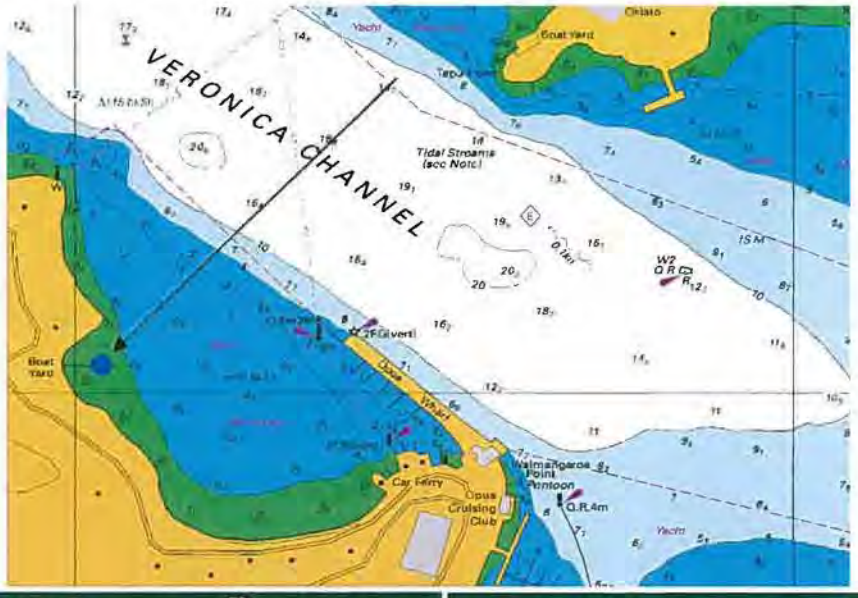
Technical Report: Preliminary Design of Timber Jetty, Pontoon and Dredging at Doug's Boatyard Opua.

Summary:

This report presents the preliminary design for a timber jetty with adjoining concrete pontoon which is proposed to be constructed in small bay in the north west corner of Opua Bay in the Bay of Islands (indicated by the blue mark and arrow). A 43m long 3m wide pile support timber jetty, with an adjoining 12m aluminium gangway which provides access to a 12m x 4m polystyrene filled concrete pontoon is propose. In addition, some dredging will be required to allow a vessel to navigate to and berth alongside the pontoon. The design chosen, had the smallest environmental impact and is the least invasive on the natural aesthetics of the bay, while still accommodating the working requirements of the boatyard. However, to achieve these goals; construction difficulty, accessibility and cost have been sacrificed.



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1.0 Introduction

A jetty and pontoon is proposed to be constructed in Walls Bay to replace the existing structure directly off Doug's Boatyard located at 1 Richardson St Opua. The pontoon should be capable of berthing a 50ft launch in all reasonable weather conditions.

An approximately 43m long 3m wide pile supported timber jetty will be constructed starting from the grassy berm at the north side of the beach. It will arch north-west following approximately the same arch as the natural bulkhead line of the northern end of the foreshore. The head of the jetty is a 4m x 6m timber turning area, which forms the abutment for the 12m long and 1.2m wide aluminium gangway. The aluminium gangway provides access to a 12m long 4m wide polystyrene filled floating concrete pontoon, which will be anchored in place using plastic sleeved driven steel piles. The area will then be dredged to allow a vessel to approach and berth alongside the pontoon.

This report analyses the sites locality and design considerations as well as the construction methodology.

2.0 Site Locality

Opua is part of a large confluence where the Kawakawa River/Inlet and Waikare River/Inlet meet. The site of the wharf is in a small bay in the northwest corner of the main bay in Opua. The bay is comprised of mud/sand gravel pocket beach separated by hard exposed rocky cusps on the boarders of the bay.

Currently the Opua Bay foreshore has many dwellings used as both permanent residents and holiday batches. There are several access routes via Franklin St, Beechy St and Richardson St. There is significant other marine development (large concrete wharf, ferry landing and extensive timber boardwalks) in the bay itself and the immediate surrounding area.

The design and location proposed for the structure (Figure 1) is intended to have negligible or minor impact on the unique natural aesthetics, environment, current residents and stakeholders in the area. The exact site proposed is shown in detail in the accompanied drawing series 0155-0504

Figure 1: Opua Bay (Google Maps)

2.1 Beach Morphodynamics

Because the site is a juxtaposition of harder igneous rock at soft sedimentary clays the costal effects of erosion and sediment transportation are still altering the coast line. Consideration was given to the location of the site, so that the new structure and construction activities have negligible or minor impact on the natural beach morphodynamics.

The morphodynamics acting in the proposed bay are a function of two primary morphodynamic principles- swash and alongshore swash motion

Swash is simply the layer of turbulent water that travels up a beach, this moves material up and down a beach, which results in cross-shore sediment exchange. However, over the length of beach, breaking waves create a circulation system where the water-driven shoreward across the surface zone, travels along the shore and returns to the offshore at the weakest point in the wave front at the centre of the bay via a backwash mini-rip (as shown in Figure 2). Swash causes erosion of the material away from the cusp horns (leaving only the hard, coarse material) and depositing it in the bay, from which point it is then transported out by the backwash.

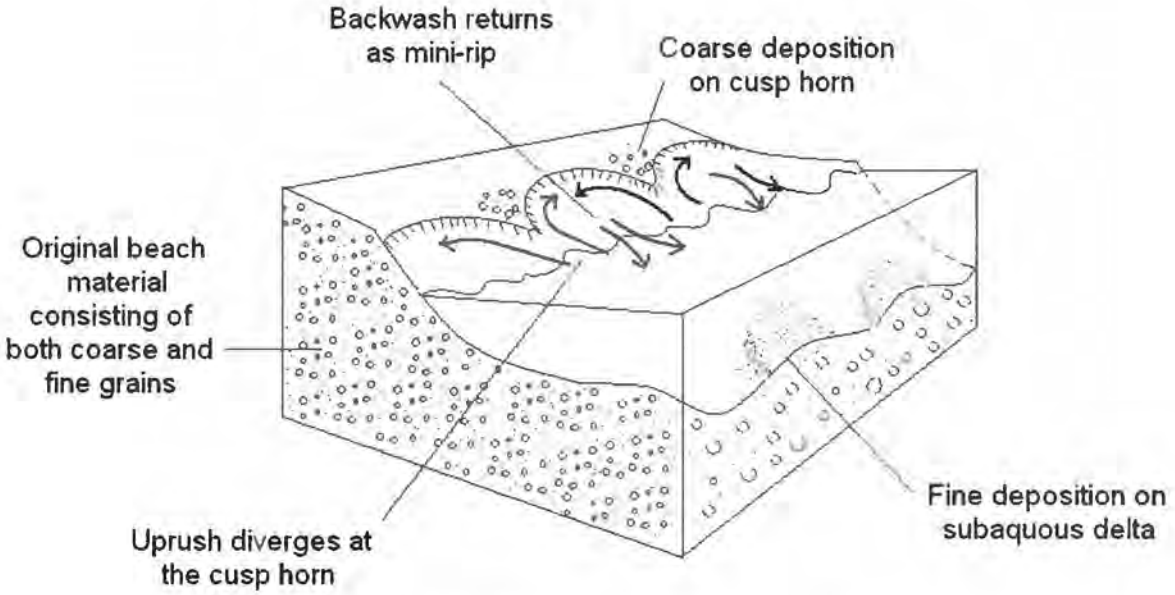

Figure 2: Beach cusp morphology (Masselink & Hughes 2003)

When you have beach cusp swash combining with alongshore swash motion this results in a slightly unsymmetrical beach cusp shape, which is exactly what we see when we look at an aerial shot of the proposed bay.

This alongshore swash motion is believed to be caused by a current moving N-NW, the presence of this current was confirmed by Brown (2018) current observations. MetOcean Solutions (2013) also indicate this current is due to tidal flows on the site; their analysis work also indicated a N-NW direction.

It is likely this NW current is also enhanced by alongshore motion call longshore drift. This is when the incoming wave approaches the beach at an oblique angle, as they can at the proposed site as the only long fetch is from the E - SE, this creates an alongshore swash motion called longshore drift which is illustrated by Figure 3.

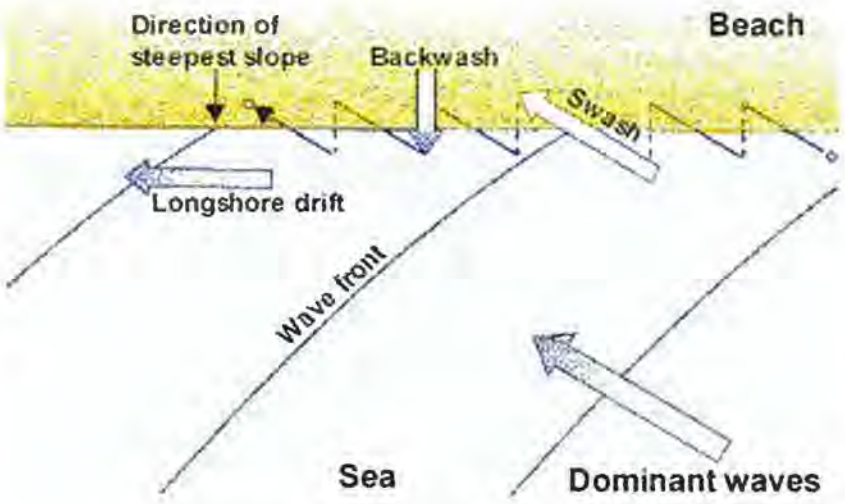

Figure 3: Longshore drift (Brunn, 2005)

This understanding of the natural morphodynamics occurring on the beach has been used to influence the design and positioning of the dredge cut, fixed structure and subsea erosion barrier.

2.2 Aesthetics

It was important that the design does not visually inhibit the view of the residents of Opua. And despite the existing structure already being there for years, for those residents that could see the structure it was important it does not compromise the natural flow of the coast line and spoil the view.

Several different steps were taken to achieve this:

1. The positioning of the jetty as close as possible to the northern side of the proposed site adjacent to the steep vertical bank, restricts it from the view of most residents to the north.
2. By shifting the structure north on the beach, it exposes more of the beach for other onlookers and the general public.
3. For those residents that will be able to see the structure (to the south, east and by water) the jetty does not protrude perpendicular to the beach, it arcs following the natural radius the beach makes with the rocky cusp and hugs that bulkhead line as close as feasibly possible so as not to impose on the beach front view.
4. For residents and public using the beach or the jetty, the jetty is designed with the lowest possible freeboard so it does not look invasive at low tide when the gap between the deck and the water is largest while still meeting the minimum engineering requirements for freeboard.
5. Lastly, the piles will be sleeved with PE sleeves, and the Joist and headstocks will be stained recessive colours so the structure "blends" in with the natural backdrop.

3.0 Construction

All different companies within the Total Marine Group will be involved in this construction.

- Total Marine Services Ltd. will conduct all engineering design and project management, as well as conducting all the construction work on site.
- Total Floating Systems Ltd. will conduct the design and construction of the polystyrene core concrete floating pontoon.
- Total Engineering Services Ltd. will fabricate all the bracketry and pile guides used on the pontoon and jetty.
- Total Dredging Ltd. will dredge the site to the required depth and batter angles, and then dispose of the dredged tailings.

Total Marine will also work with Manson Marine and Engineering Ltd to design and build the aluminium gangway.

3.1 Design

Please refer to drawing series 0155-0504 Rev 5

The design of the Jetty, Pontoon and Gangway is in accordance with relevant international and national standards.

- AS-NZS 3962 Guidelines for Design of Marinas
- AS-NZS 3600 Concrete Structures
- AS-NZS 1720 Timber Structures
- AS-NZS 1170 Structural Design Actions
- AS-NZS 1664 Aluminium Structures
- AS-NZS 1665 Welding of Aluminium Structures
- DNV-RP-C205 Environmental Conditions and Environmental Loads

Preliminary analysis suggests the sea state will be as shown in Table 1, for design conditions in accordance with AS-NZS 1170 for a 50year design life, derived from the JONSWAP wave spectrum analysis shown in Figure 4.

Table 1: Sea State Parameters for fetch 6 500m, wind speed 35.49 ms^{-1}

Sea state parameter	Sym	Value
Significant wave height	H_s	1.4613 m
Zero crossing period	T_z	3.04 sec
Mean period	T_m	3.21 sec
Wave length	L	16.46 m

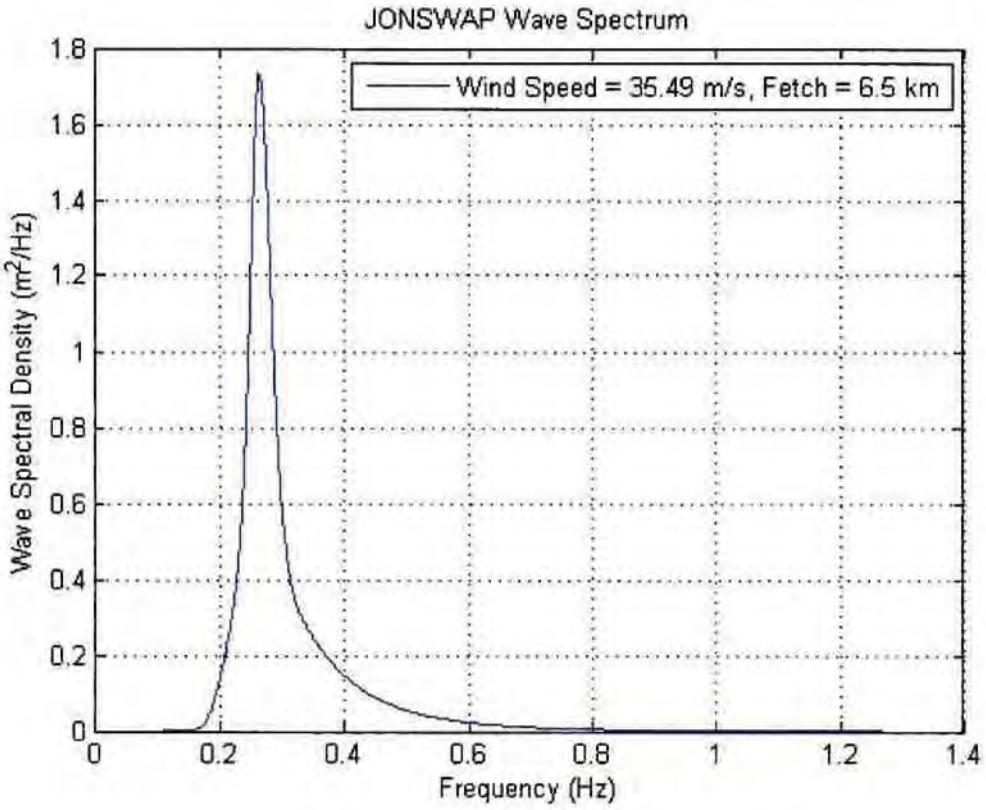

Figure 4: JONSWAP Analysis Longest fetch onsite

3.2 Dredging

Please refer to drawing series 0155-0504 Rev 5

The area will be dredged to allow all required vessels to access the wharf and berth alongside the pontoon. It is proposed to dredge the channel and berth to a depth of CD – 1.5m. It is estimated that the inground volume is 6743.8m^3, based on a hydrographic survey that was conducted by Total Marine.

Figure 5: Total Dredging Ltd.'s Longreach excavator and hopper barge

The primary method for dredging will be using a long reach excavator on a dredge barge, with a ripping tooth and rock bucket. All work associated with the dredging will be undertaken from a barge on the

water and material removed from the sea bed will be transported to a land-based disposal site. The dredge barge will not be tidally restricted. However, due to the travel time between the disposal site and dredge site it is most likely that the barge will only be onsite dredging for 4-5 hours per day. It is proposed to use a silt curtain which will fully enclose the dredge barge to prevent sediment depositing outside the dredge area and reduce the plume.

A desktop study was conducted on the design of the dredge cut to determine the most suitable batter angles of the dredge profile, based on the predicted current and sediment volumes established by MetOcean Solutions (2013). A convergence study was done of all the batter angles in the dredge profile to maintain as high as possible average velocity, while also maintaining the lowest possible deviation in the velocity profile. Based on some more extensive previous dredge model studies we have conducted, this has proved to be a reliable method of determining an optimum dredge profile without doing extensive sedimentation modelling. The established optimum profile is shown on the attached 0155-0504 drawings.

3.3 Subsea Erosion Barrier

Please refer to drawing series 0155-0504 Rev 5

It has been identified Brown (2018) that there is a small shellfish bed on the southern end of the beach. Due to the alongshore swash motion discussed above, it was apparent that there may be a migration of the shellfish bed north and onto the existing slipway.

To stabilise the shellfish bed and prevent material building up on the slipway it is proposed a groyne is placed on the edge of the shellfish bed running parallel to the slipway. Given the nature of the beach and in an attempt to manage the visual impact of this additional structure we have proposed a slightly alternative design to a traditional groyne having a smaller subsurface erosion barrier constructed from placed rock. This barrier will still have the same effect as a traditional groyne, being to interrupt the alongshore swash motion and in turn limit the movement of the sediment. As shown in Figure 6, the structure will maintain the shellfish bed by allowing material to be deposited but will keep the slipway clear by scouring out the material sitting on the slipway. Because the slipway is a hard structure this scouring will not cause any damage to the slipway structure.

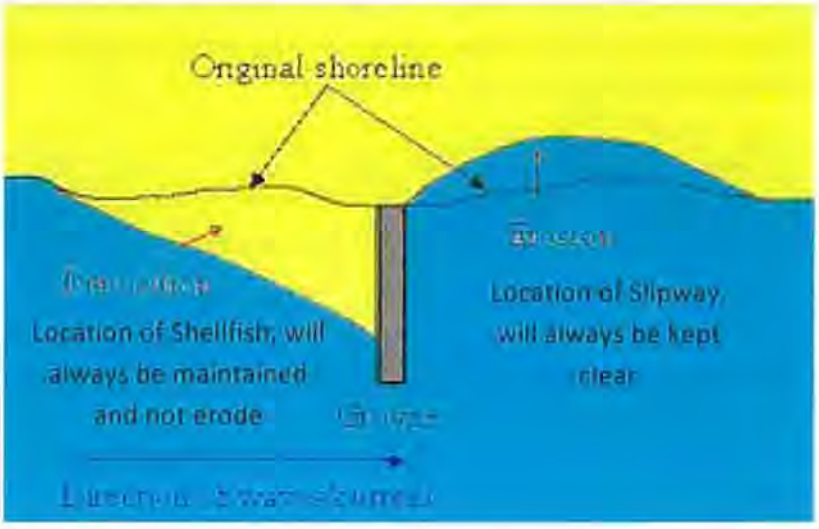

Figure 6: Illustration of how a groyne works

3.4 Timber Jetty

Please refer to drawing series 0155-0504 Rev 5

The timber jetty will be constructed using marine grade H6 timber and piles, as per the drawings.

The piles will be pile driven, drilled and piled or drilled and grouted depending on the strata encountered. Preliminary geotechnical data suggests the latter option is most likely. In total there are 30 pine piles and 4 PVC sleeved steel piles. This work will be conducted from Total Marine's piling barge. Considering tolerances and over drilling it is assessed that the total area affected for all the piles will be approximately 4m2 and an average of about 0.25 m3 of seabed removed per pile.

Figure 7: 50t Piling barge 'Northland Piler'

3.5 Pontoon

The pontoon will be constructed to support the maximum bending moment and shearing forces that will be incurred in the pontoon. As well it will be capable of resisting the berthing impact loads and environmental forces of a 60' launch.

The pontoon is primarily comprised of a polystyrene core which gives it the required buoyancy, and strategically placed steel rebar for strength. Then an approximately 50mm of concrete cover will be used to bind it all together. Timber walers run down the sides of the pontoon and are held in place with galvanized steel through rods to support the bending moment. The stainless-steel pile guides and fenders are then attached.

Figure 8: Concrete pontoon casting process.

4.0 Conclusion

The proposed design, structure and methodology is consistent with other structures built by Total Marine historically. The design and materials proposed will result in a structure that will be fit for sound and fit for purpose with minimal maintenance for 35+ years.

5.0 References

Masselink, G. and Hughes M.G. 2003, Introduction to coastal processes and geomorphology, Hodder Arnold, London

Reeve, D; Chadwick, A; Fleming, C 2004, Coastal engineering-processes, theory and design practice. New York: Spon Press.

Brown, S. 2018, Ecological Assessment: Doug's Opua Boatyard. 4Sight Consulting report prepared for Doug Schmuck. July 2018.

Met Ocean Solutions Ltd. 2013, Opua Marina Stage 2 Development modelling. Report prepared for Far North Holdings Ltd

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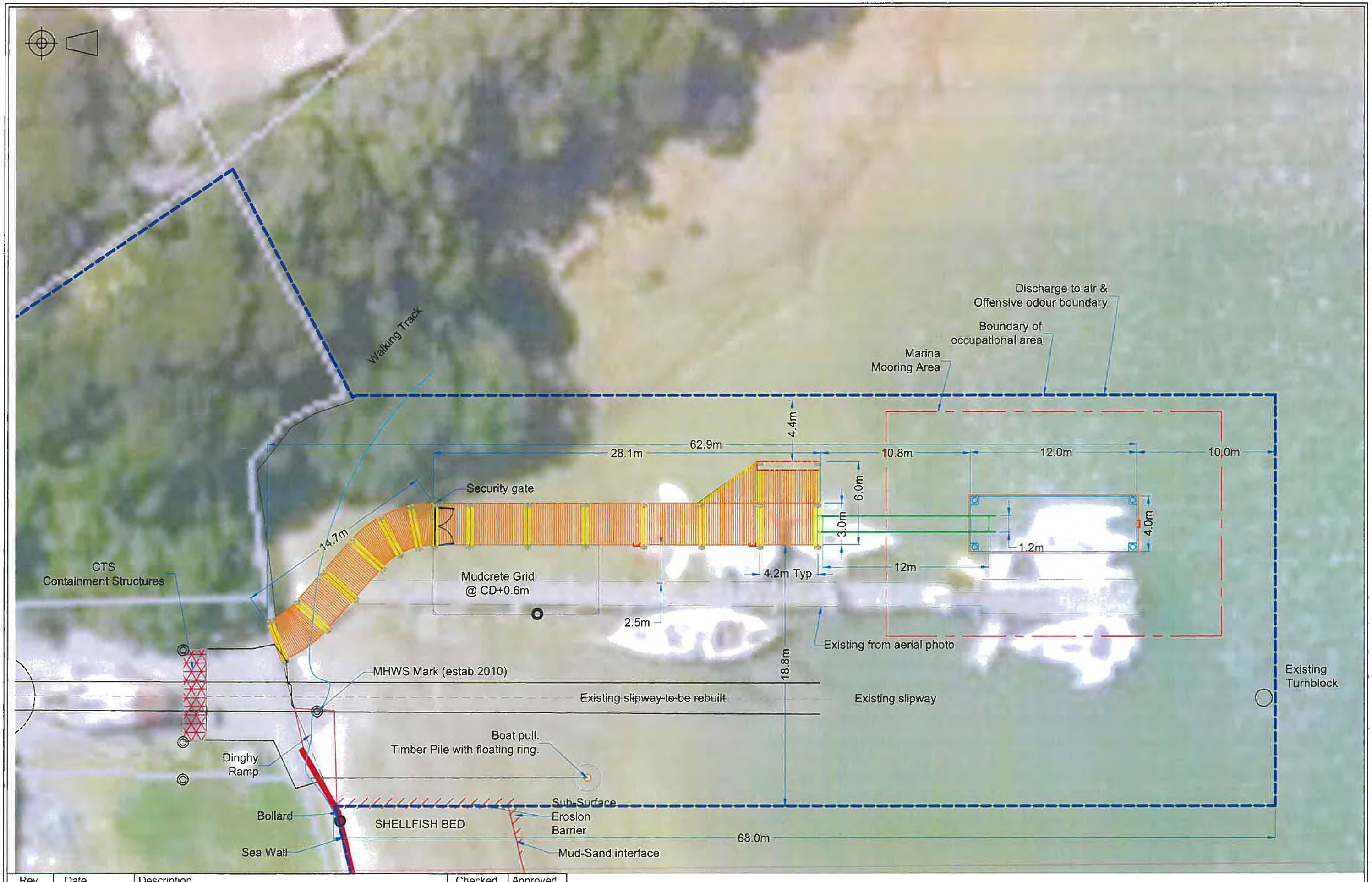
Design & Project Engineer – Total Marine Group.

Date: 11/07/2018



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2	04/05/2018	ADDED SHEETS 6 & 7	CC	AJ
3	09/05/2018	UPDATE DREDGING & MOORING MANAGEMENT PLAN	CC	AJ
4	18/05/2018	UPDATED DREDGING & BACKGROUND IMAGE	CC	AJ
5	13/07/2018	VARIOUS MINOR CHANGES	CC	AJ

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Date:	13/07/2018	Client:	Doug's Opua Boatyard
		Drawn by:	Craig Cave

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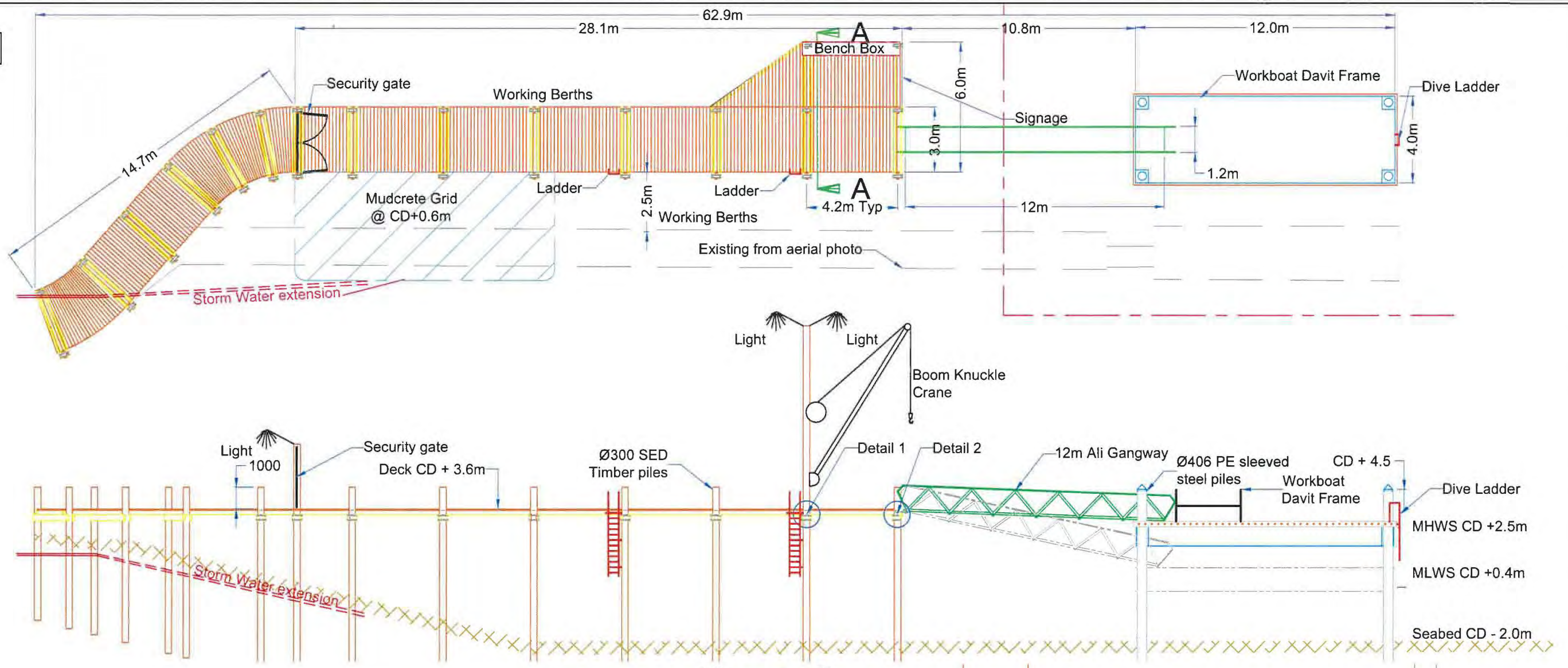
APP-039650-01-01

Structural Site Aerial Overlay



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Typical Jetty construction
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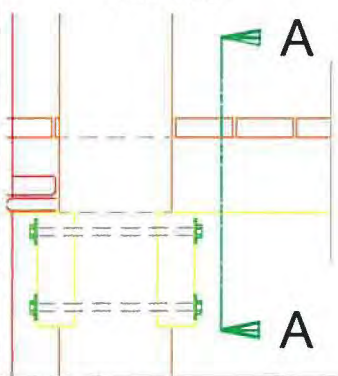

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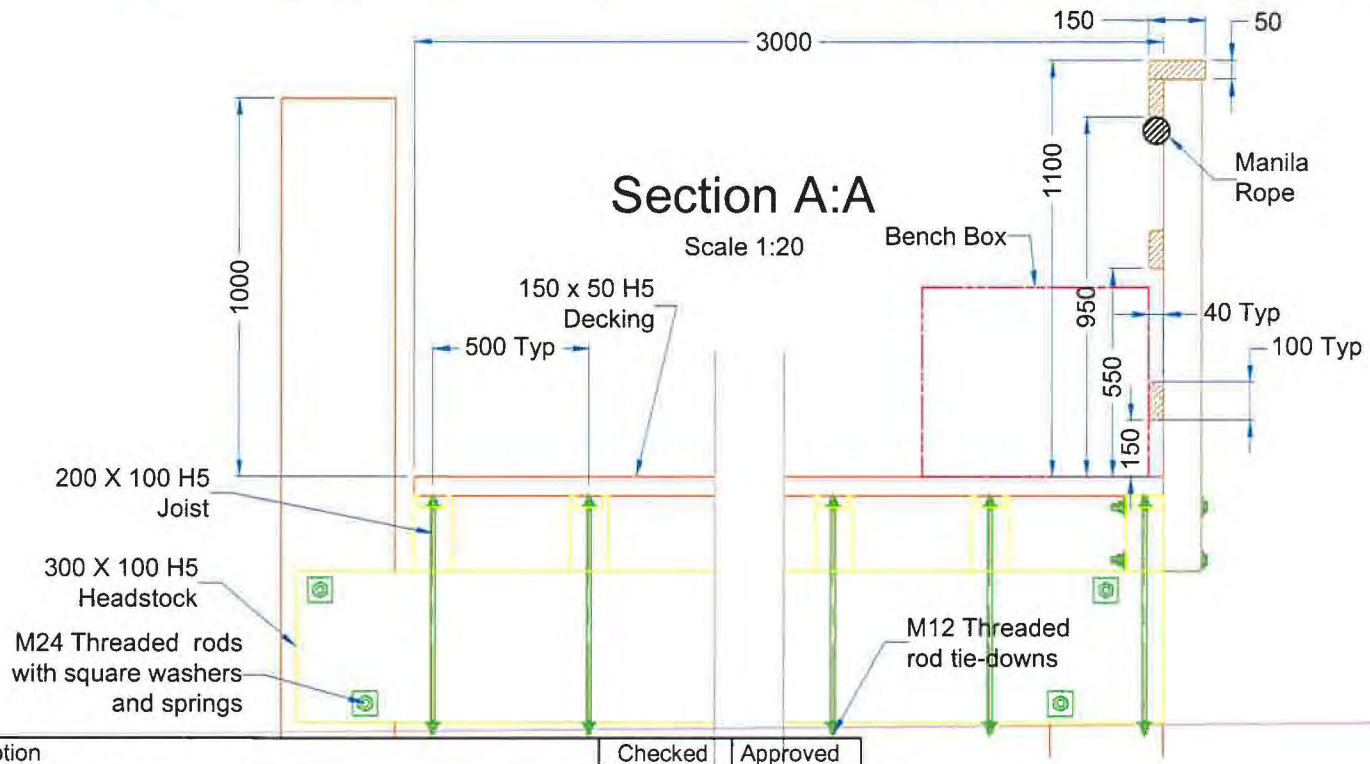

Detail 2
Gangway Abutment
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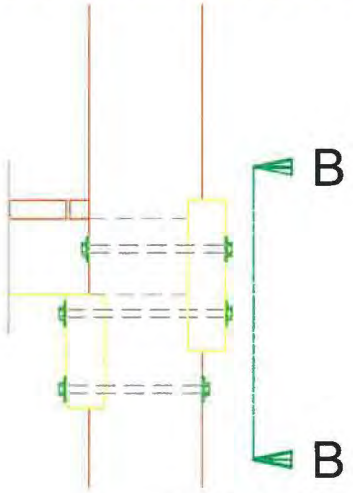

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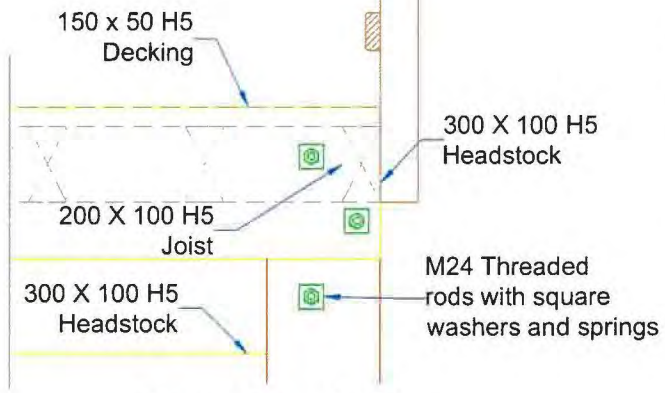

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4	18/05/2018	UPDATED DREDGING & BACKGROUND IMAGE	CC	AJ
5	13/07/2018	VARIOUS MINOR CHANGES	CC	AJ

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Date:	13/07/2018	Client:	Doug's Opua Boatyard
		Drawn by:	Craig Cave

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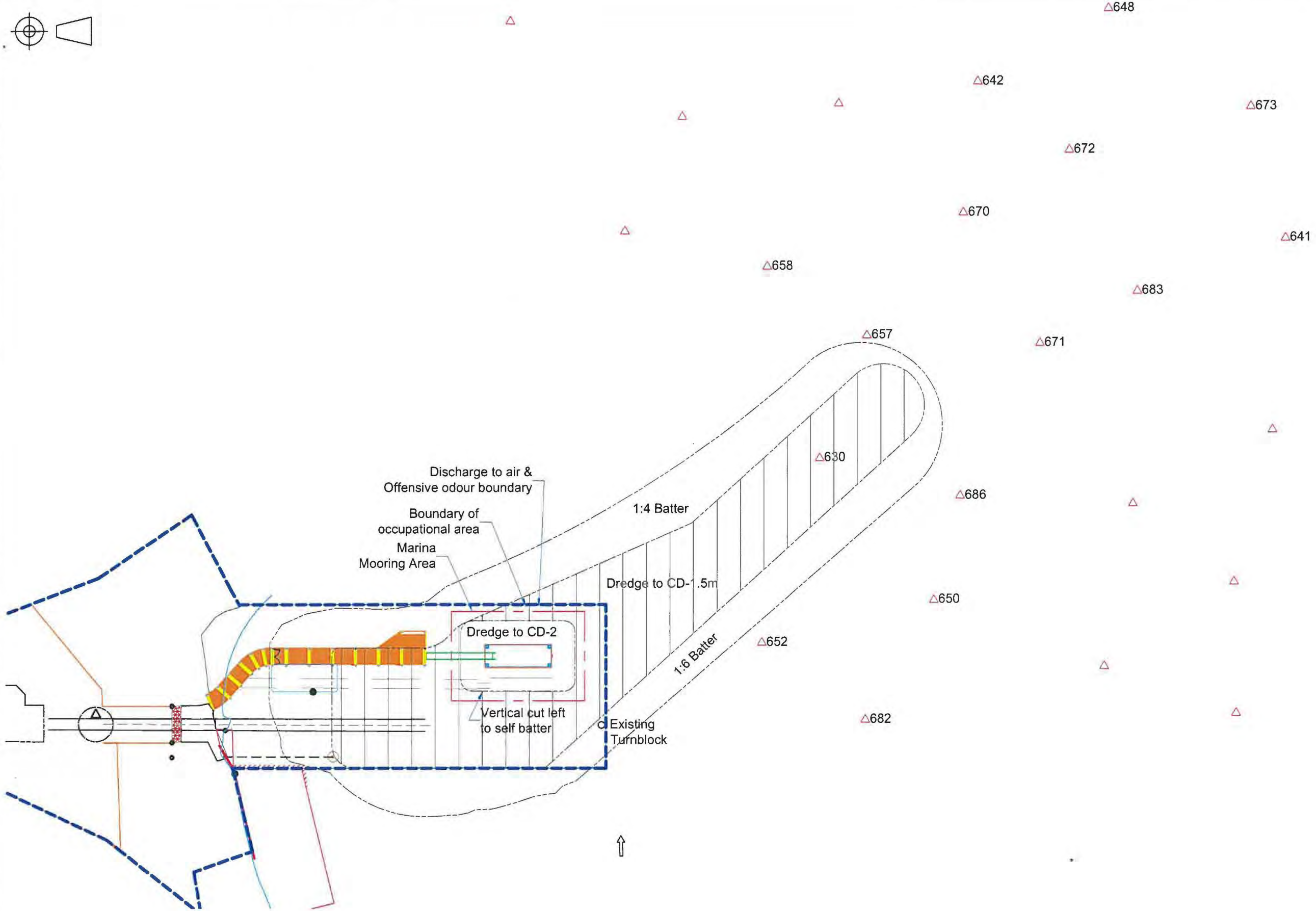
General Structural Arrangement



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Drawing No: 0155-0504-0003
Scale: 1:600
Client: Doug's Opua Boatyard
Date: 13/07/2018
Drawn by: Craig Cave

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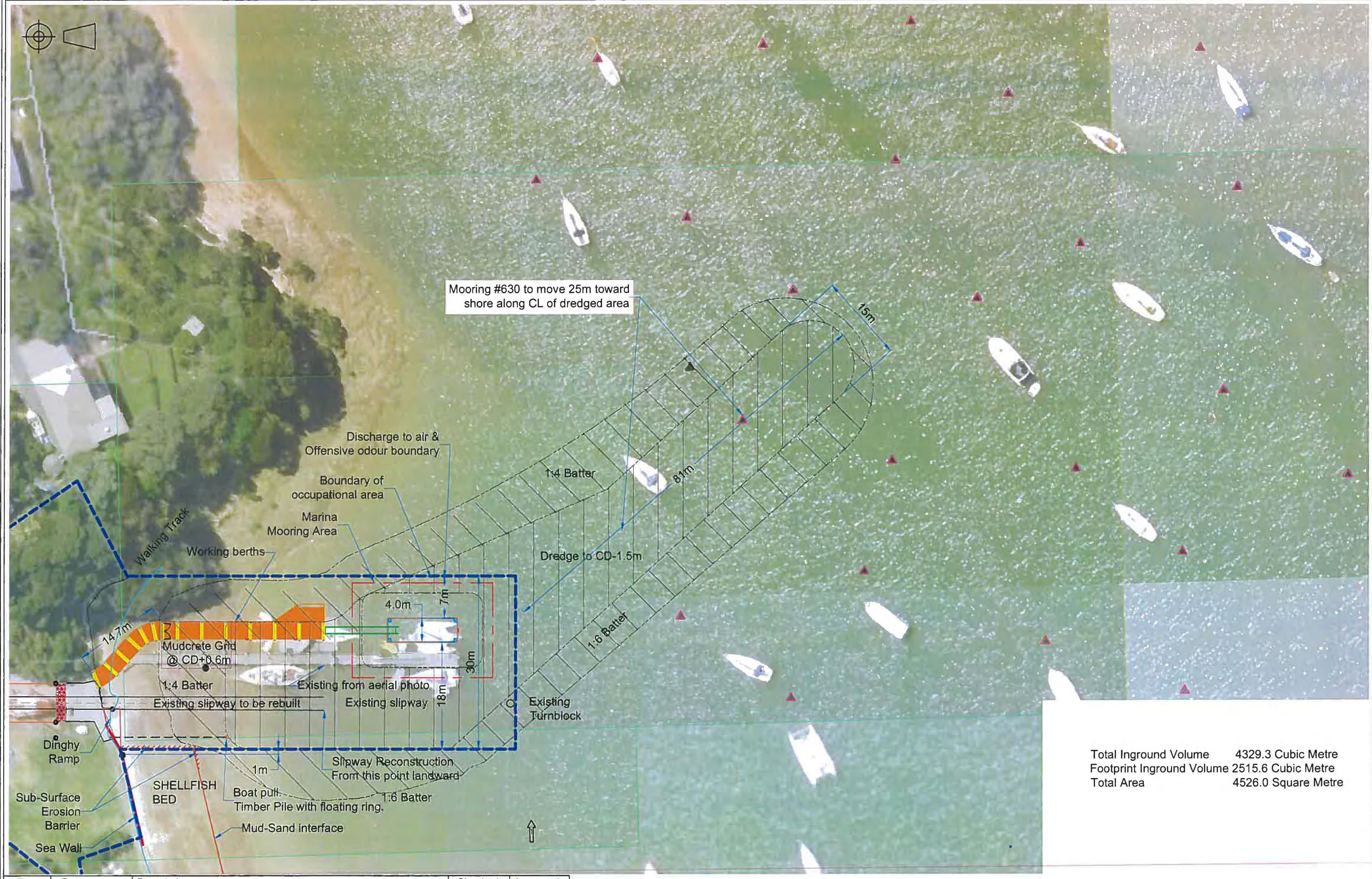
Dredging & Mooring management Plan



Total Inground Volume 4329.3 Cubic Metre
Footprint Inground Volume 2515.6 Cubic Metre
Total Area 4526.0 Square Metre

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5	13/07/2018	VARIOUS MINOR CHANGES	CC	AJ

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Date:	13/07/2018	Client :	Doug's Opua Boatyard
		Drawn by:	Craig Cave

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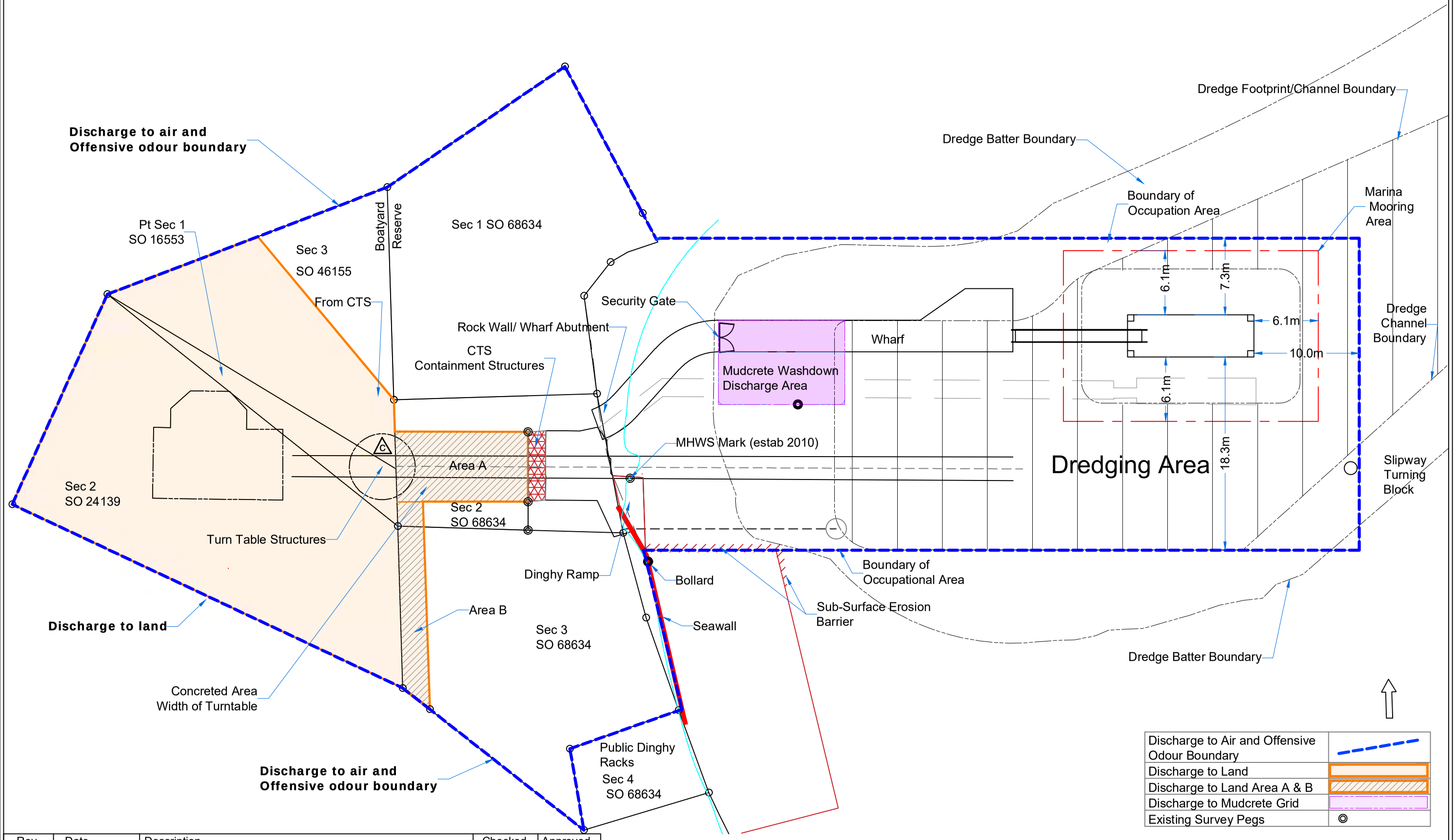
Dredging Plan With NRC aerial overlay



Discharge to Air and Offensive Odour Boundary	
Discharge to Land	
Discharge to Land Area A & B	
Discharge to Mudcrete Grid	
Existing Survey Pegs	◎

Rev	Date	Description	Checked	Approved
2	04/05/2018	ADDED SHEETS 6 & 7	CC	AJ
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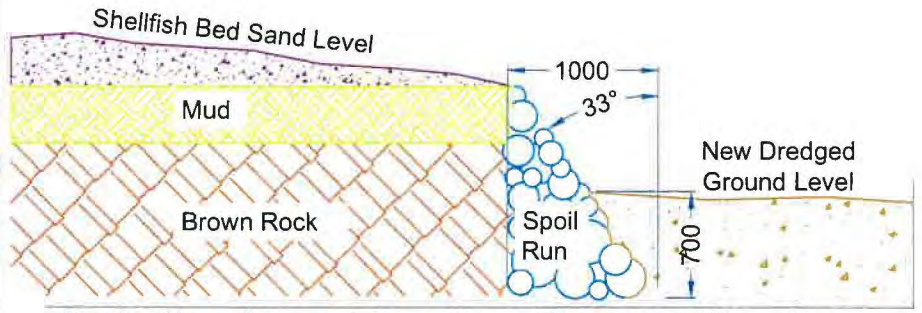
Structural Site Boundary Details



Sub Surface Erosion Barrier Section

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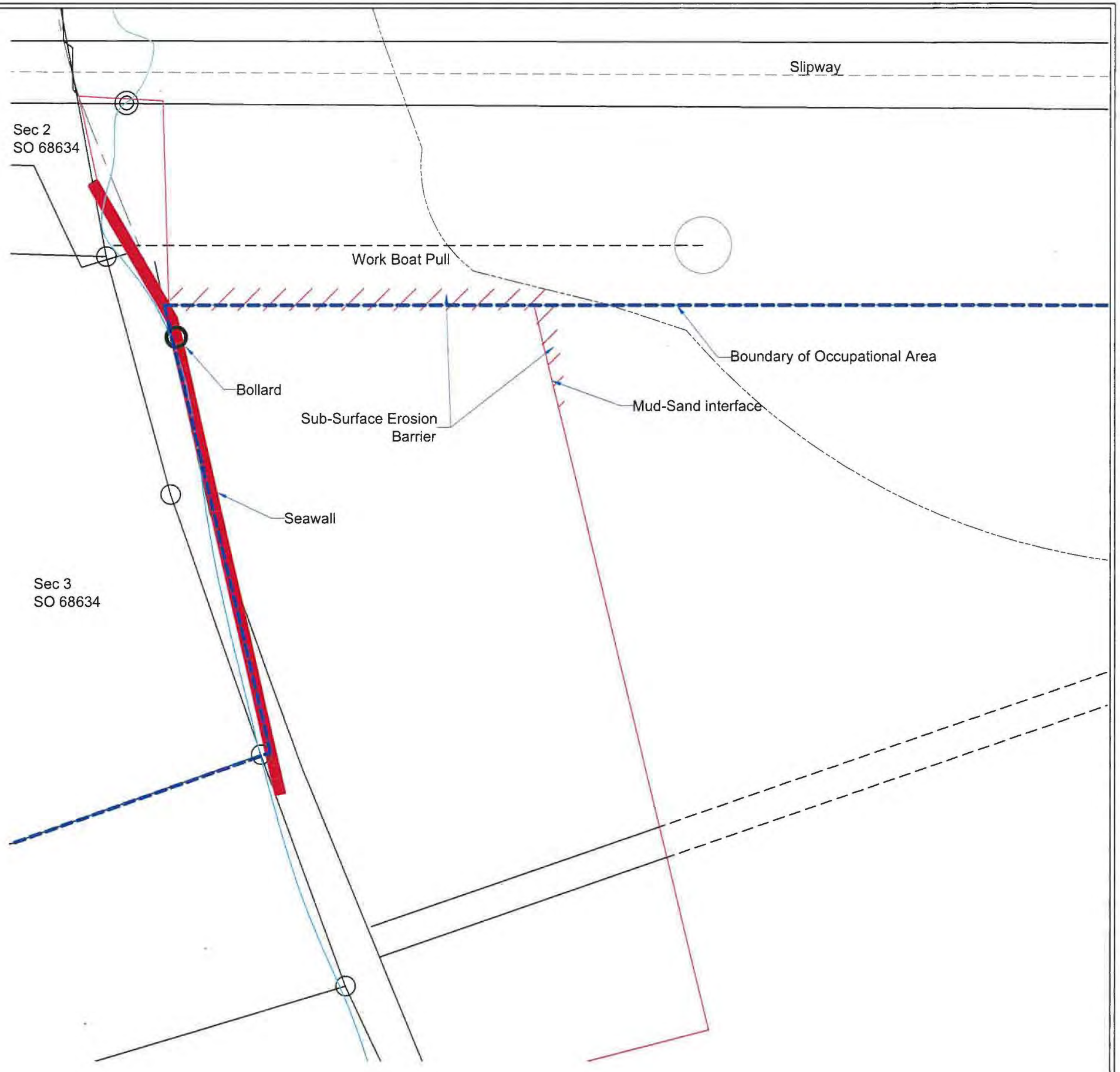

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Date:	13/07/2018	Client:	Doug's Opua Boatyard
		Drawn by:	Craig Cave

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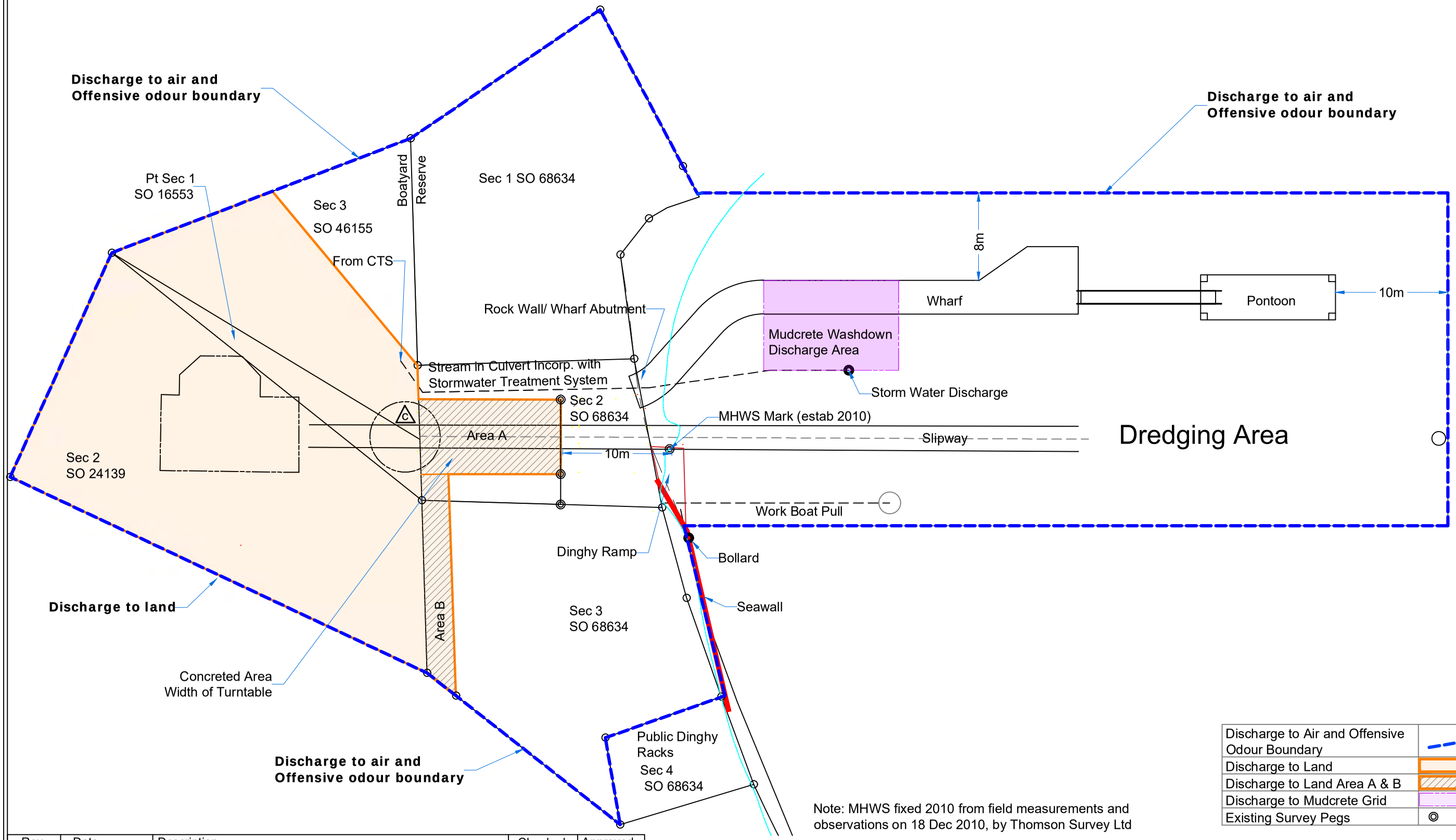
Shellfish bed Sub-Surface Erosion Barrier



Discharge to Air and Offensive Odour Boundary	
Discharge to Land	
Discharge to Land Area A & B	
Discharge to Mudcrete Grid	
Existing Survey Pegs	◎

Note: MHWS fixed 2010 from field measurements and observations on 18 Dec 2010, by Thomson Survey Ltd

Offensive odour boundary and Discharge to air boundaries, Discharges to land and to the CMA

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		Drawn by:	Craig Cave

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Discharge Boundaries