00	$ -	$ -	$ -	$ -	$ -	$ 932,000.00	$ -	$ -	$ -	$ -	$ -	$ 966,500.00	$ -
20788	107	1.3 Spoil Disposal	$ 1,822,800.00	$ -	$ -	$ -	$ -	$ -	$ 1,762,600.00	$ -	$ -	$ -	$ -	$ -	$ 1,848,600.00	$ -
20788	106	1.4 Water Quality	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00
20788	104	1.5 Administration	$ -	$ -	$ -	$ 52,250.00	$ 33,250.00	$ -	$ -	$ -	$ -	$ 52,250.00	$ 33,250.00	$ -	$ -	$ -
		TOTAL	$ 2,844,140.00	$ 35,340.00	$ 63,840.00	$ 87,590.00	$ 97,090.00	$ 35,340.00	$ 2,758,440.00	$ 35,340.00	$ 63,840.00	$ 87,590.00	$ 97,090.00	$ 35,340.00	$ 2,878,940.00	$ 35,340.00
		2. Marina														
20647	000	2.1 General Maintenance	$ 2,610.00	$ 1,110.00	$ 2,610.00	$ 1,110.00	$ 2,610.00	$ 1,110.00	$ 2,610.00	$ 1,110.00	$ 2,610.00	$ 1,110.00	$ 2,610.00	$ 1,110.00	$ 2,610.00	$ 1,110.00
20788	105	2.2 Dredging	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
20788	107	2.3 Spoil Disposal	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
20788	106	2.4 Water Quality Monitoring	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00
20788	104	2.5 Administration	$ -	$ -	$ -	$ 2,750.00	$ 1,750.00	$ -	$ -	$ -	$ -	$ 2,750.00	$ 1,750.00	$ -	$ -	$ -
		TOTAL	$ 3,360.00	$ 1,860.00	$ 3,360.00	$ 4,610.00	$ 5,110.00	$ 1,860.00	$ 3,360.00	$ 1,860.00	$ 3,360.00	$ 4,610.00	$ 5,110.00	$ 1,860.00	$ 3,360.00	$ 1,860.00
		3. Canal Walls														
20788	108	3.1 Canal Wall Repairs	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
20788	109	3.2 Canal Wall Replacement	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		TOTAL	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		4. Canal Infrastructure														
20788	110	4.1 Public Pontoon Replacement	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		GRAND TOTAL	$ 2,847,500.00	$ 37,200.00	$ 67,200.00	$ 92,200.00	$ 102,200.00	$ 37,200.00	$ 2,761,800.00	$ 37,200.00	$ 67,200.00	$ 92,200.00	$ 102,200.00	$ 37,200.00	$ 2,882,300.00	$ 37,200.00
		ACCUMULATIVE TOTAL	$ 19,903,800.00	$ 19,941,000.00	$ 20,008,200.00	$ 20,100,400.00	$ 20,202,600.00	$ 20,239,800.00	$ 23,001,600.00	$ 23,038,800.00	$ 23,106,000.00	$ 23,198,200.00	$ 23,300,400.00	$ 23,337,600.00	$ 26,219,900.00	$ 26,257,100.00
		RUNNING AVERAGE FROM 2012	$ 1,326,920.00	$ 1,246,312.50	$ 1,176,952.94	$ 1,116,688.89	$ 1,063,294.74	$ 1,011,990.00	$ 1,095,314.29	$ 1,047,218.18	$ 1,004,608.70	$ 966,591.67	$ 932,016.00	$ 897,600.00	$ 971,107.41	$ 937,753.57

Instructions for Model Summary Worksheet
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PACIFIC HARBOUR MAINTENANCE MODEL

MODEL SUMMARY

			29	30	31	32	33	34	35	36	37	38	39	40	41	42
Budget No.	Component No.	ITEM / DESCRIPTION	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057
		1. Residential Canals														
20647	000	1.1 General Maintenance	$ 49,590.00	$ 21,090.00	$ 49,590.00	$ 21,090.00	$ 49,590.00	$ 21,090.00	$ 49,590.00	$ 21,090.00	$ 49,590.00	$ 21,090.00	$ 49,590.00	$ 21,090.00	$ 49,590.00	$ 21,090.00
20788	105	1.2 Dredging	$ -	$ -	$ -	$ -	$ 382,236.22	$ -	$ -	$ -	$ -	$ -	$ 875,000.00	$ -	$ -	$ -
20788	107	1.3 Spoil Disposal	$ -	$ -	$ -	$ -	$ 626,144.88	$ -	$ -	$ -	$ -	$ -	$ 1,616,400.00	$ -	$ -	$ -
20788	106	1.4 Water Quality	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00
20788	104	1.5 Administration	$ -	$ 52,250.00	$ 33,250.00	$ -	$ -	$ -	$ -	$ 52,250.00	$ 33,250.00	$ -	$ -	$ -	$ -	$ 52,250.00
		TOTAL	$ 63,840.00	$ 87,590.00	$ 97,090.00	$ 35,340.00	$ 1,072,221.10	$ 35,340.00	$ 63,840.00	$ 87,590.00	$ 97,090.00	$ 35,340.00	$ 2,555,240.00	$ 35,340.00	$ 63,840.00	$ 87,590.00
		2. Marina														
20647	000	2.1 General Maintenance	$ 2,610.00	$ 1,110.00	$ 2,610.00	$ 1,110.00	$ 2,610.00	$ 1,110.00	$ 2,610.00	$ 1,110.00	$ 2,610.00	$ 1,110.00	$ 2,610.00	$ 1,110.00	$ 2,610.00	$ 1,110.00
20788	105	2.2 Dredging	$ -	$ -	$ -	$ -	$ 273,763.78	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
20788	107	2.3 Spoil Disposal	$ -	$ -	$ -	$ -	$ 448,455.12	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
20788	106	2.4 Water Quality Monitoring	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00
20788	104	2.5 Administration	$ -	$ 2,750.00	$ 1,750.00	$ -	$ -	$ -	$ -	$ 2,750.00	$ 1,750.00	$ -	$ -	$ -	$ -	$ 2,750.00
		TOTAL	$ 3,360.00	$ 4,610.00	$ 5,110.00	$ 1,860.00	$ 725,578.90	$ 1,860.00	$ 3,360.00	$ 4,610.00	$ 5,110.00	$ 1,860.00	$ 3,360.00	$ 1,860.00	$ 3,360.00	$ 4,610.00
		3. Canal Walls														
20788	108	3.1 Canal Wall Repairs	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
20788	109	3.2 Canal Wall Replacement	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		TOTAL	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		4. Canal Infrastructure														
20788	110	4.1 Public Pontoon Replacement	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		GRAND TOTAL	$ 67,200.00	$ 92,200.00	$ 102,200.00	$ 37,200.00	$ 1,797,800.00	$ 37,200.00	$ 67,200.00	$ 92,200.00	$ 102,200.00	$ 37,200.00	$ 2,558,600.00	$ 37,200.00	$ 67,200.00	$ 92,200.00
		ACCUMULATIVE TOTAL	$ 26,324,300.00	$ 26,416,500.00	$ 26,518,700.00	$ 26,555,900.00	$ 28,353,700.00	$ 28,390,900.00	$ 28,458,100.00	$ 28,550,300.00	$ 28,652,500.00	$ 28,689,700.00	$ 31,248,300.00	$ 31,285,500.00	$ 31,352,700.00	$ 31,444,900.00
		RUNNING AVERAGE FROM 2012	$ 907,734.48	$ 880,550.00	$ 855,441.94	$ 829,871.87	$ 859,203.03	$ 835,026.47	$ 813,088.57	$ 793,063.89	$ 774,391.89	$ 754,992.11	$ 801,238.46	$ 782,137.50	$ 764,700.00	$ 748,688.10

Instructions for Model Summary Worksheet
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PACIFIC HARBOUR MAINTENANCE MODEL

MODEL SUMMARY

			43	44	45	46	47	48	49	50
Budget No.	**Component No.**	**ITEM / DESCRIPTION**	**2058**	**2059**	**2060**	**2061**	**2062**	**2063**	**2064**	**2065**
		1. Residential Canals								
20647	000	**1.1 General Maintenance**	$ 49,590.00	$ 21,090.00	$ 49,590.00	$ 21,090.00	$ 49,590.00	$ 21,090.00	$ 49,590.00	$ 21,090.00
20788	105	**1.2 Dredging**	$ -	$ -	$ 1,083,500.00	$ -	$ -	$ -	$ -	$ -
20788	107	**1.3 Spoil Disposal**	$ -	$ -	$ 2,141,000.00	$ -	$ -	$ -	$ -	$ -
20788	106	**1.4 Water Quality**	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00
20788	104	**1.5 Administration**	$ 33,250.00	$ -	$ -	$ -	$ -	$ 52,250.00	$ 33,250.00	$ -
		TOTAL	$ 97,090.00	$ 35,340.00	$ 3,288,340.00	$ 35,340.00	$ 63,840.00	$ 87,590.00	$ 97,090.00	$ 35,340.00
		2. Marina								
20647	000	**2.1 General Maintenance**	$ 2,610.00	$ 1,110.00	$ 2,610.00	$ 1,110.00	$ 2,610.00	$ 1,110.00	$ 2,610.00	$ 1,110.00
20788	105	**2.2 Dredging**	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
20788	107	**2.3 Spoil Disposal**	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
20788	106	**2.4 Water Quality Monitoring**	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00
20788	104	**2.5 Administration**	$ 1,750.00	$ -	$ -	$ -	$ -	$ 2,750.00	$ 1,750.00	$ -
		TOTAL	$ 5,110.00	$ 1,860.00	$ 3,360.00	$ 1,860.00	$ 3,360.00	$ 4,610.00	$ 5,110.00	$ 1,860.00
		3. Canal Walls								
20788	108	**3.1 Canal Wall Repairs**	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
20788	109	**3.2 Canal Wall Replacement**	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		TOTAL	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		4. Canal Infrastructure								
20788	110	**4.1 Public Pontoon Replacement**	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		GRAND TOTAL	$ 102,200.00	$ 37,200.00	$ 3,291,700.00	$ 37,200.00	$ 67,200.00	$ 92,200.00	$ 102,200.00	$ 37,200.00
		ACCUMULATIVE TOTAL	$ 31,547,100.00	$ 31,584,300.00	$ 34,876,000.00	$ 34,913,200.00	$ 34,980,400.00	$ 35,072,600.00	$ 35,174,800.00	$ 35,212,000.00
		RUNNING AVERAGE FROM 2012	$ 733,653.49	$ 717,825.00	$ 775,022.22	$ 758,982.61	$ 744,263.83	$ 730,679.17	$ 717,853.06	$ 704,240.00

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PACIFIC HARBOUR MAINTENANCE MODEL

MAINTENANCE MODEL CASH FLOW

ITEM / DESCRIPTION	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
1. Residential Canals																		
1.1 General Maintenance																		
Litter collection	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00
Navigation Aid & Signage maintenance	$ 5,700.00	$ 5,700.00	$ 5,700.00	$ 5,700.00	$ 5,700.00	$ 5,700.00	$ 5,700.00	$ 5,700.00	$ 5,700.00	$ 5,700.00	$ 5,700.00	$ 5,700.00	$ 5,700.00	$ 5,700.00	$ 5,700.00	$ 5,700.00	$ 5,700.00	$ 5,700.00
Vegetation removal	$ 1,140.00	$ 1,140.00	$ 1,140.00	$ 1,140.00	$ 1,140.00	$ 1,140.00	$ 1,140.00	$ 1,140.00	$ 1,140.00	$ 1,140.00	$ 1,140.00	$ 1,140.00	$ 1,140.00	$ 1,140.00	$ 1,140.00	$ 1,140.00	$ 1,140.00	$ 1,140.00
Routine canal batter maintenance	$ -	$ -	$ -	$ -	$ 28,500.00	$ -	$ 28,500.00	$ -	$ 28,500.00	$ -	$ 28,500.00	$ -	$ 28,500.00	$ -	$ 28,500.00	$ -	$ 28,500.00	$ -
Canal batter repairs	$ 100,000.00	$ 100,000.00	$ 100,000.00	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
1.2 Dredging																		
Dredging Design, Approvals & Monitoring	$ -	$ -	$ -	$ 100,000.00	$ -	$ -	$ -	$ -	$ 81,556.68	$ -	$ -	$ -	$ -	$ -	$ 100,000.00	$ -	$ -	$ -
Survey	$ -	$ -	$ -	$ 55,000.00	$ -	$ -	$ -	$ -	$ 44,856.18	$ -	$ -	$ -	$ -	$ -	$ 55,000.00	$ -	$ -	$ -
Contract Execution Costs - CSD Dredging	$ -	$ -	$ -	$ 120,000.00	$ -	$ -	$ -	$ -	$ 97,868.02	$ -	$ -	$ -	$ -	$ -	$ 120,000.00	$ -	$ -	$ -
Dredging - Cutter Suction Dredging	$ -	$ -	$ -	$ 1,176,000.00	$ -	$ -	$ -	$ -	$ 723,000.00	$ -	$ -	$ -	$ -	$ -	$ 682,500.00	$ -	$ -	$ -
Contract Execution Costs - Alternative Dredging Methodology	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Dredging & Material Disposal - Alternative Dredging Methodology	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
1.3 Dredged Material Disposal\Re-use																		
Dredged Material Disposal - Contract Execution Costs	$ -	$ -	$ -	$ 120,000.00	$ -	$ -	$ -	$ -	$ 97,868.02	$ -	$ -	$ -	$ -	$ -	$ 120,000.00	$ -	$ -	$ -
Option A - Dispose Dried Material to Landfill	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Option B - Opportunistic Fill / Beneficial Re-use	$ -	$ -	$ -	$ 2,941,200.00	$ -	$ -	$ -	$ -	$ 1,809,579.70	$ -	$ -	$ -	$ -	$ -	$ 1,702,800.00	$ -	$ -	$ -
Dredged Material Handling Facility - Approvals, Design and Construction	$ -	$ -	$ 3,657,500.00	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Dredged Material Handling Facility - Land Acquisition & Offsets	$ -	$ 3,752,500.00	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
1.4 Water Quality Monitoring	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00
1.5 Administration																		
Investigation Hydrographic Survey	$ -	$ 52,250.00	$ -	$ -	$ -	$ -	$ 52,250.00	$ -	$ -	$ -	$ -	$ 52,250.00	$ -	$ -	$ -	$ -	$ -	$ 52,250.00
Review and Update of Maintenance Model	$ -	$ -	$ -	$ 33,250.00	$ -	$ -	$ -	$ 33,250.00	$ -	$ -	$ -	$ -	$ 33,250.00	$ -	$ -	$ -	$ -	$ -
TOTAL	$ 135,340.00	$ 3,940,090.00	$ 3,792,840.00	$ 4,580,790.00	$ 63,840.00	$ 35,340.00	$ 116,090.00	$ 68,590.00	$ 2,918,568.60	$ 35,340.00	$ 63,840.00	$ 87,590.00	$ 97,090.00	$ 35,340.00	$ 2,844,140.00	$ 35,340.00	$ 63,840.00	$ 87,590.00
2. Marina																		
2.1 General Maintenance																		
Litter collection	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00
Navigation Aid & Signage maintenance	$ 300.00	$ 300.00	$ 300.00	$ 300.00	$ 300.00	$ 300.00	$ 300.00	$ 300.00	$ 300.00	$ 300.00	$ 300.00	$ 300.00	$ 300.00	$ 300.00	$ 300.00	$ 300.00	$ 300.00	$ 300.00
Vegetation removal	$ 60.00	$ 60.00	$ 60.00	$ 60.00	$ 60.00	$ 60.00	$ 60.00	$ 60.00	$ 60.00	$ 60.00	$ 60.00	$ 60.00	$ 60.00	$ 60.00	$ 60.00	$ 60.00	$ 60.00	$ 60.00
Routine canal batter maintenance	$ 1,500.00	$ -	$ 1,500.00	$ -	$ 1,500.00	$ -	$ 1,500.00	$ -	$ 1,500.00	$ -	$ 1,500.00	$ -	$ 1,500.00	$ -	$ 1,500.00	$ -	$ 1,500.00	$ -
2.2 Dredging																		
Dredging Design, Approvals & Monitoring	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 18,443.32	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Survey	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 10,143.82	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Contract Execution Costs - CSD Dredging	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 22,131.98	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Dredging - Cutter Suction Dredging	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 163,500.00	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Contract Execution Costs - Alternative Dredging Methodology	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Dredging & Material Disposal - Alternative Dredging Methodology	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2.3 Dredged Material Disposal\Re-use																		
Dredged Material Disposal - Contract Execution Costs	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 22,131.98	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Option A - Dispose Dried Material to Landfill	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Option B - Opportunistic Fill / Beneficial Re-use	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 409,220.30	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Dredged Material Handling Facility - Approvals, Design and Construction	$ -	$ -	$ 192,500.00	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Dredged Material Handling Facility - Land Acquisition & Offsets	$ -	$ 197,500.00	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2.4 Water Quality Monitoring	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00
2.5 Administration																		
Investigation Hydrographic Survey	$ -	$ 2,750.00	$ -	$ -	$ -	$ -	$ 2,750.00	$ -	$ -	$ -	$ -	$ 2,750.00	$ -	$ -	$ -	$ -	$ -	$ 2,750.00
Review and Update of Maintenance Model	$ -	$ -	$ -	$ 1,750.00	$ -	$ -	$ -	$ 1,750.00	$ -	$ -	$ -	$ -	$ 1,750.00	$ -	$ -	$ -	$ -	$ -
TOTAL	$ 3,360.00	$ 202,110.00	$ 195,860.00	$ 3,610.00	$ 3,360.00	$ 1,860.00	$ 6,110.00	$ 3,610.00	$ 648,931.40	$ 1,860.00	$ 3,360.00	$ 4,610.00	$ 5,110.00	$ 1,860.00	$ 3,360.00	$ 1,860.00	$ 3,360.00	$ 4,610.00
3. Canal Walls																		
3.1 Canal Wall Repair	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
3.2 Canal Wall Replacement	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
TOTAL	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
4. Canal Infrastructure																		
4.1 Public Pontoon Replacement	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Grand Total	$ 138,700.00	$ 4,142,200.00	$ 3,988,700.00	$ 4,584,400.00	$ 67,200.00	$ 37,200.00	$ 122,200.00	$ 72,200.00	$ 3,567,500.00	$ 37,200.00	$ 67,200.00	$ 92,200.00	$ 102,200.00	$ 37,200.00	$ 2,847,500.00	$ 37,200.00	$ 67,200.00	$ 92,200.00
Cumulative Total	$ 138,700.00	$ 4,280,900.00	$ 8,269,600.00	$ 12,854,000.00	$ 12,921,200.00	$ 12,958,400.00	$ 13,080,600.00	$ 13,152,800.00	$ 16,720,300.00	$ 16,757,500.00	$ 16,824,700.00	$ 16,916,900.00	$ 17,019,100.00	$ 17,056,300.00	$ 19,903,800.00	$ 19,941,000.00	$ 20,008,200.00	$ 20,100,400.00
Running Average from 2016	$ 138,700.00	$ 2,140,450.00	$ 2,756,533.33	$ 3,213,500.00	$ 2,584,240.00	$ 2,159,733.33	$ 1,868,657.14	$ 1,644,100.00	$ 1,857,811.11	$ 1,675,750.00	$ 1,529,518.18	$ 1,409,741.67	$ 1,309,161.54	$ 1,218,307.14	$ 1,326,920.00	$ 1,246,312.50	$ 1,176,952.94	$ 1,116,688.89

Instructions for Model Cash Flow Worksheet
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(FOR RATES AND QUANTITIES RESPECTIVELY)

PACIFIC HARBOUR MAINTENANCE MODEL

MAINTENANCE MODEL CASH FLOW

ITEM / DESCRIPTION	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051
1. Residential Canals																		
1.1 General Maintenance																		
Litter collection	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00
Navigation Aid & Signage maintenance	$ 5,700.00	$ 5,700.00	$ 5,700.00	$ 5,700.00	$ 5,700.00	$ 5,700.00	$ 5,700.00	$ 5,700.00	$ 5,700.00	$ 5,700.00	$ 5,700.00	$ 5,700.00	$ 5,700.00	$ 5,700.00	$ 5,700.00	$ 5,700.00	$ 5,700.00	$ 5,700.00
Vegetation removal	$ 1,140.00	$ 1,140.00	$ 1,140.00	$ 1,140.00	$ 1,140.00	$ 1,140.00	$ 1,140.00	$ 1,140.00	$ 1,140.00	$ 1,140.00	$ 1,140.00	$ 1,140.00	$ 1,140.00	$ 1,140.00	$ 1,140.00	$ 1,140.00	$ 1,140.00	$ 1,140.00
Routine canal batter maintenance	$ 28,500.00	$ -	$ 28,500.00	$ -	$ 28,500.00	$ -	$ 28,500.00	$ -	$ 28,500.00	$ -	$ 28,500.00	$ -	$ 28,500.00	$ -	$ 28,500.00	$ -	$ 28,500.00	$ -
Canal batter repairs	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
1.2 Dredging																		
Dredging Design, Approvals & Monitoring	$ -	$ -	$ 100,000.00	$ -	$ -	$ -	$ -	$ -	$ 100,000.00	$ -	$ -	$ -	$ -	$ -	$ 58,267.72	$ -	$ -	$ -
Survey	$ -	$ -	$ 55,000.00	$ -	$ -	$ -	$ -	$ -	$ 55,000.00	$ -	$ -	$ -	$ -	$ -	$ 32,047.24	$ -	$ -	$ -
Contract Execution Costs - CSD Dredging	$ -	$ -	$ 120,000.00	$ -	$ -	$ -	$ -	$ -	$ 120,000.00	$ -	$ -	$ -	$ -	$ -	$ 69,921.26	$ -	$ -	$ -
Dredging - Cutter Suction Dredging	$ -	$ -	$ 657,000.00	$ -	$ -	$ -	$ -	$ -	$ 691,500.00	$ -	$ -	$ -	$ -	$ -	$ 222,000.00	$ -	$ -	$ -
Contract Execution Costs - Alternative Dredging Methodology	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Dredging & Material Disposal - Alternative Dredging Methodology	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
1.3 Dredged Material Disposal\Re-use																		
Dredged Material Disposal - Contract Execution Costs	$ -	$ -	$ 120,000.00	$ -	$ -	$ -	$ -	$ -	$ 120,000.00	$ -	$ -	$ -	$ -	$ -	$ 69,921.26	$ -	$ -	$ -
Option A - Dispose Dried Material to Landfill	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Option B - Opportunistic Fill / Beneficial Re-use	$ -	$ -	$ 1,642,600.00	$ -	$ -	$ -	$ -	$ -	$ 1,728,600.00	$ -	$ -	$ -	$ -	$ -	$ 556,223.62	$ -	$ -	$ -
Dredged Material Handling Facility - Approvals, Design and Construction	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Dredged Material Handling Facility - Land Acquisition & Offsets	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
1.4 Water Quality Monitoring	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00
1.5 Administration																		
Investigation Hydrographic Survey	$ -	$ -	$ -	$ -	$ -	$ 52,250.00	$ -	$ -	$ -	$ -	$ -	$ 52,250.00	$ -	$ -	$ -	$ -	$ -	$ 52,250.00
Review and Update of Maintenance Model	$ 33,250.00	$ -	$ -	$ -	$ -	$ -	$ 33,250.00	$ -	$ -	$ -	$ -	$ -	$ 33,250.00	$ -	$ -	$ -	$ -	$ -
TOTAL	$ 97,090.00	$ 35,340.00	$ 2,758,440.00	$ 35,340.00	$ 63,840.00	$ 87,590.00	$ 97,090.00	$ 35,340.00	$ 2,878,940.00	$ 35,340.00	$ 63,840.00	$ 87,590.00	$ 97,090.00	$ 35,340.00	$ 1,072,221.10	$ 35,340.00	$ 63,840.00	$ 87,590.00
2. Marina																		
2.1 General Maintenance																		
Litter collection	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00
Navigation Aid & Signage maintenance	$ 300.00	$ 300.00	$ 300.00	$ 300.00	$ 300.00	$ 300.00	$ 300.00	$ 300.00	$ 300.00	$ 300.00	$ 300.00	$ 300.00	$ 300.00	$ 300.00	$ 300.00	$ 300.00	$ 300.00	$ 300.00
Vegetation removal	$ 60.00	$ 60.00	$ 60.00	$ 60.00	$ 60.00	$ 60.00	$ 60.00	$ 60.00	$ 60.00	$ 60.00	$ 60.00	$ 60.00	$ 60.00	$ 60.00	$ 60.00	$ 60.00	$ 60.00	$ 60.00
Routine canal batter maintenance	$ 1,500.00	$ -	$ 1,500.00	$ -	$ 1,500.00	$ -	$ 1,500.00	$ -	$ 1,500.00	$ -	$ 1,500.00	$ -	$ 1,500.00	$ -	$ 1,500.00	$ -	$ 1,500.00	$ -
2.2 Dredging																		
Dredging Design, Approvals & Monitoring	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 41,732.28	$ -	$ -	$ -
Survey	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 22,952.76	$ -	$ -	$ -
Contract Execution Costs - CSD Dredging	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 50,078.74	$ -	$ -	$ -
Dredging - Cutter Suction Dredging	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 159,000.00	$ -	$ -	$ -
Contract Execution Costs - Alternative Dredging Methodology	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Dredging & Material Disposal - Alternative Dredging Methodology	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2.3 Dredged Material Disposal\Re-use																		
Dredged Material Disposal - Contract Execution Costs	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 50,078.74	$ -	$ -	$ -
Option A - Dispose Dried Material to Landfill	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Option B - Opportunistic Fill / Beneficial Re-use	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 398,376.38	$ -	$ -	$ -
Dredged Material Handling Facility - Approvals, Design and Construction	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Dredged Material Handling Facility - Land Acquisition & Offsets	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2.4 Water Quality Monitoring	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00
2.5 Administration																		
Investigation Hydrographic Survey	$ -	$ -	$ -	$ -	$ -	$ 2,750.00	$ -	$ -	$ -	$ -	$ -	$ 2,750.00	$ -	$ -	$ -	$ -	$ -	$ 2,750.00
Review and Update of Maintenance Model	$ 1,750.00	$ -	$ -	$ -	$ -	$ -	$ 1,750.00	$ -	$ -	$ -	$ -	$ -	$ 1,750.00	$ -	$ -	$ -	$ -	$ -
TOTAL	$ 5,110.00	$ 1,860.00	$ 3,360.00	$ 1,860.00	$ 3,360.00	$ 4,610.00	$ 5,110.00	$ 1,860.00	$ 3,360.00	$ 1,860.00	$ 3,360.00	$ 4,610.00	$ 5,110.00	$ 1,860.00	$ 725,578.90	$ 1,860.00	$ 3,360.00	$ 4,610.00
3. Canal Walls																		
3.1 Canal Wall Repair	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
3.2 Canal Wall Replacement	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
TOTAL	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
4. Canal Infrastructure																		
4.1 Public Pontoon Replacement	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Grand Total	$ 102,200.00	$ 37,200.00	$ 2,761,800.00	$ 37,200.00	$ 67,200.00	$ 92,200.00	$ 102,200.00	$ 37,200.00	$ 2,882,300.00	$ 37,200.00	$ 67,200.00	$ 92,200.00	$ 102,200.00	$ 37,200.00	$ 1,797,800.00	$ 37,200.00	$ 67,200.00	$ 92,200.00
Cumulative Total	$ 20,202,600.00	$ 20,239,800.00	$ 23,001,600.00	$ 23,038,800.00	$ 23,106,000.00	$ 23,198,200.00	$ 23,300,400.00	$ 23,337,600.00	$ 26,219,900.00	$ 26,257,100.00	$ 26,324,300.00	$ 26,416,500.00	$ 26,518,700.00	$ 26,555,900.00	$ 28,353,700.00	$ 28,390,900.00	$ 28,458,100.00	$ 28,550,300.00
Running Average from 2016	$ 1,063,294.74	$ 1,011,990.00	$ 1,095,314.29	$ 1,047,218.18	$ 1,004,608.70	$ 966,591.67	$ 932,016.00	$ 897,600.00	$ 971,107.41	$ 937,753.57	$ 907,734.48	$ 880,550.00	$ 855,441.94	$ 829,871.87	$ 859,203.03	$ 835,026.47	$ 813,088.57	$ 793,063.89

Instructions for Model Cash Flow Worksheet
DO NOT MODIFY CELL CONTENTS DIRECTLY
MODIFY UNIT RATES AND PROGRAM SHEETS TO UPDATE DATA.
TO SIMULATE EFFECTS OF COST VARIATION, USE SENSITIVITY FACTORS
ON DERIVED UNIT RATES AND DREDGING VOLUMES PAGES
(FOR RATES AND QUANTITIES RESPECTIVELY)

PACIFIC HARBOUR MAINTENANCE MODEL

MAINTENANCE MODEL CASH FLOW

ITEM / DESCRIPTION	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065
1. Residential Canals														
1.1 General Maintenance														
Litter collection	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00
Navigation Aid & Signage maintenance	$ 5,700.00	$ 5,700.00	$ 5,700.00	$ 5,700.00	$ 5,700.00	$ 5,700.00	$ 5,700.00	$ 5,700.00	$ 5,700.00	$ 5,700.00	$ 5,700.00	$ 5,700.00	$ 5,700.00	$ 5,700.00
Vegetation removal	$ 1,140.00	$ 1,140.00	$ 1,140.00	$ 1,140.00	$ 1,140.00	$ 1,140.00	$ 1,140.00	$ 1,140.00	$ 1,140.00	$ 1,140.00	$ 1,140.00	$ 1,140.00	$ 1,140.00	$ 1,140.00
Routine canal batter maintenance	$ 28,500.00	$ -	$ 28,500.00	$ -	$ 28,500.00	$ -	$ 28,500.00	$ -	$ 28,500.00	$ -	$ 28,500.00	$ -	$ 28,500.00	$ -
Canal batter repairs	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
1.2 Dredging														
Dredging Design, Approvals & Monitoring	$ -	$ -	$ 100,000.00	$ -	$ -	$ -	$ -	$ -	$ 100,000.00	$ -	$ -	$ -	$ -	$ -
Survey	$ -	$ -	$ 55,000.00	$ -	$ -	$ -	$ -	$ -	$ 55,000.00	$ -	$ -	$ -	$ -	$ -
Contract Execution Costs - CSD Dredging	$ -	$ -	$ 120,000.00	$ -	$ -	$ -	$ -	$ -	$ 120,000.00	$ -	$ -	$ -	$ -	$ -
Dredging - Cutter Suction Dredging	$ -	$ -	$ 600,000.00	$ -	$ -	$ -	$ -	$ -	$ 808,500.00	$ -	$ -	$ -	$ -	$ -
Contract Execution Costs - Alternative Dredging Methodology	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Dredging & Material Disposal - Alternative Dredging Methodology	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
1.3 Dredged Material Disposal\Re-use														
Dredged Material Disposal - Contract Execution Costs	$ -	$ -	$ 120,000.00	$ -	$ -	$ -	$ -	$ -	$ 120,000.00	$ -	$ -	$ -	$ -	$ -
Option A - Dispose Dried Material to Landfill	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Option B - Opportunistic Fill / Beneficial Re-use	$ -	$ -	$ 1,496,400.00	$ -	$ -	$ -	$ -	$ -	$ 2,021,000.00	$ -	$ -	$ -	$ -	$ -
Dredged Material Handling Facility - Approvals, Design and Construction	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Dredged Material Handling Facility - Land Acquisition & Offsets	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
1.4 Water Quality Monitoring	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00	$ 14,250.00
1.5 Administration														
Investigation Hydrographic Survey	$ -	$ -	$ -	$ -	$ -	$ 52,250.00	$ -	$ -	$ -	$ -	$ -	$ 52,250.00	$ -	$ -
Review and Update of Maintenance Model	$ 33,250.00	$ -	$ -	$ -	$ -	$ -	$ 33,250.00	$ -	$ -	$ -	$ -	$ -	$ 33,250.00	$ -
TOTAL	$ 97,090.00	$ 35,340.00	$ 2,555,240.00	$ 35,340.00	$ 63,840.00	$ 87,590.00	$ 97,090.00	$ 35,340.00	$ 3,288,340.00	$ 35,340.00	$ 63,840.00	$ 87,590.00	$ 97,090.00	$ 35,340.00
2. Marina														
2.1 General Maintenance														
Litter collection	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00
Navigation Aid & Signage maintenance	$ 300.00	$ 300.00	$ 300.00	$ 300.00	$ 300.00	$ 300.00	$ 300.00	$ 300.00	$ 300.00	$ 300.00	$ 300.00	$ 300.00	$ 300.00	$ 300.00
Vegetation removal	$ 60.00	$ 60.00	$ 60.00	$ 60.00	$ 60.00	$ 60.00	$ 60.00	$ 60.00	$ 60.00	$ 60.00	$ 60.00	$ 60.00	$ 60.00	$ 60.00
Routine canal batter maintenance	$ 1,500.00	$ -	$ 1,500.00	$ -	$ 1,500.00	$ -	$ 1,500.00	$ -	$ 1,500.00	$ -	$ 1,500.00	$ -	$ 1,500.00	$ -
2.2 Dredging														
Dredging Design, Approvals & Monitoring	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Survey	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Contract Execution Costs - CSD Dredging	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Dredging - Cutter Suction Dredging	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Contract Execution Costs - Alternative Dredging Methodology	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Dredging & Material Disposal - Alternative Dredging Methodology	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2.3 Dredged Material Disposal\Re-use														
Dredged Material Disposal - Contract Execution Costs	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Option A - Dispose Dried Material to Landfill	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Option B - Opportunistic Fill / Beneficial Re-use	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Dredged Material Handling Facility - Approvals, Design and Construction	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Dredged Material Handling Facility - Land Acquisition & Offsets	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2.4 Water Quality Monitoring	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00	$ 750.00
2.5 Administration														
Investigation Hydrographic Survey	$ -	$ -	$ -	$ -	$ -	$ 2,750.00	$ -	$ -	$ -	$ -	$ -	$ 2,750.00	$ -	$ -
Review and Update of Maintenance Model	$ 1,750.00	$ -	$ -	$ -	$ -	$ -	$ 1,750.00	$ -	$ -	$ -	$ -	$ -	$ 1,750.00	$ -
TOTAL	$ 5,110.00	$ 1,860.00	$ 3,360.00	$ 1,860.00	$ 3,360.00	$ 4,610.00	$ 5,110.00	$ 1,860.00	$ 3,360.00	$ 1,860.00	$ 3,360.00	$ 4,610.00	$ 5,110.00	$ 1,860.00
3. Canal Walls														
3.1 Canal Wall Repair	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
3.2 Canal Wall Replacement	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
TOTAL	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
4. Canal Infrastructure														
4.1 Public Pontoon Replacement	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Grand Total	$ 102,200.00	$ 37,200.00	$ 2,558,600.00	$ 37,200.00	$ 67,200.00	$ 92,200.00	$ 102,200.00	$ 37,200.00	$ 3,291,700.00	$ 37,200.00	$ 67,200.00	$ 92,200.00	$ 102,200.00	$ 37,200.00
Cumulative Total	$ 28,652,500.00	$ 28,689,700.00	$ 31,248,300.00	$ 31,285,500.00	$ 31,352,700.00	$ 31,444,900.00	$ 31,547,100.00	$ 31,584,300.00	$ 34,876,000.00	$ 34,913,200.00	$ 34,980,400.00	$ 35,072,600.00	$ 35,174,800.00	$ 35,212,000.00
Running Average from 2016	$ 774,391.89	$ 754,992.11	$ 801,238.46	$ 782,137.50	$ 764,700.00	$ 748,688.10	$ 733,653.49	$ 717,825.00	$ 775,022.22	$ 758,982.61	$ 744,263.83	$ 730,679.17	$ 717,853.06	$ 704,240.00

Instructions for Model Cash Flow Worksheet
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(FOR RATES AND QUANTITIES RESPECTIVELY)

PACIFIC HARBOUR MAINTENANCE MODEL

MAINTENANCE MODEL PROGRAM (QUANTITIES TIME SERIES)

ITEM / DESCRIPTION	Units	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
1. Residential Canals																															
1.1 General Maintenance																															
Litter collection	(-)	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Navigation Aid & Signage maintenance	(-)	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Vegetation removal	(-)	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Routine canal batter maintenance	(-)					0.95		0.95		0.95		0.95		0.95		0.95		0.95		0.95		0.95		0.95		0.95		0.95		0.95	
Canal batter repairs	(-)	1	1	1																											
1.2 Dredging																															
Dredging Design, Approvals & Monitoring	(-)	-	-	-	1.00	-	-	-	-	0.82	-	-	-	-	-	1.00	-	-	-	-	-	1.00	-	-	-	-	-	1.00	-	-	-
Survey	(-)	-	-	-	1.00	-	-	-	-	0.82	-	-	-	-	-	1.00	-	-	-	-	-	1.00	-	-	-	-	-	1.00	-	-	-
Contract Execution Costs - CSD Dredging	(-)	-	-	-	1.00	-	-	-	-	0.82	-	-	-	-	-	1.00	-	-	-	-	-	1.00	-	-	-	-	-	1.00	-	-	-
Dredging - Cutter Suction Dredging	m^3	-	-	-	78,400	-	-	-	-	48,200	-	-	-	-	-	45,500	-	-	-	-	-	43,800	-	-	-	-	-	46,100	-	-	-
Contract Execution Costs - Alternative Dredging Methodology	(-)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dredging & Material Disposal - Alternative Dredging Methodology	m^3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.3 Dredged Material Disposal\Re-use																															
Dredged Material Disposal - Contract Execution Costs	(-)	-	-	-	1.00	-	-	-	-	0.82	-	-	-	-	-	1.00	-	-	-	-	-	1.00	-	-	-	-	-	1.00	-	-	-
☐ Option A - Dispose Dried Material to Landfill	m^3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
☑ Option B - Opportunistic Fill / Beneficial Re-use	m^3	-	-	-	34,200	-	-	-	-	21,042	-	-	-	-	-	19,800	-	-	-	-	-	19,100	-	-	-	-	-	20,100	-	-	-
Dredged Material Handling Facility - Approvals, Design and Construction	(-)			0.95																											
Dredged Material Handling Facility - Land Acquisition & Offsets	(-)		0.95																												
1.4 Water Quality Monitoring	(-)	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
1.5 Administration																															
Investigation Hydrographic Survey	(-)		0.95					0.95					0.95						0.95						0.95						0.95
Review and Update of Maintenance Model	(-)				0.95				0.95					0.95						0.95						0.95					
2. Marina																															
2.1 General Maintenance																															
Litter collection	(-)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Navigation Aid & Signage maintenance	(-)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Vegetation removal	(-)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Routine canal batter maintenance	(-)	0.05		0.05		0.05		0.05		0.05		0.05		0.05		0.05		0.05		0.05		0.05		0.05		0.05		0.05		0.05	
2.2 Dredging																															
Dredging Design, Approvals & Monitoring	(-)	-	-	-	-	-	-	-	-	0.18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Survey	(-)	-	-	-	-	-	-	-	-	0.18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Contract Execution Costs - CSD Dredging	(-)	-	-	-	-	-	-	-	-	0.18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dredging - Cutter Suction Dredging	m^3	-	-	-	-	-	-	-	-	10,900	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Contract Execution Costs - Alternative Dredging Methodology	(-)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dredging & Material Disposal - Alternative Dredging Methodology	m^3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2.3 Dredged Material Disposal\Re-use																															
Dredged Material Disposal - Contract Execution Costs	(-)	-	-	-	-	-	-	-	-	0.18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
☐ Option A - Dispose Dried Material to Landfill	m^3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
☑ Option B - Opportunistic Fill / Beneficial Re-use	m^3	-	-	-	-	-	-	-	-	4,758	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dredged Material Handling Facility - Approvals, Design and Construction	(-)			0.05																											
Dredged Material Handling Facility - Land Acquisition & Offsets	(-)		0.05																												
2.4 Water Quality Monitoring	(-)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
2.5 Administration																															
Investigation Hydrographic Survey	(-)		0.05					0.05					0.05						0.05						0.05						0.05
Review and Update of Maintenance Model	(-)				0.05				0.05					0.05						0.05						0.05					
3. Canal Walls																															
3.1 Canal Wall Repair	m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3.2 Canal Wall Replacement	m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4. Canal Infrastructure																															
4.1 Public Pontoon Replacement	# of	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Instructions for Model Sensitivity Worksheet
MODIFY DIMENSIONLESS EVENTS BY INSERTING THE NUMBER OF EVENTS FOR THAT YEAR.
DO NOT MODIFY CELLS IN THIS SPREADSHEET WHICH APPEAR IN BROWN, AS THEY ARE LINKED TO DREDGING VOLUMES WORKSHEET. MODIFY BLUE CELLS.
THIS WORKSHEET IS THEN MULTIPLIED BY THE COSTS WORKSHEET TO PRODUCE COSTS FOR EACH ITEM
IN EVENT THAT COSTS ITEMS ARE SHARED BETWEEN 'RESIDENTIAL' & 'MARINA' SECTIONS,
PLACE A FRACTION IN EACH CELL FOR DISTRIBUTION OF COSTS (TO SUM TO 1)

PACIFIC HARBOUR MAINTENANCE MODEL

MAINTENANCE MODEL PROGRAM (QUANTITIES TIME SERIES)

ITEM / DESCRIPTION	Units	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065
1. Residential Canals																					
1.1 General Maintenance																					
Litter collection	(-)	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Navigation Aid & Signage maintenance	(-)	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Vegetation removal	(-)	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Routine canal batter maintenance	(-)	0.95		0.95		0.95		0.95		0.95		0.95		0.95		0.95		0.95		0.95	
Canal batter repairs	(-)																				
1.2 Dredging																					
Dredging Design, Approvals & Monitoring	(-)	-	-	0.58	-	-	-	-	-	1.00	-	-	-	-	-	1.00	-	-	-	-	-
Survey	(-)	-	-	0.58	-	-	-	-	-	1.00	-	-	-	-	-	1.00	-	-	-	-	-
Contract Execution Costs - CSD Dredging	(-)	-	-	0.58	-	-	-	-	-	1.00	-	-	-	-	-	1.00	-	-	-	-	-
Dredging - Cutter Suction Dredging	m^3	-	-	14,800	-	-	-	-	-	40,000	-	-	-	-	-	53,900	-	-	-	-	-
Contract Execution Costs - Alternative Dredging Methodology	(-)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dredging & Material Disposal - Alternative Dredging Methodology	m^3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.3 Dredged Material Disposal\Re-use																					
Dredged Material Disposal - Contract Execution Costs	(-)	-	-	0.58	-	-	-	-	-	1.00	-	-	-	-	-	1.00	-	-	-	-	-
☐ Option A - Dispose Dried Material to Landfill	m^3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
☑ Option B - Opportunistic Fill / Beneficial Re-use	m^3	-	-	6,468	-	-	-	-	-	17,400	-	-	-	-	-	23,500	-	-	-	-	-
Dredged Material Handling Facility - Approvals, Design and Construction	(-)																				
Dredged Material Handling Facility - Land Acquisition & Offsets	(-)																				
1.4 Water Quality Monitoring	(-)	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
1.5 Administration																					
Investigation Hydrographic Survey	(-)						0.95						0.95						0.95		
Review and Update of Maintenance Model	(-)	0.95						0.95						0.95						0.95	
2. Marina																					
2.1 General Maintenance																					
Litter collection	(-)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Navigation Aid & Signage maintenance	(-)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Vegetation removal	(-)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Routine canal batter maintenance	(-)	0.05		0.05		0.05		0.05		0.05		0.05		0.05		0.05		0.05		0.05	
2.2 Dredging																					
Dredging Design, Approvals & Monitoring	(-)	-	-	0.42	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Survey	(-)	-	-	0.42	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Contract Execution Costs - CSD Dredging	(-)	-	-	0.42	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dredging - Cutter Suction Dredging	m^3	-	-	10,600	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Contract Execution Costs - Alternative Dredging Methodology	(-)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dredging & Material Disposal - Alternative Dredging Methodology	m^3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2.3 Dredged Material Disposal\Re-use																					
Dredged Material Disposal - Contract Execution Costs	(-)	-	-	0.42	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
☐ Option A - Dispose Dried Material to Landfill	m^3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
☑ Option B - Opportunistic Fill / Beneficial Re-use	m^3	-	-	4,632	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dredged Material Handling Facility - Approvals, Design and Construction	(-)																				
Dredged Material Handling Facility - Land Acquisition & Offsets	(-)																				
2.4 Water Quality Monitoring	(-)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
2.5 Administration																					
Investigation Hydrographic Survey	(-)						0.05						0.05						0.05		
Review and Update of Maintenance Model	(-)	0.05						0.05						0.05						0.05	
3. Canal Walls																					
3.1 Canal Wall Repair	m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3.2 Canal Wall Replacement	m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4. Canal Infrastructure																					
4.1 Public Pontoon Replacement	# of	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Instructions for Model Sensitivity Worksheet
MODIFY DIMENSIONLESS EVENTS BY INSERTING THE NUMBER OF EVENTS FOR THAT YEAR.
DO NOT MODIFY CELLS IN THIS SPREADSHEET WHICH APPEAR IN BROWN, AS THEY ARE LINKED TO DREDGING VOLUMES WORKSHEET. MODIFY BLUE CELLS.
THIS WORKSHEET IS THEN MULTIPLIED BY THE COSTS WORKSHEET TO PRODUCE COSTS FOR EACH ITEM
IN EVENT THAT COSTS ITEMS ARE SHARED BETWEEN 'RESIDENTIAL' & 'MARINA' SECTIONS,
PLACE A FRACTION IN EACH CELL FOR DISTRIBUTION OF COSTS (TO SUM TO 1)

PACIFIC HARBOUR MAINTENANCE MODEL

MAINTENANCE MODEL DERIVED UNIT RATES

ITEM / DESCRIPTION	Source	Units	RATE	SENSITIVITY: RATE FACTOR	COMMENT
1. Residential Canals					
1.1 General Maintenance					
Litter collection	xv	/annum	$ 15,000.00	1	Derived Rate = Sensitivity Rate Factor * [Raw Unit Rate xv * (1 + Adopted Confidence Percentage)]
Navigation Aid & Signage maintenance	xvi	/annum	$ 6,000.00	1	Derived Rate = Sensitivity Rate Factor * [Raw Unit Rate xvi * (1 + Adopted Confidence Percentage)]
Vegetation removal	xvii	/annum	$ 1,200.00	1	Derived Rate = Sensitivity Rate Factor * [Raw Unit Rate xvii * (1 + Adopted Confidence Percentage)]
Routine canal batter maintenance	xxxiv	/2 years	$ 30,000.00	1	Derived Rate = Sensitivity Rate Factor * [Raw Unit Rate xxxiv * (1 + Adopted Confidence Percentage)]
Canal batter repairs	xviii	(-)	$ 100,000.00	1	Derived Rate = Sensitivity Rate Factor * [Raw Unit Rate xviii * (1 + Adopted Confidence Percentage)]
1.2 Dredging					
Dredging Design, Approvals & Monitoring	i	/campaign	$ 100,000.00	1	Derived Rate = Sensitivity Rate Factor * [Raw Unit Rate i * (1 + Adopted Confidence Percentage)]
Survey	ii	/campaign	$ 55,000.00	1	Derived Rate = Sensitivity Rate Factor * [Raw Unit Rate ii * (1 + Adopted Confidence Percentage)]
Contract Execution Costs - CSD Dredging	iii	/campaign	$ 120,000.00	1	Derived Rate = Sensitivity Rate Factor * [Raw Unit Rate iii * (1 + Adopted Confidence Percentage)]
Dredging - Cutter Suction Dredging	iv	/m^3	$ 15.00	1	Derived Rate = Sensitivity Rate Factor * [Raw Unit Rate iv * (1 + Adopted Confidence Percentage)]
Contract Execution Costs - Alternative Dredging Methodology	v	/campaign	$ 70,000.00	1	Derived Rate = Sensitivity Rate Factor * [Raw Unit Rate v * (1 + Adopted Confidence Percentage)]
Dredging & Material Disposal - Alternative Dredging Methodology	vi	/m^3	$ 70.00	1	Derived Rate = Sensitivity Rate Factor * [Raw Unit Rate vi * (1 + Adopted Confidence Percentage)]
1.3 Dredged Material Disposal\Re-use					
Dredged Material Disposal - Contract Execution Costs	vii	/campaign	$ 120,000.00	1	Derived Rate = Sensitivity Rate Factor * [Raw Unit Rate vii * (1 + Adopted Confidence Percentage)]
Option A - Dispose Dried Material to Landfill	miii	/m^3	$ 206.00	1	Derived Rate = Sensitivity Rate Factor * Derived Unit Rate miii (below)
Option B - Opportunistic Fill / Beneficial Re-use	mv	/m^3	$ 86.00	1	Derived Rate = Sensitivity Rate Factor * Derived Unit Rate mv (below)
Dredged Material Handling Facility - Approvals, Design and Construction	xiii	(-)	$ 3,850,000.00	1	Derived Rate = Sensitivity Rate Factor * [Raw Unit Rate xiii * (1 + Adopted Confidence Percentage)]
Dredged Material Handling Facility - Land Acquisition & Offsets	xiv	(-)	$ 3,950,000.00	1	Derived Rate = Sensitivity Rate Factor * [Raw Unit Rate xiv * (1 + Adopted Confidence Percentage)]
1.4 Water Quality Monitoring	xxxii	/annum	$ 15,000.00	1	Derived Rate = Sensitivity Rate Factor * [Raw Unit Rate xxxii * (1 + Adopted Confidence Percentage)]
1.5 Administration					
Investigation Hydrographic Survey	v	(-)	$ 55,000.00	1	Derived Rate = Sensitivity Rate Factor * [Raw Unit Rate v * (1 + Adopted Confidence Percentage)]
Review and Update of Maintenance Model	xxvii	(-)	$ 35,000.00	1	Derived Rate = Sensitivity Rate Factor * [Raw Unit Rate xxvii * (1 + Adopted Confidence Percentage)]
2. Marina					
2.1 General Maintenance					
Litter collection	xix	/annum	$ 15,000.00	1	Derived Rate = Sensitivity Rate Factor * [Raw Unit Rate xix * (1 + Adopted Confidence Percentage)]
Navigation Aid & Signage maintenance	xxi	/annum	$ 6,000.00	1	Derived Rate = Sensitivity Rate Factor * [Raw Unit Rate xxi * (1 + Adopted Confidence Percentage)]
Vegetation removal	xxii	/annum	$ 1,200.00	1	Derived Rate = Sensitivity Rate Factor * [Raw Unit Rate xxii * (1 + Adopted Confidence Percentage)]
Routine canal batter maintenance	xxiii	/2 years	$ 30,000.00	1	Derived Rate = Sensitivity Rate Factor * [Raw Unit Rate xxiii * (1 + Adopted Confidence Percentage)]
2.2 Dredging					
Dredging Design, Approvals & Monitoring	i	/campaign	$ 100,000.00	1	Derived Rate = Sensitivity Rate Factor * [Raw Unit Rate i * (1 + Adopted Confidence Percentage)]
Survey	ii	/campaign	$ 55,000.00	1	Derived Rate = Sensitivity Rate Factor * [Raw Unit Rate ii * (1 + Adopted Confidence Percentage)]
Contract Execution Costs - CSD Dredging	iii	/campaign	$ 120,000.00	1	Derived Rate = Sensitivity Rate Factor * [Raw Unit Rate iii * (1 + Adopted Confidence Percentage)]
Dredging - Cutter Suction Dredging	iv	/m^3	$ 15.00	1	Derived Rate = Sensitivity Rate Factor * [Raw Unit Rate iv * (1 + Adopted Confidence Percentage)]
Contract Execution Costs - Alternative Dredging Methodology	v	/campaign	$ 70,000.00	1	Derived Rate = Sensitivity Rate Factor * [Raw Unit Rate v * (1 + Adopted Confidence Percentage)]
Dredging & Material Disposal - Alternative Dredging Methodology	vi	/m^3	$ 70.00	1	Derived Rate = Sensitivity Rate Factor * [Raw Unit Rate vi * (1 + Adopted Confidence Percentage)]
2.3 Dredged Material Disposal\Re-use					
Dredged Material Disposal - Contract Execution Costs	vii	/campaign	$ 120,000.00	1	Derived Rate = Sensitivity Rate Factor * [Raw Unit Rate vii * (1 + Adopted Confidence Percentage)]
Option A - Dispose Dried Material to Landfill	miii	/m^3	$ 206.00	1	Derived Rate = Sensitivity Rate Factor * Derived Unit Rate miii (below)
Option B - Opportunistic Fill / Beneficial Re-use	mv	/m^3	$ 86.00	1	Derived Rate = Sensitivity Rate Factor * Derived Unit Rate mv (below)
Dredged Material Handling Facility - Approvals, Design and Construction	xiii	(-)	$ 3,850,000.00	1	Derived Rate = Sensitivity Rate Factor * [Raw Unit Rate xiii * (1 + Adopted Confidence Percentage)]
Dredged Material Handling Facility - Land Acquisition & Offsets	xiv	(-)	$ 3,950,000.00	1	Derived Rate = Sensitivity Rate Factor * [Raw Unit Rate xiv * (1 + Adopted Confidence Percentage)]
2.4 Water Quality Monitoring	xxxiii	/annum	$ 15,000.00	1	Derived Rate = Sensitivity Rate Factor * [Raw Unit Rate xxxiii * (1 + Adopted Confidence Percentage)]
2.5 Administration					
Investigation Hydrographic Survey	v	(-)	$ 55,000.00	1	Derived Rate = Sensitivity Rate Factor * [Raw Unit Rate v * (1 + Adopted Confidence Percentage)]
Review and Update of Maintenance Model	xxix	(-)	$ 35,000.00	1	Derived Rate = Sensitivity Rate Factor * [Raw Unit Rate xxix * (1 + Adopted Confidence Percentage)]
3. Canal Walls					
3.1 Canal Wall Repair	xxiv	/m	$ 1,100.00	1	Derived Rate = Sensitivity Rate Factor * [Raw Unit Rate xxiv * (1 + Adopted Confidence Percentage)]
3.2 Canal Wall Replacement	xxv	/m	$ 5,000.00	1	Derived Rate = Sensitivity Rate Factor * [Raw Unit Rate xxv * (1 + Adopted Confidence Percentage)]
4. Canal Infrastructure					
4.1 Public Pontoon Replacement	xxxiv	/item	$ 50,000.00	1	Derived Rate = Sensitivity Rate Factor * [Raw Unit Rate xxxiv * (1 + Adopted Confidence Percentage)]

CALCULATED UNIT RATES FOR SPOIL DISPOSAL SYSTEMS

ITEM / DESCRIPTION	Source	Units	RATE	REF NO.	COMMENT
Option A - Dispose Dried Material to Landfill					
Excavate, spread, and treat material	viii	$/$m^3$	$ 25.00		Excavate, spread, and treat material
Haul to Landfill Site	mxi	$/$m^3$	$ 112.00		Derived unit rate shown below
Dispose at Landfill Site	mxii	$/$m^3$	$ 68.80		Derived unit rate shown below
		$/$m^3$	$ 206.00	miii	Rounded total
Option B - Opportunistic Fill / Beneficial Re-use					
Excavate, spread, and treat material	viii	$/$m^3$	$ 25.00		Excavate, spread, and treat material
Haul to Site	mxiii	$/$m^3$	$ 44.80		Derived unit rate shown below
Dispose at Site	mxiv	$/$m^3$	$ 16.00		Derived unit rate shown below
		$/$m^3$	$ 86.00	mv	Rounded total

CALCULATED UNIT RATES - CONVERSION FOR $/T TO $/M^3

ITEM / DESCRIPTION	Source	Units	RATE	REF NO.	COMMENT
Haul to Landfill Site - Option A	ix	$/$m^3$	$ 112.00	mxi	Estimated haulage cost for disposal at Ti Tree Bio Energy site - Willowbank (approx. 125km haulage distance)
Disposal cost at Landfill Site - Option A	xi	$/$m^3$	$ 68.80	mxii	Quote from Veolia for disposal at Ti Tree Bio Energy site
Haul to Opportunistic Fill / Beneficial Re-use Site - Option B	x	$/$m^3$	$ 44.80	mxiii	Estimated haulage cost - assuming approx. 50 km haulage distance
Disposal cost at Opportunistic Fill or Beneficial Re-use Site - Option B	xii	$/$m^3$	$ 16.00	mxiv	Estimate - notional amount to cover disposal fees at nominated site

MAINTENANCE MODEL DERIVED UNIT RATES
USER MODIFY CELLS IN RED
DO NOT MODIFY RATE CELLS DIRECTLY AS THESE ARE LINKED TO RAW UNIT RATES
COSTS SHOWN ARE UNIT RATES WITH CERTAINTY FACTOR APPLIED

Instructions for Model Sensitivity Worksheet
1 . Use the coloured cells to apply a factor to the adjacent item.
2. Unchanged cells (=1.0) will be displaced as light green, while cells with a factor applied will be displaced as light brown

PACIFIC HARBOUR MAINTENANCE MODEL

RAW UNIT RATES TABLE

ALL RATES ARE IN 2016 DOLLARS AND EXCLUDE GST

REF NO.	ITEM	UNIT	RATE	CONFIDENCE LEVEL	ORIGIN / REFERENCE / DATE / COMMENT
	Dredging				
i	Dredging Design, Approvals & Monitoring	$	100,000.00	3	Estimate based on NW 2013-14 and 2016 (planned) Dredging Campaigns
ii	Survey	$	55,000.00	1	Estimate based on costs for 2014 full canal estate survey - plus allowance for pre-dredge survey (dredge area only)
iii	Contract Execution Costs - CSD Dredging	$	120,000.00	2	Estimate based on NW 2013-14 Dredging Campaign
iv	Dredging Rate - Cutter Suction Dredging	$/m^3	15.00	3	Estimate based on rates for NW 2011-12 and 2013-14 Dredging Campaigns and increased average pumping distances
v	Contract Execution Costs - Alternative Dredging Methodology	$	70,000.00	3	Estimate assumes Grab Dredging and disposal at MIDMPA - Estimate based on Newport Capital Dredging 2012-13 and Scarborough Entrance Channel Maintenance 2015 Dredging Campaigns - (Estimate excludes allowance for any protective measures to Bribie Island Bridge as the scope for this is unknown)
vi	Dredging & Material Disposal Rate - Alternative Dredging Methodology	$/m^3	70.00	3	Estimate assumes Grab Dredging and disposal at MIDMPA - Estimate based on NW Capital and Scarborough Maintenance Dredging Campaigns
	Dredged Material Treatment & Disposal\Re-use				
vii	Dredged Material Disposal - Contract Execution Costs	$	120,000.00	3	Estimate based on NW 2013-14 Material Disposal Campaign
viii	Excavate, spread, and treat material	$/m^3	25.00	4	Estimate based on previous NW model estimate (Neumann) and information provided by Contractor
ix	Haul to Landfill Site - Option A	$/tonne	70.00	4	Estimated haulage cost for disposal at Ti Tree Bio Energy site - Willowbank (approx. 125km haulage distance)
x	Haul to Opportunistic Fill / Beneficial Re-use Site - Option B	$/tonne	28.00	3	Estimated haulage cost - assuming approx. 50 km haulage distance
xi	Disposal cost at Landfill Site - Option A	$/tonne	43.00	1	Quote from Veolia for disposal at Ti Tree Bio Energy site
xii	Disposal cost at Opportunistic Fill or Beneficial Re-use Site - Option B	$/tonne	10.00	5	Estimate - notional amount to cover disposal fees at nominated site
xiii	Dredged Material Handling Facility - Approvals, Design and Construction	$	3,850,000.00	4	MBRC Estimate - Apportioned in PROGRAM sheet
xiv	Dredged Material Handling Facility - Land Acquisition & Offsets	$	3,950,000.00	5	MBRC Estimate - Apportioned in PROGRAM sheet
	Maintenance - Residential Canals				
xv	Litter Collection - Residential Canals	$/annum	15,000.00	2	MBRC Estimate (Total Rate/Cost) - Apportioned in PROGRAM sheet
xvi	Navigation Aid & Signage Maintenance - Residential Canals	$/annum	6,000.00	2	MBRC Estimate (Total Rate/Cost) - Apportioned in PROGRAM sheet
xvii	Vegetation Removal - Residential Canals	$/annum	1,200.00	2	MBRC Estimate (Total Rate/Cost) - Apportioned in PROGRAM sheet
xxiv	Routine canal batter maintenance - Residential Canals	$/2 years	30,000.00	2	MBRC Estimate (Total Rate/Cost) - Apportioned in PROGRAM sheet
xviii	Canal batter repairs - Residential Canals	$	100,000.00	2	MBRC Estimate
	Maintenance - Marina				
xix	Litter Collection - Marina	$/annum	15,000.00	2	MBRC Estimate (Total Rate/Cost) - Apportioned in PROGRAM sheet
xxi	Navigation Aid & Signage maintenance - Marina	$/annum	6,000.00	2	MBRC Estimate (Total Rate/Cost) - Apportioned in PROGRAM sheet
xxii	Vegetation Removal - Marina	$/annum	1,200.00	2	MBRC Estimate (Total Rate/Cost) - Apportioned in PROGRAM sheet
xxiii	Routine canal batter maintenance - Marina	$/2 years	30,000.00	2	MBRC Estimate (Total Rate/Cost) - Apportioned in PROGRAM sheet
	Canal Walls				
xxiv	Canal Wall Repairs	$/m	1,100.00	4	Not Applied in Model - Rate from Previous Estimate - BEJ009 - Unit Cost Estimate - doc #: TD-MN-CAL-0001
xxv	Canal Wall Replacement	$/m	5,000.00	5	Not Applied in Model - Rate from Previous Estimate - applicable to areas with good accessibility- "cost could reach ~$15,000/m3 for poor accessibility etc."
	Administration - Residential Canals				
xxvii	Review and Update of Maintenance Model	$/annum	35,000.00	2	Estimate based on 2015-16 review - Apportioned in PROGRAM sheet
	Administration - Marina				
xxix	Review and Update of Maintenance Model	$/annum	35,000.00	2	Estimate based on 2015-16 review - Apportioned in PROGRAM sheet
	Residential Canals Environmental				
xxxii	Water Quality Monitoring	$/annum	15,000.00	1	MBRC Estimate - Apportioned in PROGRAM sheet
	Marina Environmental				
xxxiii	Water Quality Monitoring	$/annum	15,000.00	1	MBRC Estimate - Apportioned in PROGRAM sheet
	Canal Infrastructure				
xxxiv	Public Pontoon Replacement	$	50,000.00	2	Not Applied in Model - Rate from Previous Estimate - BEJ009 - Unit Cost Estimate - doc #: TD-MN-CAL-0001

CONFIDENCE		Optimistic (P10)	Pessimistic (P90)	Adopted Confidence	Indicative Situation
Very High	0	-2%	5%	**0.33%**	Clear, concise scope supported by fixed quotes & labour rates, etc.
High	1	-5%	10%	**0.00%**	Some minor uncertainty exists regarding scope and/or estimate process, etc.
Moderate	2	-10%	20%	**0.00%**	Scope moderately clear, estimate based on mix of quotes & prices from similar jobs.
Low	3	-15%	30%	**0.00%**	Low scope confidence. Estimate based on factoring from other non-identical jobs.
Very Low	4	-20%	40%	**0.00%**	Vague / uncertain scope, prices factored from other similar (not identical) projects.
Order of Magnitude	5	-25%	50%	**0.00%**	Based on the best guess of experienced employees or similar methods.

DEFINITION
Optimistic - P10 = 90% Probability of exceedance
Pessimistic - P90 = 10% Probability of exceedance

CONFIDENCE FACTOR ADJUSTMENT	
Optimistic	**Pessimistic**

Instructions for Raw Unit Rates Table Worksheet
THIS PAGE CONTAINS RAW COSTING DATA
EACH COST ITEM HAS A CONFIDENCE ATTACHED TO ACCOUNT FOR UNCERTAINTY (SEE ABOVE)
"DERIVED UNIT RATES" WORKSHEET CONTAINS OUTPUT BASED ON THIS RAW DATA, INCLUDING THE ERROR ESTIMATE
UNIT RATES MAY BE UPDATED AS NEW DATA BECOMES AVAILABLE, HOWEVER REFERENCE AND DATE TO BE RECORDED.

PACIFIC HARBOUR MAINTENANCE MODEL

ESTIMATED DREDGED MATERIAL VOLUMES

ITEM / DESCRIPTION	Units	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
SENSITIVITY: QUANTITIES FACTOR		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
DREDGED MATERIAL VOLUMES (*In situ* Density)	(m^3)	-	-	-	**78,400**	-	-	-	-	**59,100**	-	-	-	-	-	**45,500**	-	-	-	-	-	**43,800**	-	-	-	-	-	**46,100**	-	-	-	-	-	**25,400**	-	-
DREDGED MATERIAL VOLUMES - RESIDENTIAL PROPORTION	%	0%	0%	0%	100%	0%	0%	0%	0%	82%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	58%	0%	0%
DREDGED MATERIAL VOLUMES - MARINA PROPORTION	%	0%	0%	0%	0%	0%	0%	0%	0%	18%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	42%	0%	0%
INCREASE OR REDUCTION IN DREDGED VOLUMES																																				
☐ INCREASED/REDUCED SILTATION - factored by: 50%	(m^3)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DREDGING AND METHODOLOGY																																				
CSD to Material Handling Facility		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Alternative Dredging and Material Disposal Methodology																																				
FACTORED DREDGED MATERIAL VOLUMES (*In situ* Density)																																				
Total Volume to be Dredged	(m^3)	-	-	-	78,400	-	-	-	-	59,100	-	-	-	-	-	45,500	-	-	-	-	-	43,800	-	-	-	-	-	46,100	-	-	-	-	-	25,400	-	-
Residential Canals Volume to be Dredged	(m^3)	-	-	-	78,400	-	-	-	-	48,200	-	-	-	-	-	45,500	-	-	-	-	-	43,800	-	-	-	-	-	46,100	-	-	-	-	-	14,800	-	-
Marina Volume to be Dredged	(m^3)	-	-	-	-	-	-	-	-	10,900	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10,600	-	-
MATERIAL VOLUMES IN MATERIAL HANDLING FACILITY ('Pond Wet' Density)																																				
Total Volume	(m^3)	-	-	-	69,500	-	-	-	-	52,400	-	-	-	-	-	40,300	-	-	-	-	-	38,800	-	-	-	-	-	40,900	-	-	-	-	-	22,500	-	-
Residential Canals Volume	(m^3)	-	-	-	69,500	-	-	-	-	42,736	-	-	-	-	-	40,300	-	-	-	-	-	38,800	-	-	-	-	-	40,900	-	-	-	-	-	13,110	-	-
Marina Volume	(m^3)	-	-	-	-	-	-	-	-	9,664	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9,390	-	-
MATERIAL VOLUMES - DRIED AND BULKED ('Pond Crust in Truck - Bulked' Density)																																				
Total Volume	(m^3)	-	-	-	34,200	-	-	-	-	25,800	-	-	-	-	-	19,800	-	-	-	-	-	19,100	-	-	-	-	-	20,100	-	-	-	-	-	11,100	-	-
Residential Canals Volume	(m^3)	-	-	-	34,200	-	-	-	-	21,042	-	-	-	-	-	19,800	-	-	-	-	-	19,100	-	-	-	-	-	20,100	-	-	-	-	-	6,468	-	-
Marina Volume	(m^3)	-	-	-	-	-	-	-	-	4,758	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4,632	-	-

DREDGING VOLUMES INPUT

		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Total Volumes	(m^3)	-	-	-	**78,400**	-	-	-	-	**59,100**	-	-	-	-	-	**45,500**	-	-	-	-	-	**43,800**	-	-	-	-	-	**46,100**	-	-	-	-	-	**25,400**	-	-
Residential Canals	(m^3)	-	-	-	78,400	-	-	-	-	48,200	-	-	-	-	-	45,500	-	-	-	-	-	43,800	-	-	-	-	-	46,100	-	-	-	-	-	14,800	-	-
Marina (Zone 5)	(m^3)	-	-	-	-	-	-	-	-	**10,900**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**10,600**	-	-

Instructions for Dredging Volumes Worksheet
DREDGING VOLUMES INPUT TABLE IS BASED ON DREDGING SCHEDULE - VALUES CAN ALSO BE MANUALLY INPUT (CELLS SHOWN IN BOLD RED FONT AND BLUE SHADING)
MANUAL INPUT IS ONLY ADVISABLE IF THE USER HAS A KNOWLEDGE OF THE DREDGING SCHEDULE AND DREDGING AND DISPOSAL CONSTRAINTS
THE SPOIL VOLUMES FOR EACH DISPOSAL METHOD ARE TRACKED THROUGH AND FACTORED BY THE DREDGING TECHNICAL PARAMETERS
DREDGED MATERIAL AND MATERIAL VOLUMES DIRECTLY INFORM THE PROGRAM SHEET, AND THEREFORE AFFECTS COSTS

PACIFIC HARBOUR MAINTENANCE MODEL

ESTIMATED DREDGED MATERIAL VOLUMES

ITEM / DESCRIPTION	Units	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	REFERENCE / COMMENT
SENSITIVITY: QUANTITIES FACTOR		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
DREDGED MATERIAL VOLUMES (*In situ* Density)	(m^3)	-	-	-	**40,000**	-	-	-	-	-	**53,900**	-	-	-	-	-	
DREDGED MATERIAL VOLUMES - RESIDENTIAL PROPORTION	%	0%	0%	0%	100%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	
DREDGED MATERIAL VOLUMES - MARINA PROPORTION	%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	
INCREASE OR REDUCTION IN DREDGED VOLUMES																	
☐ INCREASED/REDUCED SILTATION - factored by: 50%	(m^3)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Switch on/off and use drop-down box at apply additional volume to account for increased/decreased dredging vols.
DREDGING AND METHODOLOGY																	
CSD to Material Handling Facility		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Alternative Dredging and Material Disposal Methodology																	
FACTORED DREDGED MATERIAL VOLUMES (*In situ* Density)																	
Total Volume to be Dredged	(m^3)	-	-	-	40,000	-	-	-	-	-	53,900	-	-	-	-	-	*These Volumes linked to PROGRAM*
Residential Canals Volume to be Dredged	(m^3)	-	-	-	40,000	-	-	-	-	-	53,900	-	-	-	-	-	*These Volumes linked to PROGRAM*
Marina Volume to be Dredged	(m^3)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*These Volumes linked to PROGRAM*
MATERIAL VOLUMES IN MATERIAL HANDLING FACILITY ('Pond Wet' Density)																	
Total Volume	(m^3)	-	-	-	35,500	-	-	-	-	-	47,800	-	-	-	-	-	Total settled volume of dredged material in Material Handling Facility ('Pond Wet' Density)
Residential Canals Volume	(m^3)	-	-	-	35,500	-	-	-	-	-	47,800	-	-	-	-	-	
Marina Volume	(m^3)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
MATERIAL VOLUMES - DRIED AND BULKED ('Pond Crust in Truck - Bulked' Density)																	Dried Dredged Material Volumes in Material Handling Facility
Total Volume	(m^3)	-	-	-	17,400	-	-	-	-	-	23,500	-	-	-	-	-	*These Volumes linked to PROGRAM*
Residential Canals Volume	(m^3)	-	-	-	17,400	-	-	-	-	-	23,500	-	-	-	-	-	*These Volumes linked to PROGRAM*
Marina Volume	(m^3)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*These Volumes linked to PROGRAM*

DREDGING VOLUMES INPUT

Volumes Input from Dredging Schedule

		2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	Total	% of Total
Total Volumes	(m^3)	-	-	-	40,000	-	-	-	-	-	53,900	-	-	-	-	-	392,200	
Residential Canals	(m^3)	-	-	-	40,000	-	-	-	-	-	53,900	-	-	-	-	-	370,700	95%
Marina (Zone 5)	(m^3)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	21,500	5%

Instructions for Dredging Volumes Worksheet
DREDGING VOLUMES INPUT TABLE IS BASED ON DREDGING SCHEDULE - VALUES CAN ALSO BE MANUALLY INPUT (CELLS S
MANUAL INPUT IS ONLY ADVISABLE IF THE USER HAS A KNOWLEDGE OF THE DREDGING SCHEDULE AND DREDGING AND D
THE SPOIL VOLUMES FOR EACH DISPOSAL METHOD ARE TRACKED THROUGH AND FACTORED BY THE DREDGING TECHNI
DREDGED MATERIAL AND MATERIAL VOLUMES DIRECTLY INFORM THE PROGRAM SHEET, AND THEREFORE AFFECTS COST

PACIFIC HARBOUR MAINTENANCE MODEL

DREDGING VOLUMES - TECHNICAL PARAMETERS TABLE

Volume Conversion Factors - Dredge Spoil			
Spoil Location	**From *In situ* to the following:**	**M.C. %**	**% Air Volume**
In situ	1.00	152	0.00
C/S Dredge	2.95	525	0.00
Pond wet	0.89	130	0.00
Pond Crust on Batter	0.36	20	7.24
Pond Crust in Truck - Bulked	0.44	10	22.85

Assuming:

Bulking Factor	1.2
Density of Spoil (t/m^3)	1.6

Instructions for Technical Parameters Worksheet
DO NOT MODIFY CELL CONTENTS WITHOUT NEW GEOTECHNICAL DATA
BULKING FACTOR APPLIED FOR TRUCKING VOLUMES

SUPPORTING GEOTECHNICAL CALCULATIONS

ρ_{solids} = 2.600 t/m^3 ρ_{water} = 1.025 t/m^3

Location	Total V(m^3)	ρ_{bulk} (t/m^3)	Solids (t/m^3)	Water (t/m^3)	% Solids Mass	% Solids Vol	% Water Vol	% Air Vol	M.C. (%)	Total Mass (t)	Solids Mass (t)
In situ	***1,000***	***1.350***	0.537	0.813	39.74	20.63	79.37	***0.00***	152	1,350	537
C/S Dredge	2,955	***1.135***	0.182	0.953	16.00	6.98	93.02	***0.00***	525	3,353	537
Pond wet	887	1.391	0.605	0.786	43.48	23.27	76.73	***0.00***	***130***	1,234	537
Spadeable	363	1.919	1.476	0.443	76.92	56.79	43.21	***0.00***	***30***	697	537
Pond Crust	335	***1.920***	1.600	0.320	83.33	61.54	31.22	7.24	***20***	644	537
Heaped Dry	335	1.760	1.600	0.160	90.91	61.54	15.61	22.85	***10***	590	537

Note : Bold and italic is the assumed or known value

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