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Tanker Jetty, Esperance Remediation Report

Prepared for
The Jetty Group Incorporated

DOCUMENT HISTORY

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1 INTRODUCTION

Bonacci Infrastructure (Bonacci) was engaged by The Jetty Group Inc. following the decision of the Esperance Shire Council to invite Contractors to tender for the demolition of the Tanker Jetty, which located on the Esperance shoreline. The Jetty is 81 years old and is one of only three (3) remaining Heritage listed timber jetties left in Western Australia of this length and scale. The Jetty was closed to public assess, by the Council, in November 2015 following the release of a Condition Assessment report prepared by BMT JFA, on behalf of the Council.

2 PROFESSIONAL BACKGROUND AND QUALIFICATIONS

My name is Mr Terry James Memory. My CV is attached in Appendix D. I have 25 years' experience as a structural engineer, predominantly in the design and construction industry, but I also have academic experience and have on numerous occasions been engaged as an expert consultant/witness. I am a member of the following organisations:

- Member of the Institution of Engineers Australia (MIEAust)
- Chartered Profession Engineer (CPENG)
- Register Member of the Board of Profession Engineers Queensland (RPEQ)
- Register Member of the Board of Building Practitioners North Territory (Aust.)
- Member of the New Zealand Institute of Professional Engineers (IPENZ)

I am a principal and company Director of Bonacci Infrastructure whose registered office is Level 3, 51 Alfred Street, Fortitude Valley, QLD 4006, Australia.

My primary area of expertise lies in the design of civil infrastructure including marine works, mining and resources, bridges, tunnels and large scale water treatment facilities. A particular area of interest is the numerical modelling of soil and its interaction with structural elements and the subsequent design of those structural elements. Also attached, in Appendix C, are Bonacci Infrastructure company brochures dedicated to our speciality areas of Marine and Mining, and Construction Engineering.

3 DISCLOSURE OF INTEREST

Prior to preparing this report, I have had no involvement with the proposed demolition or preservation of the Tanker Jetty.

4 TERMINOLOGY

Throughout this report, engineering terminology is used to describe the Jetty and its condition or technical concepts. Below is a short list and explanation of these engineering terms.

- **Piles**: refers to the current HW timber piles that support the Jetty
- **Headstock**: refers to the horizontal structural element that both supports the Jetty Deck and is connected to the top of the piles.
- **Jetty Bent or Bent**: refers to the "frame" that is comprised of two piles and a headstock and on this Jetty are spaced at 4.6m along the length of the Jetty.
- **Corbel**: refers to the 1.5m long HW timber element that is horizontal and located above the piles and below the main deck. Its structural function is to reinforce the area above the pile by facilitating the spread of the pile load up through the corbel to the deck timbers.
- **Deck Stringers or Stringers**: refer to the main horizontal HW timbers that span from headstock to headstock. On this Jetty, each stringer is 9.2m long and each stringer spans two bays.

- **HW Decking**: refers to the HW deck planks that are laid across the stringers and are currently covered by a concrete deck.
- **Substructure**: refers to all the elements below the underside of the stringer
- **Superstructure**: refers to all the elements above the underside of the stringers, inclusive of the stringers.

Below is an image of a typical bent, showing the piles, headstock beam (connected to the pile via the halfcap joint), the timber corbel on the headstock and the stringers above the corbel. This particular image also shows one of the very few bents that still have the original (1935) central timber piles still attached.

5 JETTY OWNERSHIP AND MAINTENANCE

The BMT JFA report cited above in the introduction did not condemn the structural integrity of the entire Jetty, however, it did highlight and warn of serious structural concerns that required immediate rectification. Additionally, the report highlighted the requirement for ongoing maintenance after the initial repair works.

In regard to Jetty maintenance, we understand that in 1987 the Esperance Port Authority contributed to and facilitated the replacement of 72No. original timber piles with new timber piles. Likewise, we understand that in 1990, the same process was repeated whereby another 148No. piles were replaced, courtesy of the Port Authority. Therefore, in 1990 a total of 220 piles had been replaced. The jetty currently utilises 224 piles.

With regard to ownership, the State Government of Western Australian is the owner of the Jetty. However, in August 1990 the Esperance Shire Council entered into a Licensing agreement with the State Government whereby the Shire was licensed to maintain and use the jetty. That is, the Shire Council accepted the responsibility to maintain and use the jetty as its' own and upon executing this licensing agreement. The State paid to the Shire Council a sum of $150,000 as part of the agreement. The terms and conditions of the license are clearly defined and include the following:

- to use the full amount of the said sum ($150,000) for the purpose of the restoration and repair of the Jetty Structure and the beautification of the adjoining foreshore and not to use any portion of the said money for any other purpose whatsoever.
- to forthwith establish a trust fund and to pay the whole of the said sum into that trust fund.

- To actively seek financial assistance and support from the private sector for the cost of restoration repairs and maintenance of the Jetty structure
- Forthwith to prepare and submit to the Minister for approval a written detailed program of the works to be carried out by the Licensee to fully restore the Jetty structure to a state of good safe and substantial repair order and condition.
- At its own expense to put and keep and maintain the jetty structure in a state of good and substantial repair order and condition at all times.
- Not to make any alteration in or addition to the Jetty structure or any part thereof with the written consent of the Minister first
- To insure the Jetty in an amount not less than two million dollars ($2,000,000)....
- At its own expense to restore the Jetty structure in accordance with the above referenced program of works and to carry out all restoration work on the Jetty Structure to the satisfaction and approval of the Minister.
- That upon the termination of this license by the Minister the Licensee (Shire Council) shall if requested by the Minister within 1 month thereafter remove from the licensed area the Jetty Structure including all piles and other parts below the water level.

It is therefore quite clear that the Shire Council entered into an agreement whereby they became solely responsible for both the full restoration of the Jetty and its ongoing maintenance. Given the current state of the Jetty it is reasonable to concluded that the Shire Council has demonstrably failed to fulfil the terms of their License agreement.

To our knowledge, the Council has not undertaken any planned and regular program of Jetty maintenance since it acquired responsibility to do so, in August 1990. Rather, intermittent repair works have been undertaken in response to localised structural failures or imminent failures. Below is a chronology of Jetty works expenditure by the shire Council since 1990.

Year	Total Expenditure	
1989/90	$	22,570
1990/91	$	-
1991/92	$	33,247
1992/93	$	11,070
1993/94	$	348,848
1994/95	$	-
1995/96	$	-
1996/97	$	-
1997/98	$	-
1998/99	$	-
1999/00	$	-
2000/01	$	9,536
2001/02	$	4,779
2002/03	$	22,804
2003/04	$	10,932
2004/05	$	15,159
2005/06	$	15,780
2006/07	$	6,881
2007/08	$	9,426
2008/09	$	37,728
2009/10	$	149,065
2010/11	$	131,647
2011/12	$	40,197
2012/13	$	29,104
2013/14	$	214,851
2014/15	$	37,913
2015/16	$	66,837
Total	**$**	**1,218,374**

Shire Council Expenditure on the Jetty Structure since 1990

The above total figure of $1.2M is approximately divided into $600K on capital improvements, $300K on general maintenance and $300K on reports and studies. On average, the Shire Council has spent only $11,000 p.a. on general maintenance of the Jetty. It is noted that in 1995 the shire Council resolved to allocate $20,000 pa to the Jetty, being $33,000 when indexed to present day value.

In 2010 the Shire Council commissioned a detailed structural investigation report which was in turn used for a 2011 structural assessment report. The both the 2010 and the 2011 reports highlighted the need for regular maintenance, and areas of specific concern. In 2013 we understand that six (6) of the thirteen (13) pile identified in the 2010/2011 reports were sleeved and grouted – this being a relatively crude technique to prolong the life of a rotted timber pile. In 2013 another report was commission, by a different consultant, and again this report highlighted the need for immediate repair and maintenance. To our knowledge, the Shires response was to grout another six (6) piles, but no other repairs were undertaken despite the recommendation to do so. In 2015 a fourth report was commissioned and based on this report the Jetty was closed and structurally condemned by the Shire Council. Presently, the Jetty has two areas of severe and localised neglect. Being in bent 94, where a corbel timber has been dislodged and the deck has sagged approximately 300mm and bent 82 which is missing a pile. The Shire Council has temporarily propped the deck at bent 82, however, the circumstances surrounding the relatively recent removal of the pile are unclear.

6 HISTORICAL AND INDIGENOUS SIGNIFICANCE

The Tanker Jetty was constructed in 1935 and is now 81 years old. The name is derived from the fact that a key functional aspect of the Jetty was the transmission of petroleum between vessels and the adjacent fuel tank farm located on the shoreline. Originally, the Jetty was a commercial facility servicing the Esperance harbour. The Jetty itself was originally in excess of 872m long, complete with a Jetty Head for berthing vessels and a locomotive rail line from shore to Jetty head. The Jetty Head and seaward end of the Jetty was suffered damage from storms and accidental vessel collisions. This damage resulted in the Jetty Head being isolated from the main jetty. The isolated portion was demolished in 2015. Currently, the Jetty extends to bent 143, of the original 192 bents.

The recent foreshore redevelopment has also necessitated the demolition of the shore end of the Jetty, such that bent 31 is now the first remaining bent of the Jetty. An aluminium gangway presently spans the foreshore to bent 31, to enable access onto the Jetty. Currently the Jetty is comprised of 112 x 4.57m spans, on 113 twin pile bents. The Jetty is currently 512m long, configured as a graceful arch into the harbour.

During my trip to Esperance, I noticed and read the storyboards erected as part of the recent foreshore redevelopment. At the Jetty itself, the storyboards celebrate the Jetty via large-scale images of the Jetty's construction in 1935. Whilst I did not walk the entire length of the foreshore redevelopment, the apparent absence of references to the local indigenous heritage, acknowledgment or recognition was surprising to me.

The Jetty does have indigenous significance, however, it is not something to celebrate, rather to acknowledge and respect. In the past, the Jetty was the landmark delineating the boundary between colonial and indigenous communities and now known colloquially as the "line of sorrow". That is, historically, after night fall indigenous peoples were not permitted past the Jetty and thereby not permitted to enter the township of Esperance. Rather, they were to base themselves at Bandy Creek. Whilst this historical fact is clearly an anathema to any modern society, it is nevertheless a significant reminder of the prejudices and wrongs done in this country under the name of colonialism. I therefore submit that preservation of the Jetty and the documenting of this historical fact, via a storyboard at the Jetty, is a necessary and respectful acknowledgment of the past. To this end, I would suggest and encourage The Jetty Group to seek guidance from the local indigenous community, indigenous leaders and anthropologists.

7 PREVIOUS REPORTS

Since taking over the Jetty's maintenance, the Esperance Shire Council has commissioned several reports relating to the Jetty. These include:

Dec 2015…."Esperance Jetties Condition Assessments – Condition Inspection and Maintenance Strategy Report", by BMT JFA, for Shire of Esperance
Sept 2014…"Esperance Tanker Jetty Replacement Concept Design and Costing", by BMT JTA, for Shire of Esperance
Sept 2013…"Esperance Jetties Condition – Jetty Condition Assessment Update", by BMT JFA, for Shire of Esperance
June 2011…"Esperance Tanker Jetty Structural Assessment – Structural Analysis Report", by BG&E, for Shire of Esperance
Oct 2010….."Esperance Tanker Jetty Structural Assessment – Detailed Inspection Report", by BG&E, for Shire of Esperance

The 2015 report identifies the need for immediate repair to the Jetty, particularly at bent 94, where the corbel has both rotted and dislocated such that it is completely ineffective. The deck has subsequently and locally dropped the height of the corbel, being 320mm.

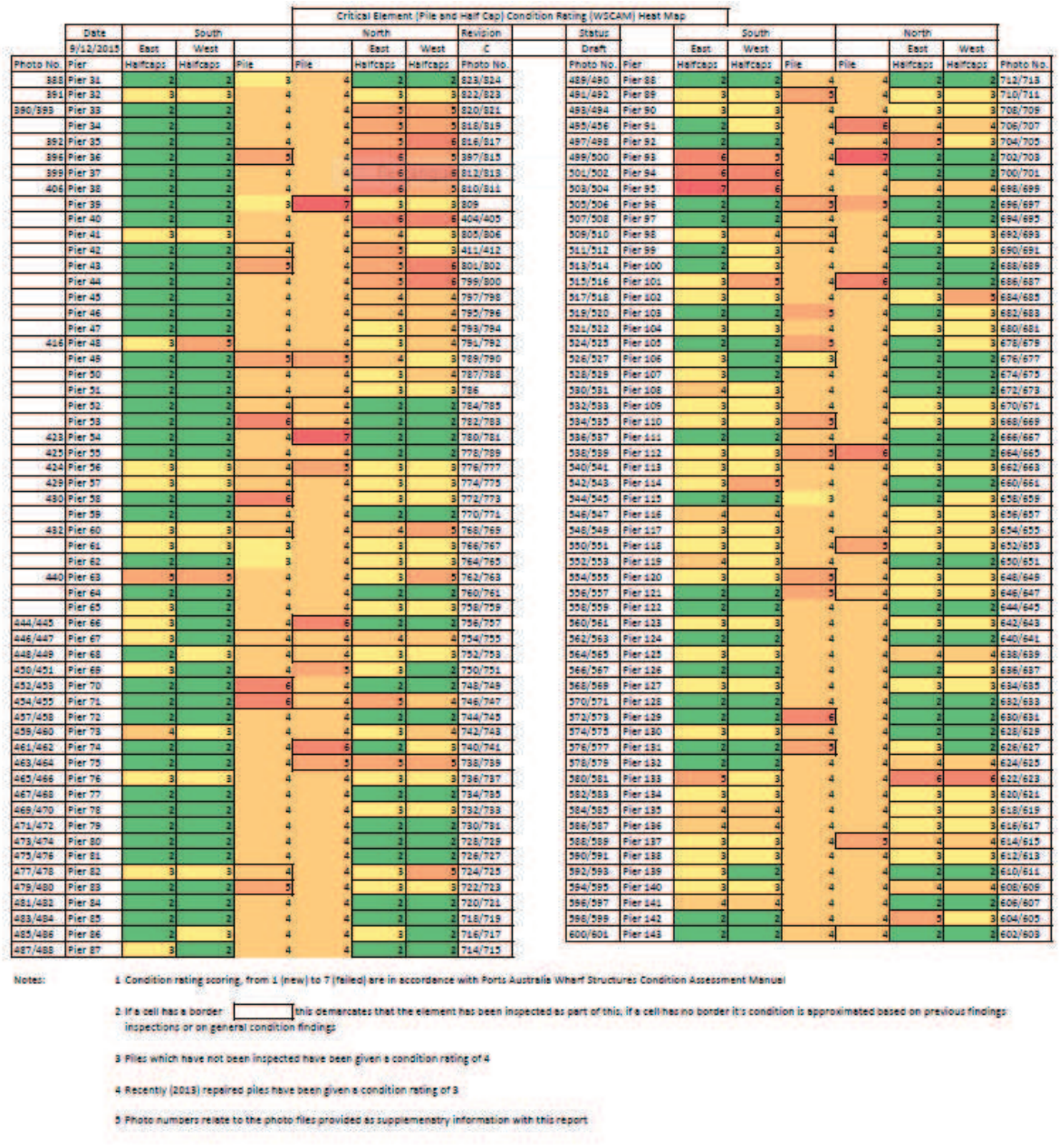
The 2015 report does not claim to be exhaustive in its assessment; rather it acknowledges that it has focussed on the areas of greatest concern. Therefore the report, if read in isolation, can inadvertently present the Jetty in a most unfavourable light. For the condition assessment, the BMT JTA report uses the "Wharf Structure Condition Assessment Manual" (WSCAM) published by Ports Australia. This manual recommends a 1-7 scale rating for deterioration, 7 being the worst. The table below is an extract from the manual, describing this rating system.

Condition State	Peak Score	Mean Score	Expected Rem. Life (% of Original Design Life)	Recommended Action
1	<5	0-3	100	No repairs required. Re-inspection at next scheduled inspection may be considered
2	5-14	4-12	55-100	No repairs required. Re-inspection at next scheduled inspection may be considered
3	15-39	13-31	40-55	Planned and preventative maintenance works may be considered.
4	40-69	32-55	25-40	Further testing; reactive maintenance and some minor upgrades may be considered.
5	70-89	56-71	15-25	Structural assessment is recommended. Maintenance; upgrade or rehabilitation works may be considered.
6	90-100	72-90	0-15	Structural assessment is recommended. Rehabilitation or renewal works may be considered.
7	>100	>90	0	Rehabilitation required immediately or replace component/asset.. Structural assessment is recommended where rehabilitation works are to be undertaken

Figure 1: Condition Rating Scale, courtesy of the WSCAM.

An important table in the report is the condition rating of the piles and headstock-pile joint, using the 1-7 scale cited above. This condition assessment is conveniently presented as a colour-coded table and is reproduced below for convenience. The conclusions that can be drawn from the table are thus:

1. With the exception of bents 93, 94, and 95, the southern pile-headstock (halfcaps) are general sound and attract a condition rating of 2-3.
2. The northern side halfcaps have in general suffered more deterioration compared to the southern side. Halfcaps on bents 33-45 and 133 have all attracted a 5-6 rating
3. The majority of piles have not been inspected and have been assigned a condition rating of 4, based on previous inspections. Only the piles in the worst condition have been inspected as part of the 2015 Report and these piles typically attracting a rating of 6-7.
4. The primary area of structural concern is the Jetty sub-structure, as opposed to the superstructure.



Critical Element (Pile and Half Cap) Condition Rating (WSCAM) Heat Map

Date		South				North		Revision		Status		South				North		
9/12/2015		East	West			East	West	C		Draft		East	West			East	West	
Photo No.	Pier	Halfcaps	Halfcaps	Pile	Pile	Halfcaps	Halfcaps	Photo No.		Photo No.	Pier	Halfcaps	Halfcaps	Pile	Pile	Halfcaps	Halfcaps	Photo No.
388	Pier 31	2	2	3	4	2	2	823/824		489/490	Pier 88	2	2	4	4	2	2	713/713
391	Pier 32	3	3	4	4	3	3	822/823		491/492	Pier 89	3	3	5	4	3	3	710/711
390/393	Pier 33	2	2	4	4	5	5	820/821		493/494	Pier 90	3	3	4	4	3	3	708/709
	Pier 34	2	2	4	4	5	5	818/819		495/496	Pier 91	2	3	4	6	4	4	706/707
392	Pier 35	2	2	4	4	5	6	816/817		497/498	Pier 92	2	2	4	4	5	3	704/705
396	Pier 36	2	2	5	4	6	5	387/815		499/500	Pier 93	6	5	4	7	2	2	702/703
399	Pier 37	2	2	4	4	6	6	812/813		501/502	Pier 94	6	6	4	4	2	2	700/701
406	Pier 38	2	2	4	4	6	5	810/811		503/504	Pier 95	7	6	4	4	4	4	698/699
	Pier 39	2	2	3	7	3	3	809		505/506	Pier 96	2	2	5	5	2	2	696/697
	Pier 40	2	2	4	4	6	6	404/405		507/508	Pier 97	2	2	4	4	2	2	694/695
	Pier 41	3	3	4	4	4	3	805/806		509/510	Pier 98	3	4	4	4	3	3	692/693
	Pier 42	2	2	4	4	5	3	411/412		511/512	Pier 99	2	3	4	4	2	3	690/691
	Pier 43	2	2	5	4	5	6	801/802		513/514	Pier 100	2	3	4	4	2	2	688/689
	Pier 44	2	2	4	4	5	6	799/800		515/516	Pier 101	3	5	4	6	2	2	686/687
	Pier 45	2	2	4	4	4	4	797/798		517/518	Pier 102	3	3	4	4	3	5	684/685
	Pier 46	2	2	4	4	4	4	795/796		519/520	Pier 103	2	2	5	4	2	3	682/683
	Pier 47	2	2	4	4	3	4	793/794		521/522	Pier 104	3	3	4	4	3	3	680/681
416	Pier 48	3	5	4	4	3	4	791/792		524/525	Pier 105	2	2	5	4	2	3	678/679
	Pier 49	2	2	5	5	4	3	789/790		526/527	Pier 106	3	2	3	4	2	2	676/677
	Pier 50	2	2	4	4	3	4	787/788		528/529	Pier 107	3	2	4	4	2	2	674/675
	Pier 51	2	2	4	4	3	3	786		530/531	Pier 108	4	3	4	4	2	2	672/673
	Pier 52	2	2	4	4	2	2	784/785		532/533	Pier 109	3	3	4	4	3	3	670/671
	Pier 53	2	2	6	4	2	2	782/783		534/535	Pier 110	3	3	5	4	3	3	668/669
423	Pier 54	2	2	4	7	2	2	780/781		536/537	Pier 111	2	2	4	4	2	2	666/667
425	Pier 55	2	2	4	4	2	2	778/789		538/539	Pier 112	3	3	5	6	2	2	664/665
424	Pier 56	3	3	4	5	3	3	776/777		540/541	Pier 113	3	3	4	4	3	3	662/663
429	Pier 57	3	3	4	4	3	3	774/775		542/543	Pier 114	3	5	4	4	2	2	660/661
430	Pier 58	2	2	6	4	3	3	772/773		544/545	Pier 115	2	2	3	4	2	3	658/659
	Pier 59	2	2	4	4	2	2	770/771		546/547	Pier 116	4	4	4	4	3	3	656/657
432	Pier 60	3	3	4	4	4	5	768/769		548/549	Pier 117	3	3	4	4	3	3	654/655
	Pier 61	3	3	3	4	3	3	766/767		550/551	Pier 118	3	3	4	5	3	3	652/653
	Pier 62	2	2	3	4	3	3	764/765		552/553	Pier 119	4	3	4	4	2	2	650/651
440	Pier 63	5	5	4	4	3	5	762/763		554/555	Pier 120	3	3	5	4	3	3	648/649
	Pier 64	2	2	4	4	2	2	760/761		556/557	Pier 121	2	2	5	4	3	3	646/647
	Pier 65	3	2	4	4	3	3	758/759		558/559	Pier 122	2	2	4	4	2	2	644/645
444/445	Pier 66	3	2	4	6	2	2	756/757		560/561	Pier 123	3	3	4	4	3	3	642/643
446/447	Pier 67	3	2	4	4	4	4	754/755		562/563	Pier 124	2	2	4	4	2	2	640/641
448/449	Pier 68	2	3	4	4	3	3	752/753		564/565	Pier 125	3	3	4	4	4	4	638/639
450/451	Pier 69	3	2	4	5	3	2	750/751		566/567	Pier 126	2	2	4	4	2	3	636/637
452/453	Pier 70	2	2	6	4	2	2	748/749		568/569	Pier 127	3	3	4	4	3	3	634/635
454/455	Pier 71	2	2	6	4	5	4	746/747		570/571	Pier 128	2	2	4	4	2	2	632/633
457/458	Pier 72	2	2	4	4	2	2	744/745		572/573	Pier 129	2	2	6	4	2	2	630/631
459/460	Pier 73	4	3	4	4	3	4	742/743		574/575	Pier 130	3	3	4	4	2	2	628/629
461/462	Pier 74	2	2	4	6	2	3	740/741		576/577	Pier 131	2	2	5	4	3	2	626/627
463/464	Pier 75	2	2	4	5	5	5	738/739		578/579	Pier 132	2	2	4	4	4	4	624/625
465/466	Pier 76	3	3	4	4	3	3	736/737		580/581	Pier 133	5	3	4	4	6	6	622/623
467/468	Pier 77	2	2	4	4	2	2	734/735		582/583	Pier 134	3	3	4	4	3	3	620/621
469/470	Pier 78	2	2	4	4	3	3	732/733		584/585	Pier 135	4	4	4	4	3	3	618/619
471/472	Pier 79	2	2	4	4	2	2	730/731		586/587	Pier 136	4	4	4	4	3	3	616/617
473/474	Pier 80	2	2	4	4	2	2	728/729		588/589	Pier 137	3	3	4	5	4	4	614/615
475/476	Pier 81	2	2	4	4	2	2	726/727		590/591	Pier 138	3	3	4	4	3	3	612/613
477/478	Pier 82	3	3	4	4	3	5	724/725		592/593	Pier 139	3	2	4	4	2	2	610/611
479/480	Pier 83	2	2	5	4	3	3	722/723		594/595	Pier 140	3	3	4	4	4	4	608/609
481/482	Pier 84	2	2	4	4	2	2	720/721		596/597	Pier 141	4	4	4	4	2	2	606/607
483/484	Pier 85	2	2	4	4	2	2	718/719		598/599	Pier 142	2	2	4	4	5	3	604/605
485/486	Pier 86	2	3	4	4	3	2	716/717		600/601	Pier 143	2	2	4	4	2	2	602/603
487/488	Pier 87	3	2	4	4	2	2	714/715										

Notes:

1 Condition rating scoring, from 1 (new) to 7 (failed) are in accordance with Ports Australia Wharf Structures Condition Assessment Manual

2 If a cell has a border [ ] this demarcates that the element has been inspected as part of this. If a cell has no border it's condition is approximated based on previous findings inspections or on general condition findings

3 Piles which have not been inspected have been given a condition rating of 4

4 Recently (2013) repaired piles have been given a condition rating of 3

5 Photo numbers relate to the photo files provided as supplementary information with this report

Figure 2: Pile and Halfcap Condition Summary, courtesy of the BMT JFA 2015 Report.

8 JETTY INSPECTION

The Jetty was inspected by myself over a two-day period between the 31/08 and 01/09. The Jetty was inspected from both deck level and under the deck, via boat. The inspection was very valuable as it facilitated independent validation of the previously commissioned condition assessments and resulted in the following independent conclusions being made:

a) That the Jetty sub-structure should only be rehabilitated with new materials, as opposed to trying to salvage the existing timber piles or headstocks for structural re-use.
b) Several external stringers have deteriorated to the extent that they needed replacement or strength augmentation. Below are typical examples of stringer that need replacement.

Examples of typical external stringers that require replacement or structural augmentation

c) The internal stringers appear to be in relatively good condition and this is most likely because they are shielded from direct sunlight and salt rich wind. Below are two images showing typical stringers.

Examples of typical internal stringers is relatively sound condition

d) The Jetty deck level is quite irregular and this irregularity should be corrected if the Jetty is rehabilitated.
e) The current concrete deck has sustained cracking and from both a structural and aesthetic point of view should be replaced as part of any rehabilitation regime.

8.1 Addressing Structural Concerns

In regard to the Jetty sub-structure I agree with the sentiment of the most recent Council commissioned report, that immediate rehabilitation is required. I also believe that it is not technically feasible to consider the reuse of any existing piles or headstock for structural purposes. That is, they may be retained or re-used for aesthetic purposes should that be deemed desirable. I am therefore of the opinion that the sub-structure needs to be completely replaced, however, I also believe this can be achieved with reasonable ease and at a cost that much lower than that suggested by the Council. The details of how this could be done are discussed later in Section 9 and the design drawings are contained in Appendix A.

As part of the proposed substructure replacement program, I have also included a construction methodology for re-levelling the deck. This concept is illustrated on Drawing S120 in Appendix A. In practice, this re-levelling task is simply an extra construction activity, undertaken whilst installing the new Jetty bent.

In total there are 48 external stringers that have been identified by myself as requiring replacement or structural augmentation. In section 9 below, I discuss the proposed stringer replacement or strengthening options.

The concrete deck surface is currently laid over the top of the original HW decking and is separated from (debonded) from the HW via a plastic membrane that was placed over the decking, prior to the concrete being poured. Removal of the existing concrete shall therefore be quite easy as it is effectively “loose” on the deck. We recommend that this deck be replaced as part of the rehabilitation program for structural and aesthetic reasons.

8.2 Addressing Community Concerns

The immediate concern for the community is the potential loss of their Jetty. It is easy for critics to dismiss the Jetty as little more than a fishing platform, however, having spoken to several people in the Esperance community it is clear that the Jetty provides the following:

- Yes, it is a fishing platform and also a facility that offers a 500m long promenade or jog route.
- It is an historic and iconic landmark that significantly contributes to the identity of the town and the people who dwell in it.
- It is a constant, that has linked generations along an 81 year timeline and if rehabilitated will continue to do so for generations to come.

On the counter side, should the Jetty be demolished, the following is true:

- There is no coherent or funded plan to rebuild the Jetty. Prior to the writing of this report the only publicly released document pertaining to any new Jetty was the BMT JTA Jetty Options Study of Sept 2014 and some 19 pages long. Whilst preparing this Report the Shire Council engaged and GHD Woodhead, a trading entity of GHD P/L, to develop high-level artistic impressions for a new and somewhat glamourous Jetty. The GHD Woodhead proposal, whilst elegant, is clearly more expensive than the concepts proposed and priced by BMT JTA. I understand Shire Council do not have funds available for any new Jetty and nor has it made any meaningful progress to raise such funding.
- The Jetty length option promoted by the Council is notionally 250m, compared to the current Jetty that is 512m long. A 250m long Jetty would end in 3.1m deep water (at LAT) compared to the current termination in 6m deep water (at LAT).
- Should the current Jetty be demolished prior to securing funding for a new Jetty, as is currently the case, there is a lost opportunity cost. This is because the securing of State or

Federal funding for the new Jetty will be become increasingly difficult as the community and businesses adjust to not having a Jetty.

8.3 Addressing Council Concerns

As an experienced marine and civil engineer I am quite cognisant of the technical and liability issues faced by the Esperance Shire Council in regard to the Jetty. Presently and given the recent BMT JFA Report it is most likely that the Jetty is uninsurable and this the core reason why the Jetty has been closed. With regard to durability, however, I would suggest that the core issue for the Council is both the current and future liability of the Jetty sub-structure, and in particular the components in the tidal zone or below. This is simply because these elements on a marine structure are always the most vulnerable in terms of deterioration – as evidenced on the Tanker Jetty.

Accordingly, any rehabilitation plan must necessarily address both the current, poor condition of the Jetty's substructure and also the future life of the substructure, in particular the piles. The plan described in Section 9 below does both of these things. Importantly, the plan restores the Jetty's sub-structure to brand new condition with a 30-50 year design life, depending on the maintenance program.

Importantly, the rehabilitation program proposed also enables structural certification of the remediated Jetty and this is essential to facilitate the execution of insurance policies.

8.4 Addressing Heritage Concerns

The Jetty is heritage listed, however, had it not been for the intervention of The Jetty Group this Heritage status would have been passed over to facilitate the Jetty's demolition. Indeed, this report is written as part of a submission to the WA Heritage Council. A key part of any heritage preservation is the preservation of the aesthetic, if not the components themselves. Within this report I recommend that the entire Jetty substructure be replaced and likewise, the entire original superstructure be retained, save for the repaired stringers. This is a compromised position and indeed it could be argued that more could be done to preserve both the aesthetic and materials, relative to the baseline case presented below in Section 9. I agree with this position, however, the greater the preservation, the greater the cost. Notwithstanding the cost argument, I have provided the second proposal, which better captures the current Jetty aesthetic, should extra (heritage) funding become available.

9 TECHNICAL SOLUTIONS TO REMEDIATE THE JETTY

Below I present two options for the rehabilitation of the Tanker Jetty. Option 1 is referred to as the baseline case as it represents the most cost-effective solution, but not necessarily the most heritage or aesthetically sensitive solution. This baseline solution has been developed in the absence of any committed rehabilitation funding. It has also been developed as a comparison to the Esperance Shire Council's claim that the Jetty cannot be saved for less than $10M, and moreover, the suggestion that the Council should allocate such funds, should they become real, to the construction of a new, shorter, Jetty.

9.1 Key Design loads

The rehabilitation design proposed herein assumes no vehicles are permitted on the Jetty deck, rather, the design is governed by crowd loading, taken as 5kPa (500kg/m2). Additionally, 10% of this crowd loading has been considered to act simultaneously in the horizontally direction at deck level.

Wave loading on the substructure has also been considered. A design wave with a height of 3m and a period of 7sec was considered. Such a wave would have a crest level just below the underside of the

deck at Highest Astronomic Tide (HAT). The lateral force generated on the piles by this wave is equal to the 10% lateral loading cited above.

9.2 The need for design innovation

From a technical point of view the reporting commissioned by the Council to date has failed to effectively address the central issue, which is, *How could the Jetty be rehabilitated?* I don't believe this question has ever been addressed and maybe it has never been asked. In the most recent BMT JFA report there is reference to the fact that the Jetty is already on its second round of piling and the idea of a third round of piling is largely dismissed as impractical. Indeed, I would agree that to re-pile in the same plane as the existing bents would be impractical, so much so that it necessarily means one should look to re-piling in a different location. This is precisely why the solutions presented below and in Appendix A show the new pile bents 1.2m from the existing. Doing this means that the new bents can be installed without interfering with the existing and likewise, the existing bents can be readily removed after the new bents are installed. This idea is the fundamental difference between this report and all previous reports that suggest, or infer, that rehabilitation is not possible or not practical.

9.3 Option 1 – Baseline Case

The baseline case is presented herein as the most cost-effective solution to preserve the Jetty in its current position and at its current length. It is also the solution that seeks to achieve the lowest cost base whilst addressing the key concerns and aspiration of stakeholders. That is, it is a solution that:

- Preserves the Jetty at is current length for use by the Esperance community and for tourism.
- Replaces the entire sub-structure with new material to address the Shire Councils primary safety, liability, insurance and maintenance concerns.
- Retains the original superstructure, the deck curvature and the Jetty's physical position for Heritage and Indigenous significance.

9.3.1 New Pile Configuration

The existing Jetty has piles installed on the incline, known as raked piles. The inclination of the rake is 1:8. Construction of raked piles is significantly more difficult than the installation of vertical piles. This is primarily because the temporary housing required to support a raked pile during its installation is more complex than that required for a vertical. This is because the driving hammer is inclined and also offset from the pile toe - because of the rake. This lateral offset generates temporary lateral loads during the driving operation and these loads need to be resisted by either the Jetty or the barge from which the piling is being undertaken.

The Jetty in its current condition can only sustain very modest lateral loads and would not be able to resist the temporary loads generated by the driving of raked piles without the inclusion of a secondary support system. This means that the cost and time required to install raked piles would be greater, compared to vertical piles. It was on this basis that vertical piles are proposed for the Baseline case.

9.3.2 The argument for a sleeved pile arrangement

The baseline case incorporates a pile sleeve arrangement. This technique is used to minimise fabrication works over water, or put another way, it is a technique used to maximise fabrication onshore, in a controlled workshop environment. The technique seeks to have entire headframe, or headstock in this case, fabricated offsite and to have these units subsequently installed in a "single" operation. The headstock assembly is therefore fitted with tubes that are larger than the piles and the idea is that the entire assembly can be fitted, or slid, over the driven piles. The gap between the pile and sleeve is filled with a concrete grout to bond the two components together. This technique is common in marine engineering and used throughout Australian and the world.

For the Tanker Jetty it is impossible to slide the new headstock over the previously driven piles because the headstock must be fitted under the existing Jetty. The logical solution is therefore to drive the piles through the sleeve and therefore the headstock assembly must be secured to the Jetty prior to pile installation. I have previously designed a system just like this for the construction of a 140m long temporary bridge in Mackay, Queensland. Below is an image of the suspended headstock frame, complete with sleeves, prior to the piles being inserted (into the sleeves) and driven. In the image below the penultimate bent has the completed pile installed plus a rod suspension system for level adjustment.

Figure 3: Example of a previous program in which piles were driven through a suspend headstock.

The sleeve arrangement is therefore fundamental to the success of the sub-structure rebuild, as it facilitates:

a) High quality offsite fabrication and painting of the entire headstock, with no requirement for welding or painting over water.
b) A temporary piling gate arrangement is not required as the sleeve performs this function.
c) Pile position tolerance is guaranteed as the piles are driven through their permanent headstock.
d) Headstock installation can be advanced ahead of the piling works to ensure this activity is not on the construction programs critical path.
e) Prior to grouting the pile-sleeve assembly, the pile and sleeved headstock can be used to relevel the deck.

9.3.3 New Pile Bent Position

As previous mentioned herein, it is impractical to consider the installation of a new sub-structure bent in the same location as the current bent. It is therefore proposed that the new bents be located 1.2m away from the existing bents. The 1.2m distance was selected for practical reasons to aid in

construction and in this sense there is some latitude to alter the dimension should there be an argument to do so.

The proposed design assumes that the existing bents provide no support to the rehabilitated Jetty and therefore the existing bents can be completed removed, if so desired. Presently there is a butt joint between adjacent stringers on every second bent - each stringer spans two bents. Clearly, an existing bent under a stringer joint can't be removed prior to the joint being modified. The modification proposed is the installation of a 1.2m long aluminium slice plate across each stringer joint. The plate does not need to reinstate the flexural capacity of the stringer, rather, its design purpose is to transfer only shear between the two stringers. The splice detail has been developed assuming the stringers are seasoned Jarrah with a joint strength Group classification of JD2. The slice detail is shown on drawing S107.

9.3.4 Superstructure works

The existing HW stringers are generally in good condition, with the exception of several external stringers, which display unacceptable deterioration. These individual stringers have been identified on the rehabilitation drawings and must be replaced, or repaired. The proposal herein includes two options for this repair, either using a retrofitted aluminium beam, that will be hidden from view, or a new compound HW timber member. Both options are equally viable and shown on Drawing S108.

A new 130mm thick concrete walking surface is proposed for the Jetty. The current decking is 100mm thick fibremesh. The new concrete deck has been sized to carry the 5kPa crowd load in full. That is, the existing original HW deck timbers, that shall remain in place, are not required from a strength point of view, rather, they will function only as the soffit form - as they did for the original concrete pour.

9.3.5 Durability

The Baseline case presents a steel sub-structure solution, which is typical for modern marine works in Australia. The durability treatment that has been assumed and costed within this report is as follows:

a) All mild carbon steel has been sized assuming a 3mm corrosion loss all round.
b) A passive zinc anode cathodic protection system for all piles has been assumed and costed.
c) A marine epoxy paint system, such as Interzone 954, to all mild carbon steel has been assumed and costed.

The durability regime listed above is typical for all modern commercial marine infrastructure around Australia, save for the fact that on major infrastructure an impressed current cathodic protection system is used, as opposed to the anode system proposed here. Such a regime is considered to provide a design life of 30-50 years depending on the degree of maintenance provided by the asset owner and the prevailing environmental conditions (water temperature, swell height).

9.4 Option 2 – Improved aesthetic and heritage case

The baseline case was developed to fulfil the requirement for the most cost effective design solution. The aesthetic of vertical piles is, however, not overly sympathetic to the original bent geometry. Accordingly, a second design option is presented, refer drawing S115, which is in principle similar to the baseline case, however, there are two key differences. Those being the piles are installed with the 1:8 rake, as per the current Jetty, and the piles are shown as HW timber piles. Whilst not shown on the drawings, the use of steel tubular piles (instead of HW timber) for this case is very much an option.

The use of unprotected HW timber piles does have the potential to attract durability concerns. The Australian Guidelines for the Design of Maritime Structures, AS4997, suggests that timber piles exposed to marine organisms have an expected duration until the “first maintenance” of 5-10 years. Conversely, if the pile is not exposed to marine organisms the duration to first maintenance is cited as 10-30 years. It is important to appreciate that exposure is not necessarily connected to chemical treatment of the pile. That is, a chemically treated pile may still be vulnerable to marine organism attack, such as the toredo worm. The best protection available for a timber pile is to physical wrap it in a membrane to prevent exposure to the marine organism larvae that migrate through the tidal zone.

The most likely source for HW piles would be the Australian supplier “Koppers”. Kopper’s recommend double H6 chemical treatment for marine piles and suggest that this treatment, in southern (cooler) waters, will achieve a design life of 30 years. If the pile is wrapped with a membrane, they suggest a 75 year design life is achievable.

At this stage we have opted to show a full wrap system for timber piles, to avoid debate over durability issues. The protection system proposed is the Denso “Seashield Series 60 System”, a copy of the supplier’s Brochure is included in Appendix B. A final visible sheath of this wrapping system is black HDPE (plastic). The visible portion of the piles will therefore be black in colour.

9.5 Abutment works and Heritage Opportunity

The current abutment span is a 20m long aluminium gangway onto the existing Jetty. The gangway is approximately 1.9m wide (clear), whereas the Jetty is 4.6m wide. A photo of the gangway-jetty connection is shown below. It has been assumed that this existing arrangement will remain for the baseline case, to minimise costs. However, the opportunity exists to improve upon this somewhat unattractive and relatively narrow entrance onto the Jetty. In particular, I suggest consideration be given to the design of a special feature “Entry span” constructed from or featuring original and salvaged Jetty timber. We suggest the cost of such an entry span (4.6m wide x 20m long) would be in the order of $200,000.

Current aluminium gangway span onto the Jetty

10 REHABILITATION COSTING AND CONSTRUCTION PROGRAM

The baseline case presented in the design drawings (Appendix A) was issued to a third party Marine construction contractor based in Western Australia. This company has provided an independent construction estimate for the project and they are also a contender for executing the works should

they proceed. Below is a high level Capital Cost summary followed by a more detailed breakdown. The headline construction cost is $5.9M but a 20% contingency allowance takes the estimate, for budgetary purposes, to $7.1M.

High Level Cost Estimate Breakdown		
Item	Cost	
Mobilisation and Preliminaries	$	467,150
New Piling works	$	2,044,336
New Headstocks and removal of existing bents	$	2,442,720
New ConcreteDeck & Stringer repair	$	397,698
New Deck furniture and lighting	$	324,560
Professional Services	$	250,000
Total	**$**	**5,926,464**
Contingency (20%)	$	1,185,293
Budget Estimate	**$**	**7,111,756**

Figure 4: Capital Cost Summary.

Cost	Description	No. off	Unit price	Unit weight kg/m	Unit length m	Total weight kg
	Mobilisation and Preliminaries					
$ 287,658	Mobilisation and demobilisation	1	287,658			
$ 127,168	Insurance and Project Management	1	127,168			
$ 52,324	Existing Services removal	1	52,324			
	New Piling works					
$ 2,044,336	Dia. 323 x 9 Pile (avg. length 16m)	224	9,127	73.7	16.000	264,141
	Marine epoxy finish to 3m below bed level (Interzone 954)	item				
	Surveyor costs	item				
	Zinc anode CP System (supply and installed)	item				
	Labour and Installation costs	item				
	New Headstock + stringer splice plates					
$ 2,442,720	200x150x9 RHS Headstock	112	21,810	37.7	4.900	20690
	89x6 Btm Chord	112		14.6	4.900	8012
	89x6 Braces	224		14.6	3.000	9811
	Dia. 406x9.5 Pile Sleeve	224		93.0	2.400	49997
	Marine epoxy finish	item				
	Supply and install Alum. String splice plates	275		4.05	1.2	1337
	Re-leveling of deck	item				
	Removal of existing substructure below stringer level	item				
	Labour and barges	item				
	Deck Remediation					
$ 50,000	Removal of existing concrete deck	item				
$ 100,425	New 130mm concrete deck, 4.57m wide	515	195			
$ 52,273	New HW edge kerb (120x35)	1030	50.75			
$ 27,000	Kerb brackets	900	30			
$ 168,000	Replace/reposition rotten stringers	48	3500			
	Deck Furniture and Services					
$ 79,200	Supply and Install Hydrib light, 6m HDG hinged pole	6	13,200			
$ 109,180	Alum. handrail and posts northern side	515	212	3.025	515	1558
$ 109,180	Alum. handrail and posts southern side	515	212	3.025	515	1558
$ 15,000	Fish Cleaning station + water supply	1	15000			
$ 12,000	Bench seating along jetty	10	1200			
	Professional Services					
$ 200,000	Civil and Structural Design	item				
$ 20,000	CP Design	item				
$ 15,000	Pile PDA testing, 4 No. test	item				
$ 15,000	Timber strength testing	item				
$ 5,926,464	**Total**					
$ 1,185,293	Contigency	20%				
$ 7,111,756	**Grand total**					

Figure 5: Capital Cost Breakdown.

10.1 Whole of Life Costing

Below is a whole of life, net present value (NPV), costing for the Jetty over the next 50 years. The 50 year whole of life costing for the baseline solution is $9.7M. As shown in the table, maintenance works are programed every five (5) years and the NPV of these works vary from $100K to $600K on each occasion. Over the 50 year period the total amount allocated to repair and maintenance is $2.6M, meaning on average the annual maintenance budget of approximately $52,000 (NPV) is required.

Whole of Life Costing

	Capital Costs		Maintanence				Sub-Total Summary		NPV Assessment					
Year	Cost	Description	Inspections	Paint Repair (sub-structure)	Timber repair (superstructure)	Anode inspection (Dive team)	Capital Exp	Maintanence Sub total	Cap Ex + Maintanence	Contingency (20%)	Cap Ex + Maintanence+ Contigency	+ Inflation @ 3% pa	Discount @ 6% pa	NPV
1	$ 5,926,464	Jetty Rehabilitation					$ 5,926,464	$ -	$ 5,926,464	$1,185,293	$ 7,111,756	$ 7,111,756	100%	**$ 7,111,756**
2							$ -	$ -	$ -	$ -	$ -	$ -	94%	**$ -**
3							$ -	$ -	$ -	$ -	$ -	$ -	89%	**$ -**
4							$ -	$ -	$ -	$ -	$ -	$ -	84%	**$ -**
5	$ 60,000	Fab Inspection/access frame	$ 63,000			$ 50,000	$ 60,000	$ 113,000	$ 173,000	$ 34,600	$ 207,600	$ 233,656	79%	**$ 185,077**
6							$ -	$ -	$ -	$ -	$ -	$ -	75%	**$ -**
7							$ -	$ -	$ -	$ -	$ -	$ -	70%	**$ -**
8							$ -	$ -	$ -	$ -	$ -	$ -	67%	**$ -**
9							$ -	$ -	$ -	$ -	$ -	$ -	63%	**$ -**
10			$ 63,000	$ 75,000	$ 200,000		$ -	$ 338,000	$ 338,000	$ 67,600	$ 405,600	$ 529,216	59%	**$ 313,242**
11							$ -	$ -	$ -	$ -	$ -	$ -	56%	**$ -**
12							$ -	$ -	$ -	$ -	$ -	$ -	53%	**$ -**
13							$ -	$ -	$ -	$ -	$ -	$ -	50%	**$ -**
14							$ -	$ -	$ -	$ -	$ -	$ -	47%	**$ -**
15			$ 63,000	$ 75,000	$ 200,000	$ 50,000	$ -	$ 388,000	$ 388,000	$ 77,600	$ 465,600	$ 704,262	44%	**$ 311,496**
16							$ -	$ -	$ -	$ -	$ -	$ -	42%	**$ -**
17							$ -	$ -	$ -	$ -	$ -	$ -	39%	**$ -**
18							$ -	$ -	$ -	$ -	$ -	$ -	37%	**$ -**
19							$ -	$ -	$ -	$ -	$ -	$ -	35%	**$ -**
20			$ 63,000	$ 75,000	$ 200,000		$ -	$ 338,000	$ 338,000	$ 67,600	$ 405,600	$ 711,222	33%	**$ 235,068**
21							$ -	$ -	$ -	$ -	$ -	$ -	31%	**$ -**
22							$ -	$ -	$ -	$ -	$ -	$ -	29%	**$ -**
23							$ -	$ -	$ -	$ -	$ -	$ -	28%	**$ -**
24							$ -	$ -	$ -	$ -	$ -	$ -	26%	**$ -**
25			$ 63,000	$ 75,000	$ 200,000	$ 50,000	$ -	$ 388,000	$ 388,000	$ 77,600	$ 465,600	$ 946,469	25%	**$ 233,758**
26							$ -	$ -	$ -	$ -	$ -	$ -	23%	**$ -**
27							$ -	$ -	$ -	$ -	$ -	$ -	22%	**$ -**
28							$ -	$ -	$ -	$ -	$ -	$ -	21%	**$ -**
29							$ -	$ -	$ -	$ -	$ -	$ -	20%	**$ -**
30		Significant timber replacement	$ 63,000	$ 75,000	$ 1,000,000		$ -	$ 1,138,000	$ 1,138,000	$ 227,600	$ 1,365,600	$ 3,218,126	18%	**$ 593,927**
31							$ -	$ -	$ -	$ -	$ -	$ -	17%	**$ -**
32							$ -	$ -	$ -	$ -	$ -	$ -	16%	**$ -**
33							$ -	$ -	$ -	$ -	$ -	$ -	15%	**$ -**
34							$ -	$ -	$ -	$ -	$ -	$ -	15%	**$ -**
35		Significant timber replacement	$ 63,000	$ 75,000	$ 1,000,000	$ 50,000	$ -	$ 1,188,000	$ 1,188,000	$ 237,600	$ 1,425,600	$ 3,894,604	14%	**$ 537,111**
36							$ -	$ -	$ -	$ -	$ -	$ -	13%	**$ -**
37							$ -	$ -	$ -	$ -	$ -	$ -	12%	**$ -**
38							$ -	$ -	$ -	$ -	$ -	$ -	12%	**$ -**
39							$ -	$ -	$ -	$ -	$ -	$ -	11%	**$ -**
40			$ 63,000	$ 75,000	$ 100,000		$ -	$ 238,000	$ 238,000	$ 47,600	$ 285,600	$ 904,503	10%	**$ 93,214**
41							$ -	$ -	$ -	$ -	$ -	$ -	10%	**$ -**
42							$ -	$ -	$ -	$ -	$ -	$ -	9%	**$ -**
43							$ -	$ -	$ -	$ -	$ -	$ -	9%	**$ -**
44							$ -	$ -	$ -	$ -	$ -	$ -	8%	**$ -**
45			$ 63,000	$ 75,000	$ 100,000	$ 50,000	$ -	$ 288,000	$ 288,000	$ 57,600	$ 345,600	$ 1,268,854	8%	**$ 97,713**
46							$ -	$ -	$ -	$ -	$ -	$ -	7%	**$ -**
47							$ -	$ -	$ -	$ -	$ -	$ -	7%	**$ -**
48							$ -	$ -	$ -	$ -	$ -	$ -	6%	**$ -**
49							$ -	$ -	$ -	$ -	$ -	$ -	6%	**$ -**
50							$ -	$ -	$ -	$ -	$ -	$ -	6%	**$ -**
Total	**$ 5,986,464**		**$ 378,000**	**$ 600,000**	**$ 3,000,000**	**$ 250,000**	**$ 5,986,464**	**$ 4,417,000**	**$ 10,403,464**	**$2,080,693**	**$ 12,484,156**	**$ 19,522,667**	**$ 17**	**$ 9,712,362**

BONACCI INFRASTRUCTURE

10.2 Construction Program (Timing)

With respect to program, different Marine contractors will use different plant and may approach the construction staging in different ways. Nevertheless, there are practical constraints that will be common to all bidders of the work and in this sense a construction program estimate can be developed. Again, I have sought and received external advice concerning construction timelines and offer the following summary for the purposes of preliminary planning. I highlight my expectation that this preliminary program is likely to be reduced in a competitive tender situation.

Whilst undertaking water based construction activities, I suggest that the contractor should program the works such that the critical path (a program concept) is the installation and driving of piles. Removal of the existing concrete deck and its replacement should be off the critical path. Likewise, the stringer replacement should be off the critical path and this is done by having a separate work front for this activity. If this is done, the headstock installation could be programmed as the critical path on a 1.5 day cycle time in which all other activities happen in parallel and off the critical path. Doing this brings the core construction program to 34 weeks (28 weeks const. + 6 weeks inclement weather). As per the budget cost estimate, allow for a 20% contingency this means the entire construction program could take up to 40 weeks to complete.

In addition to the above, the Jetty could be progressively opened to the public, in say 3No. x 170m long sections. Below is a high level overall program after funding is secured:

- 1 month for Design and Consultation
- 1 month for Approvals and Shire Council ratification
- 1 month tender period
- 1 month to review tender, negotiations and award.
- 1 month post award before the Contractor is mobilised on site, plus the commencement of early procurement activities (1st batch of piles and headstocks + painting).
- 9 months construction, but open a 170m long section every 3 months

Appendix A: Design drawings

Appendix B: Denso Seashield series 60 system

Appendix C: Company capability brochures

Appendix D: Terry Memory CV

GENERAL ARRANGMENT - EXISTING TANKER JETTY

SCALE 1 : 1500

Issue	Revision	Date	By	App.
P2	PRELIMINARY ISSUE - REVISED SHEET NUMBERS	07.09.16	FS	TJM
P1	PRELIMINARY ISSUE	30.08.16	FS	TJM

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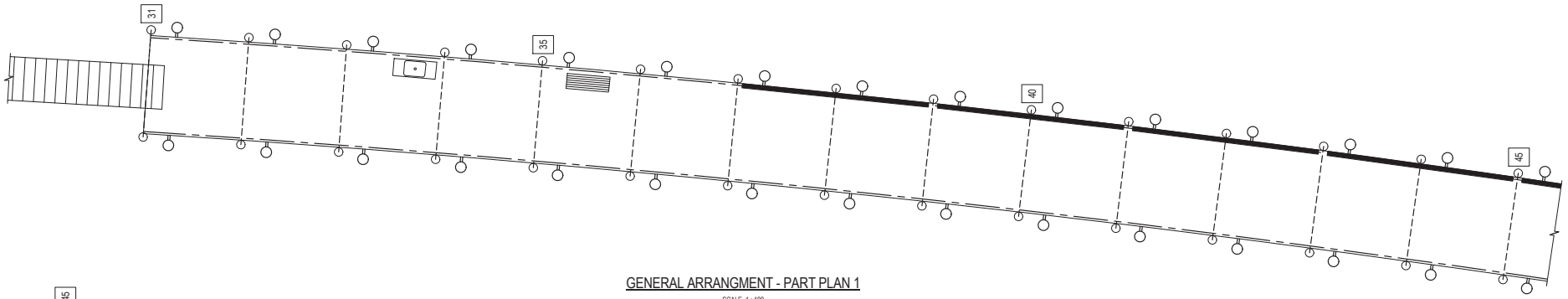
Project
TANKER JETTY
REHABILITATION

Drawing Title
GENERAL ARRANGEMENT PLAN

PRELIMINARY

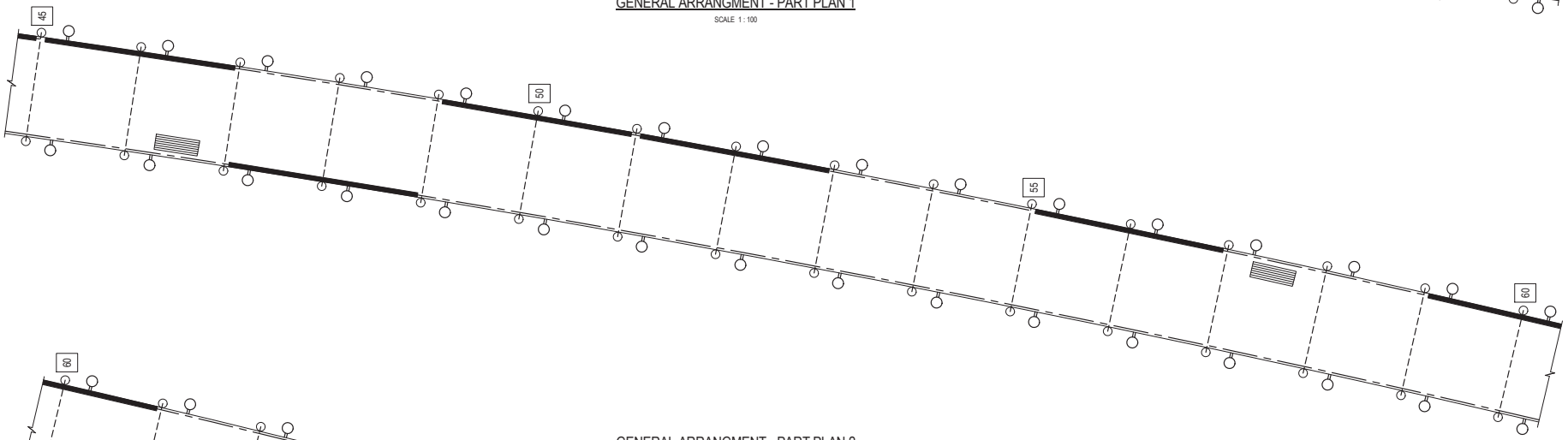
Designed	TJM	Project Director Approved	Date: SEP 2016
Drawn	FS		North
Scale	AS SHOWN	Project Ref: B4222	Drawing No: S101
Date			Issue: P2

Plotted on: 7/09/2016 3:06:00 PM



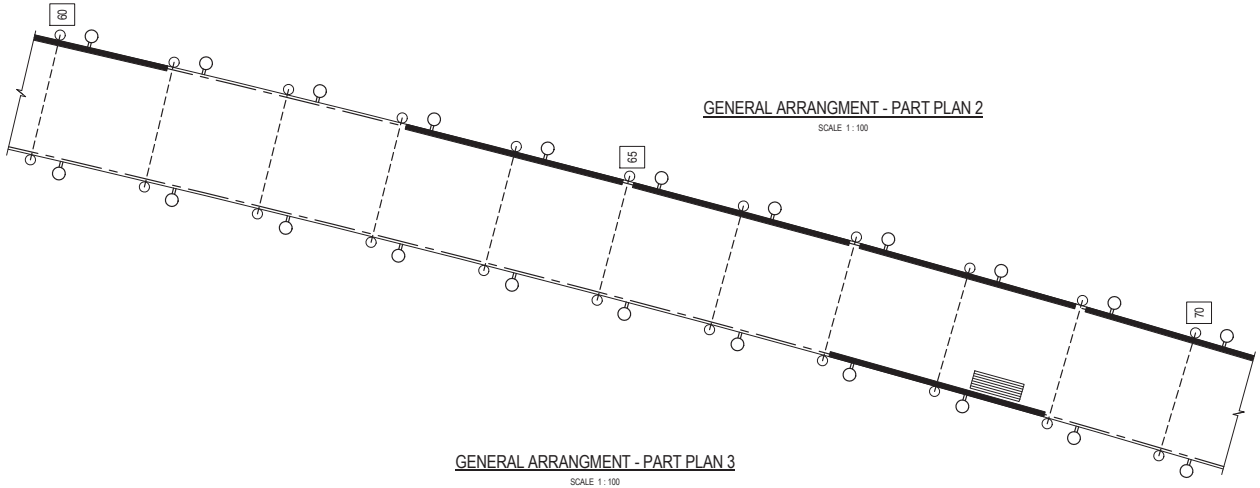
GENERAL ARRANGMENT - PART PLAN 1

SCALE 1 : 100



GENERAL ARRANGMENT - PART PLAN 2

SCALE 1 : 100



GENERAL ARRANGMENT - PART PLAN 3

SCALE 1 : 100

REFER DRG...S103 FOR CONTINUATION

LEGEND:

- DENOTES EXISTING PILES & HEADSTOCKS
- DENOTES NEW PILES & HEADSTOCKS
- DENOTES REPLACEMENT OF EXISTING STRINGER LOCATIONS
- DENOTES HANDRAIL EXTENT
- DENOTES BENCH SEATING
- DENOTES FISH CLEANING STATION

Issue	Revision	Date	By	App.
P3	PRELIMINARY ISSUE - REVISED SHEET NUMBERS	07.09.16	FS	TJM
P2	PRELIMINARY ISSUE - SECTIONS ADDED	05.09.16	FS	TJM
P1	PRELIMINARY ISSUE	29.08.16	FS	TJM

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Project
TANKER JETTY REHABILITATION

Drawing Title
GENERAL ARRANGEMENT PART PLANS - SHEET 1

PRELIMINARY

Designed	TJM	Project Director Approved	Date: SEP 2016
Drawn	FS		
Scale	AS SHOWN		
Date			

Project Ref	Drawing No	Issue
B4222	S102	P3

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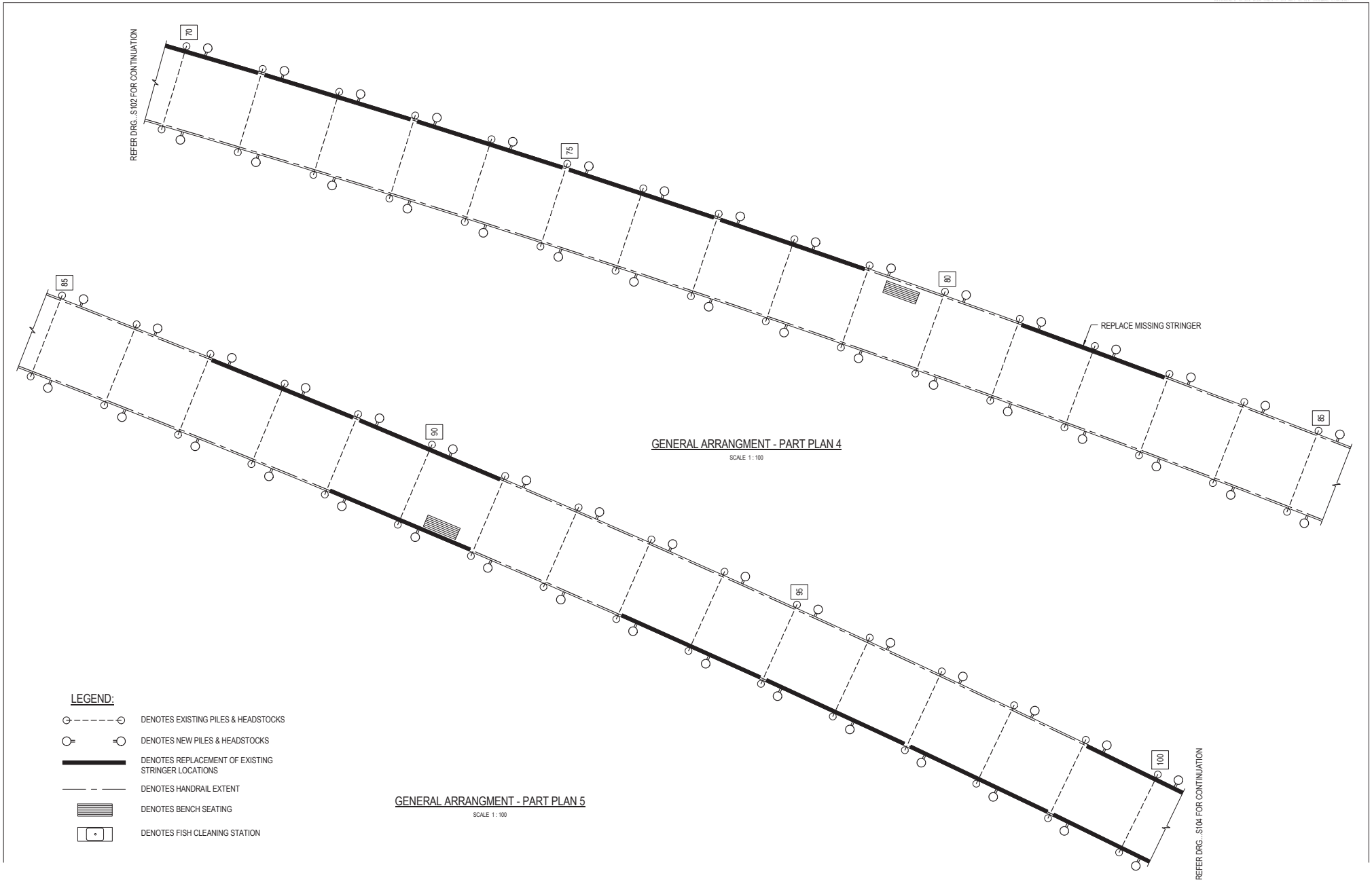

GENERAL ARRANGMENT - PART PLAN 4

SCALE 1 : 100

GENERAL ARRANGMENT - PART PLAN 5

SCALE 1 : 100

LEGEND:

- DENOTES EXISTING PILES & HEADSTOCKS
- DENOTES NEW PILES & HEADSTOCKS
- DENOTES REPLACEMENT OF EXISTING STRINGER LOCATIONS
- DENOTES HANDRAIL EXTENT
- DENOTES BENCH SEATING
- DENOTES FISH CLEANING STATION

Issue	Revision	Date	By	App.
P3	PRELIMINARY ISSUE - REVISED SHEET NUMBERS	07.09.16	FS	TJM
P2	PRELIMINARY ISSUE - SECTIONS & DETAILS ADDED	05.09.16	FS	TJM
P1	PRELIMINARY ISSUE	29.08.16	FS	TJM

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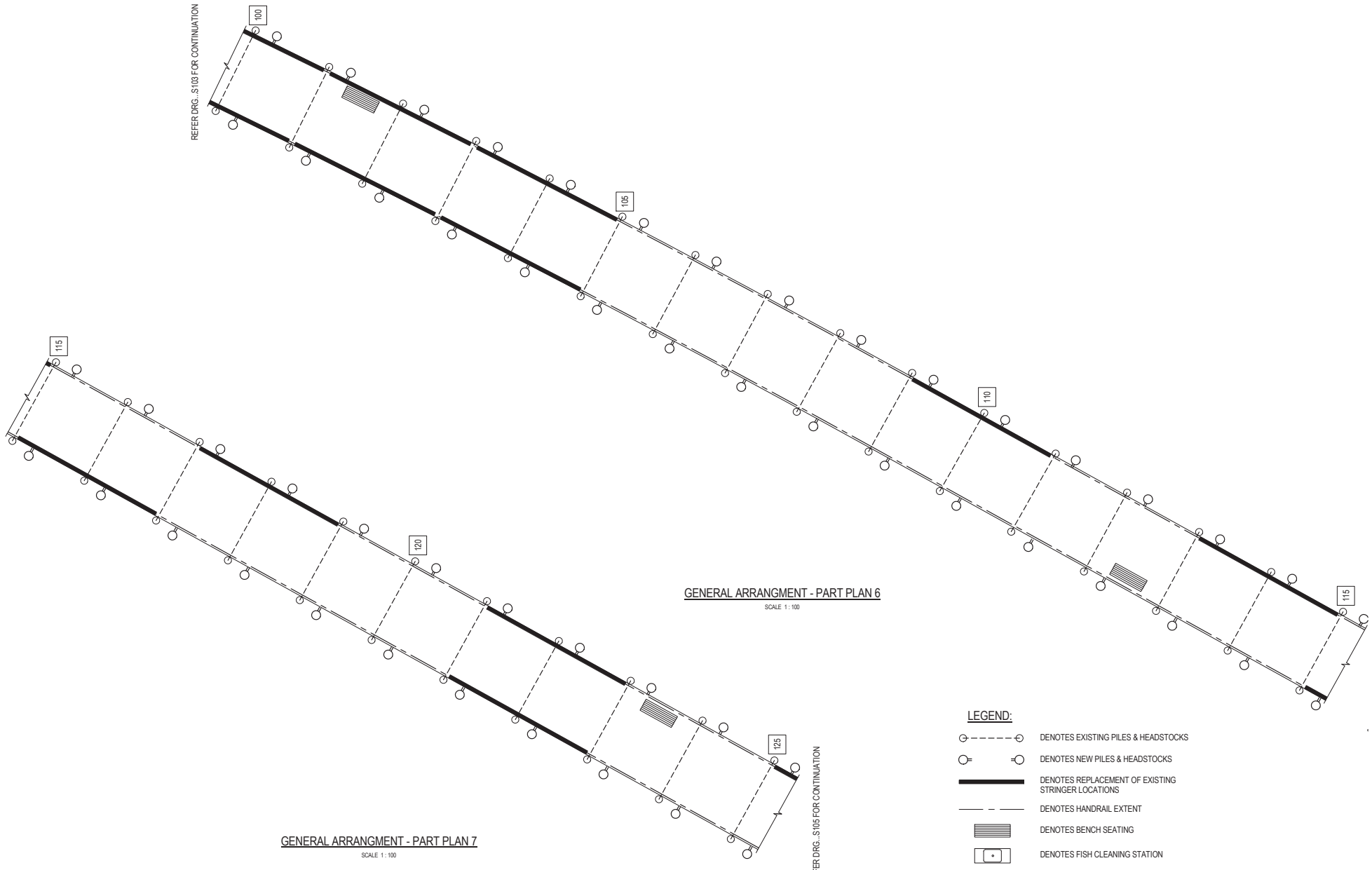
Project
TANKER JETTY
REHABILITATION

Drawing Title
GENERAL ARRANGEMENT PART PLANS - SHEET 2

PRELIMINARY

Designed	TJM	Project Director Approved	Date: SEP 2016
Drawn	FS		North
Scale	AS SHOWN	Project Ref: B4222	Drawing No: S103
Date			Issue: P3

Plotted on: 7/09/2016 3:06:04 PM



GENERAL ARRANGMENT - PART PLAN 6

SCALE 1 : 100

GENERAL ARRANGMENT - PART PLAN 7

SCALE 1 : 100

Issue	Revision	Date	By	App.
P2	PRELIMINARY ISSUE - REVISED SHEET NUMBERS	07.09.16	FS	TJM
P1	PRELIMINARY ISSUE	30.08.16	FS	TJM

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Project
TANKER JETTY REHABILITATION

Drawing Title
GENERAL ARRANGEMENT PART PLANS - SHEET 3

PRELIMINARY

Designed	TJM	Project Director Approved	Date: SEP 2016
Drawn	FS		North
Scale	AS SHOWN		
Date			

Project Ref	Drawing No	Issue
B4222	S104	P2

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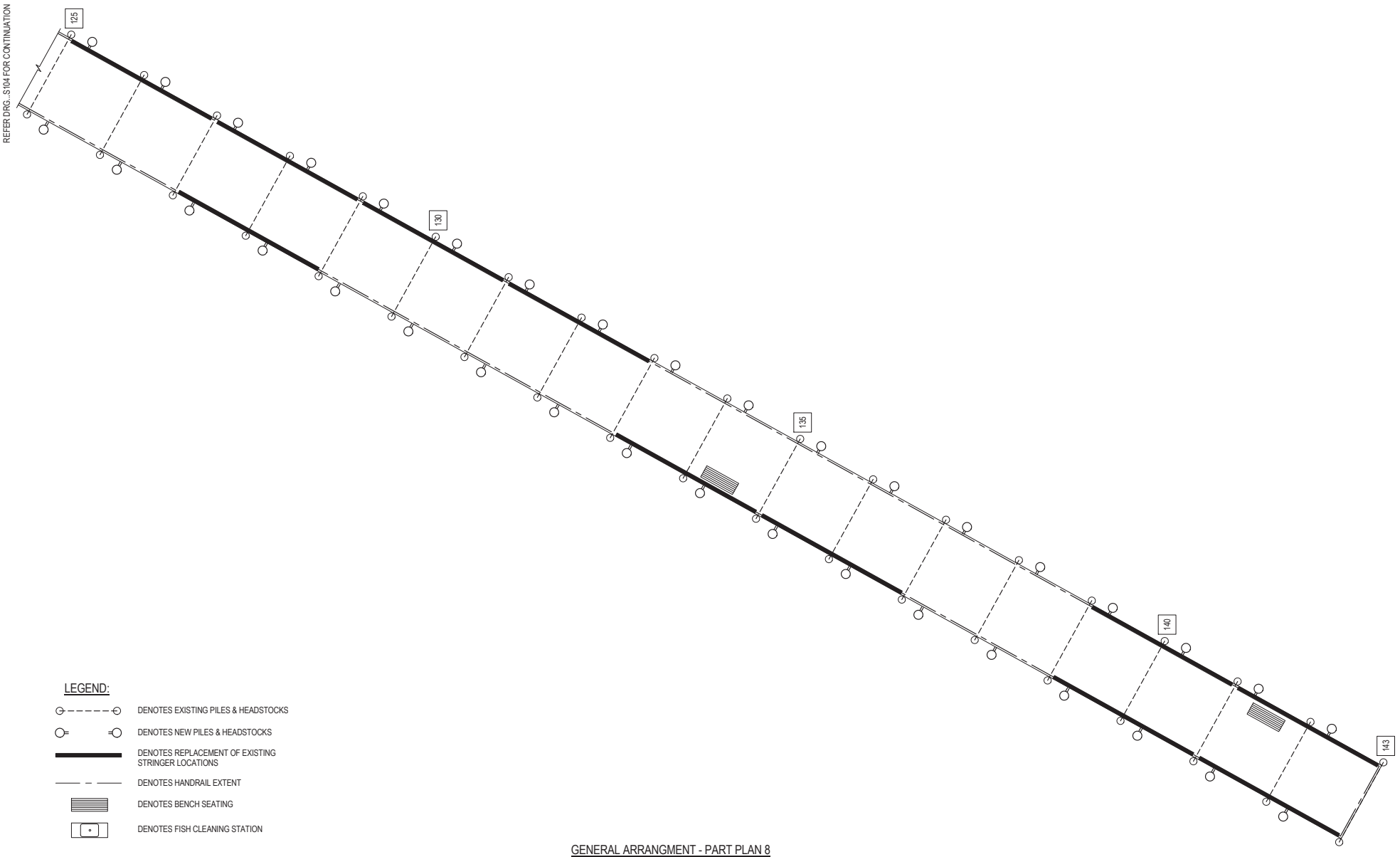

LEGEND:

- DENOTES EXISTING PILES & HEADSTOCKS
- DENOTES NEW PILES & HEADSTOCKS
- DENOTES REPLACEMENT OF EXISTING STRINGER LOCATIONS
- DENOTES HANDRAIL EXTENT
- DENOTES BENCH SEATING
- DENOTES FISH CLEANING STATION

GENERAL ARRANGMENT - PART PLAN 8

SCALE 1 : 100

Issue	Revision	Date	By	App.
P2	PRELIMINARY ISSUE - REVISED SHEET NUMBERS	07.09.16	FS	TJM
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Project
TANKER JETTY REHABILITATION

Drawing Title
GENERAL ARRANGEMENT PART PLANS - SHEET 4

PRELIMINARY

Designed	TJM	Project Director Approved	Date: SEP 2016
Drawn	FS		North
Scale	AS SHOWN	Project Ref: B4222	Drawing No: S105
Date			Issue: P2

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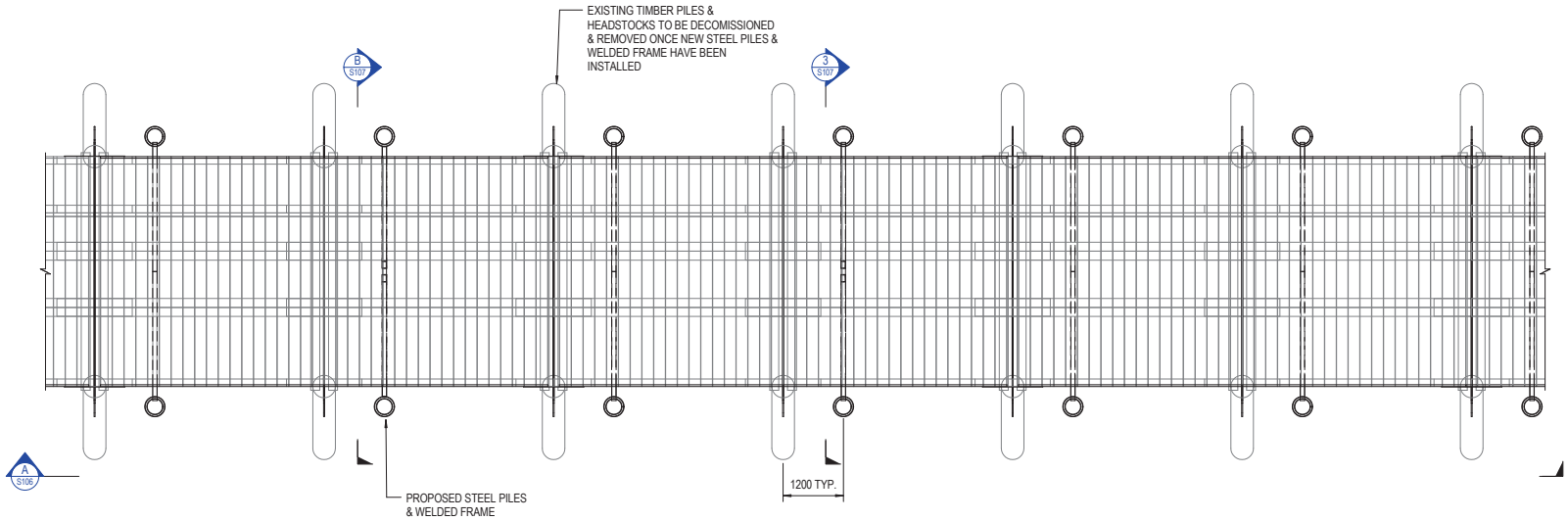
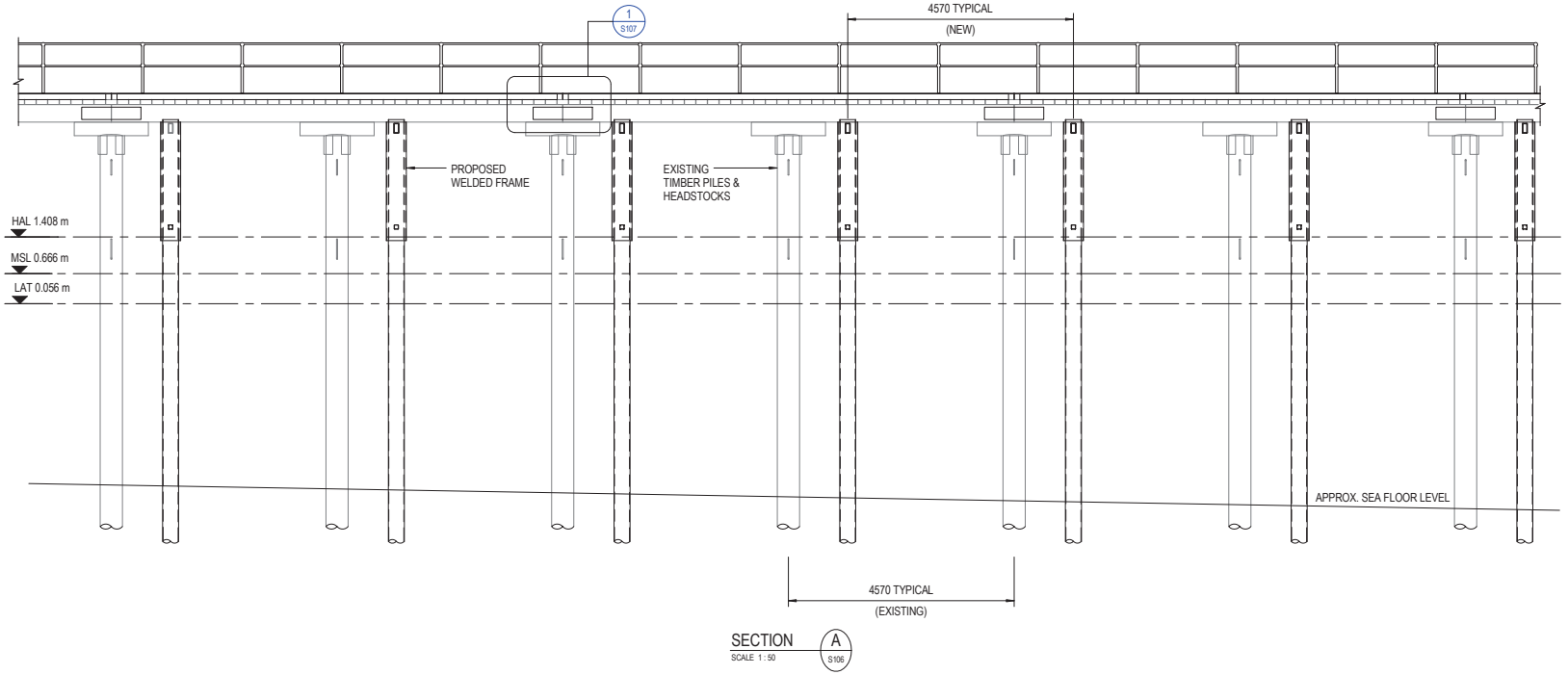


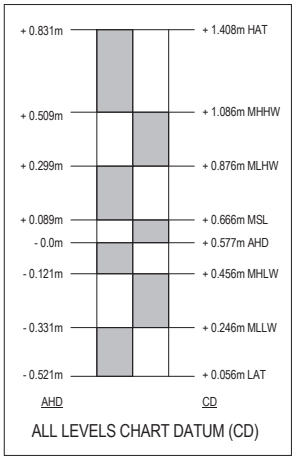
ESPERANCE TANKER JETTY PART PLAN-4.57m OPTION

SCALE 1 : 50



SECTION A S106

SCALE 1 : 50



ALL LEVELS CHART DATUM (CD)

DATUMS & TIDAL DATA

SCALE 1 : 10

Issue	Revision	Date	By	App.
P2	PRELIMINARY ISSUE - REVISED SHEET NUMBERS	07.09.16	FS	TJM
P1	PRELIMINARY ISSUE	30.08.16	FS	TJM

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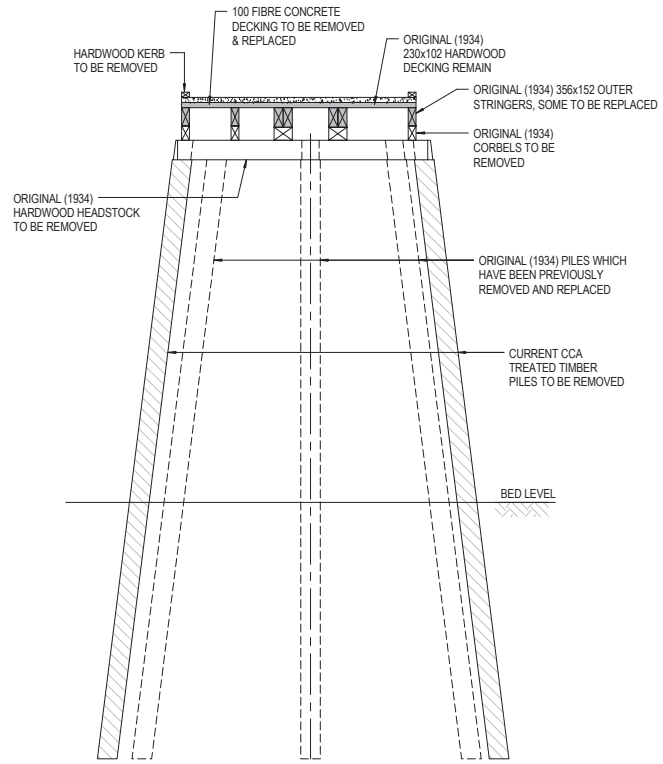
Project
TANKER JETTY REHABILITATION
Drawing Title
TYPICAL BENT AT 4.57m CRS PART PLAN & ELEVATIONS

PRELIMINARY

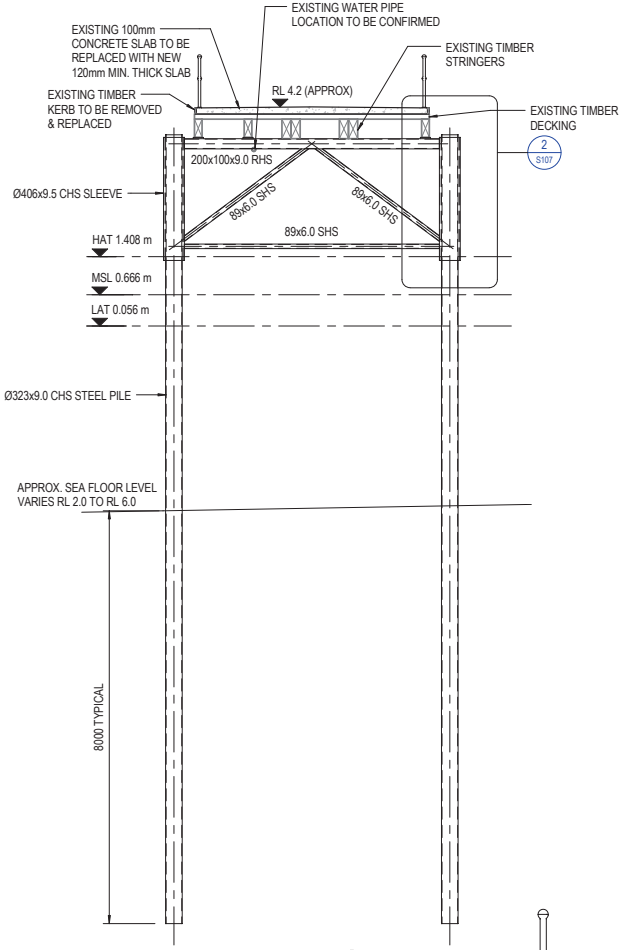
Designed	TJM	Project Director Approved	Date: AUG 2016
Drawn	FS		North
Scale	AS SHOWN	Project Ref: B4222	Drawing No: S106
Date			Issue: P2

Plotted on: 7/09/2016 3:06:09 PM



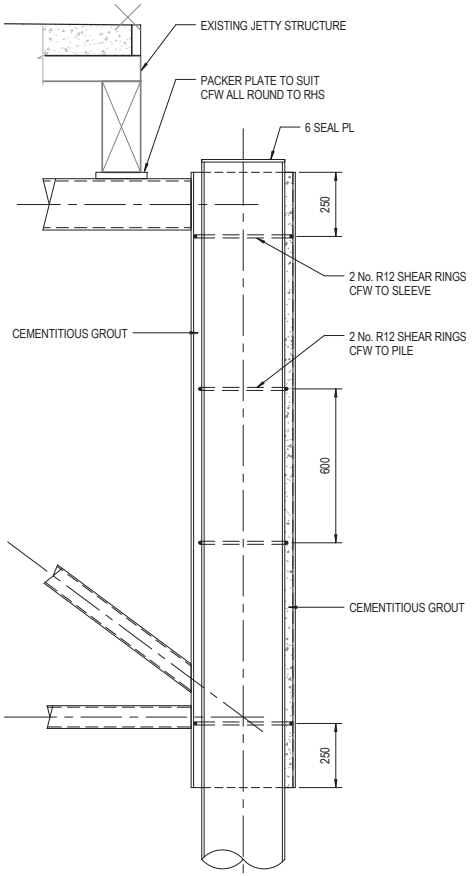
TYPICAL SECTION THROUGH EXISTING JETTY

SCALE 1 : 50



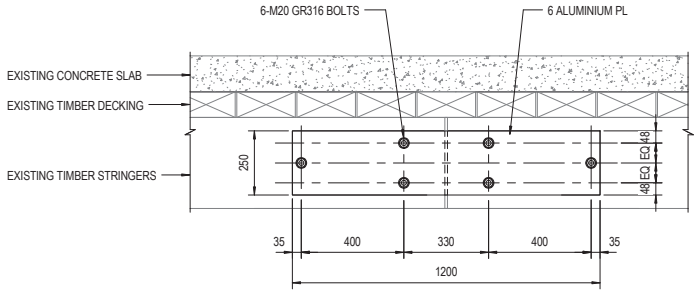
SECTION B S106

SCALE 1 : 50



DETAIL 2 S107

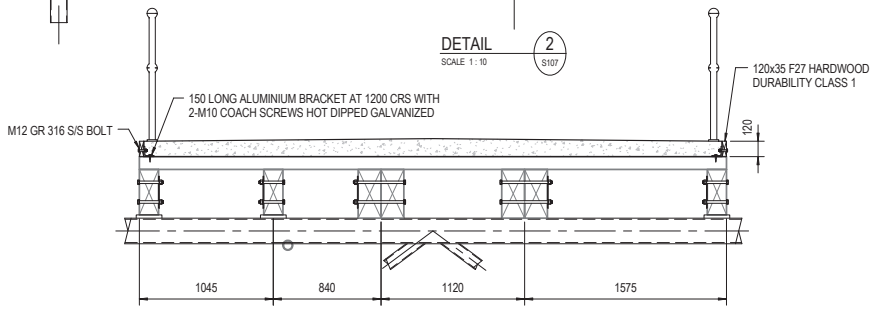
SCALE 1 : 10



TYPICAL STRINGER SPLICE DETAIL - OPTION 1

DETAIL 1 S106

SCALE 1 : 10



TYPICAL SECTION THROUGH NEW DECKING WORKS

SECTION 3 S106

SCALE 1 : 20

Issue	Revision	Date	By	App.
P1	PRELIMINARY ISSUE	07.09.16	FS	TJM

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Project
TANKER JETTY REHABILITATION

Drawing Title
TYPICAL BENT AT 4.57m CRS SECTIONS & DETAILS - SHEET 1

PRELIMINARY

Designed	TJM	Project Director Approved	Date	North
Drawn	FS		AUG 2016	
Scale	AS SHOWN	Project Ref	Drawing No	Issue
Date		B4222	S107	P1

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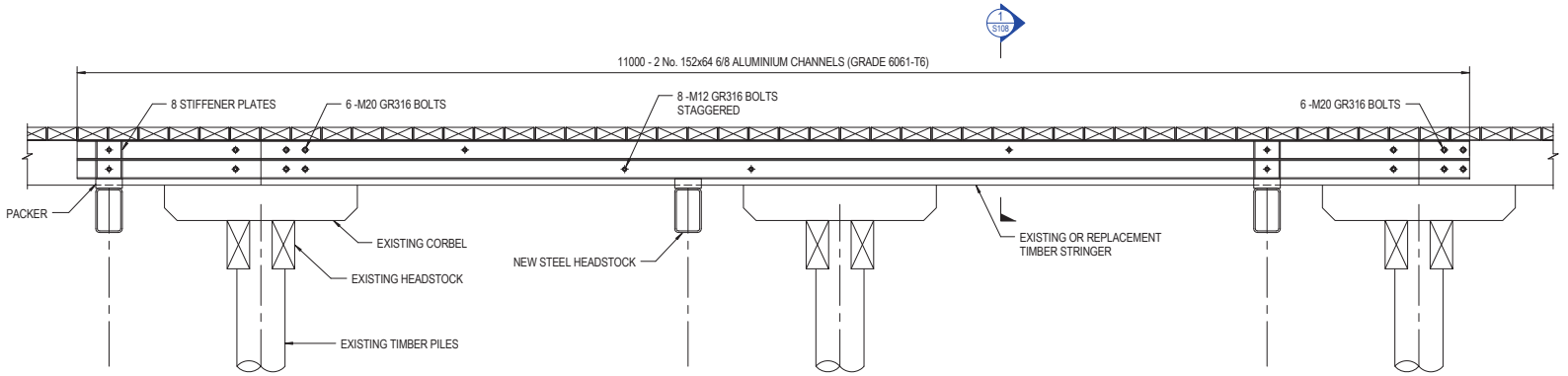
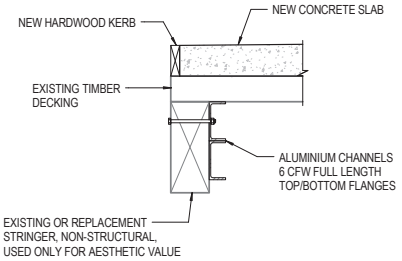


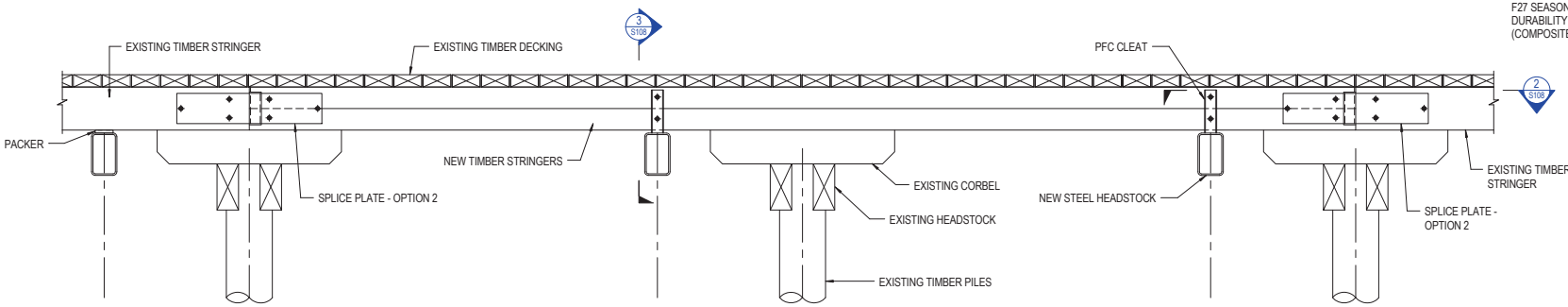
TYPICAL STRINGER REPAIR - OPTION 1

SCALE 1 : 20



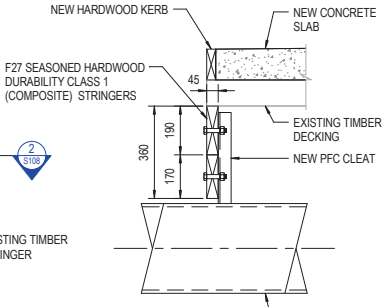
SECTION 1 S108

SCALE 1 : 10



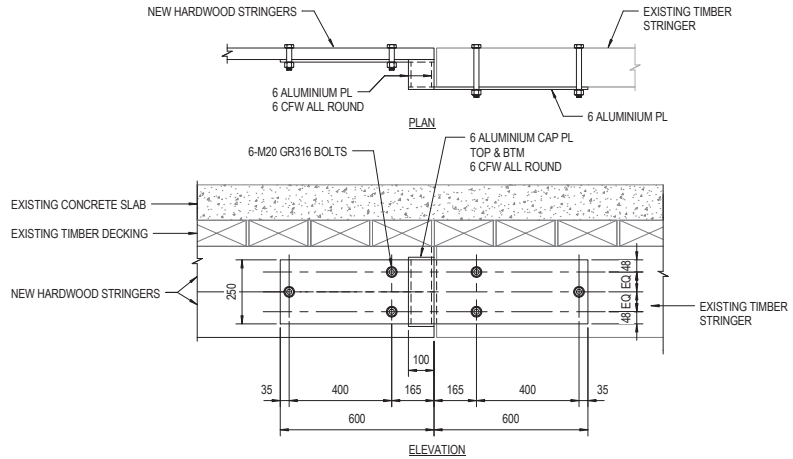
TYPICAL STRINGER REPAIR - OPTION 2

SCALE 1 : 20

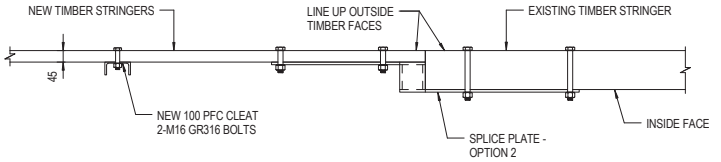


SECTION 3 S108

SCALE 1 : 10



TYPICAL STRINGER SPLICE DETAIL - OPTION 2



SECTION 2 S108

SCALE 1 : 10

Issue	Revision	Date	By	App.
P1	PRELIMINARY ISSUE	07.09.16	FS	TJM

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Project
TANKER JETTY
REHABILITATION
Drawing Title
TYPICAL BENT AT 4.57m CRS
SECTIONS & DETAILS - SHEET 2

PRELIMINARY

Designed	TJM	Project Director Approved	Date	North
Drawn	FS		SEP 2016	
Scale	AS SHOWN	Project Ref	Drawing No	Issue
Date		B4222	S108	P1

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3D - NEW & EXISTING STRUCTURES - 4.57m OPTION

3D - NEW SUPPORT STRUCTURE - 4.57m OPTION

Issue	Revision	Date	By	App.
P1	PRELIMINARY ISSUE	07.09.16	FS	TJM

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Project
TANKER JETTY
REHABILITATION

Drawing Title
TYPICAL BENT AT 4.57m CRS
3D VIEWS

PRELIMINARY

Designed	TJM	Project Director Approved	Date: AUG 2016
Drawn	FS		North
Scale	AS SHOWN	Project Ref: B4222	Drawing No: S109
Date			Issue: P1

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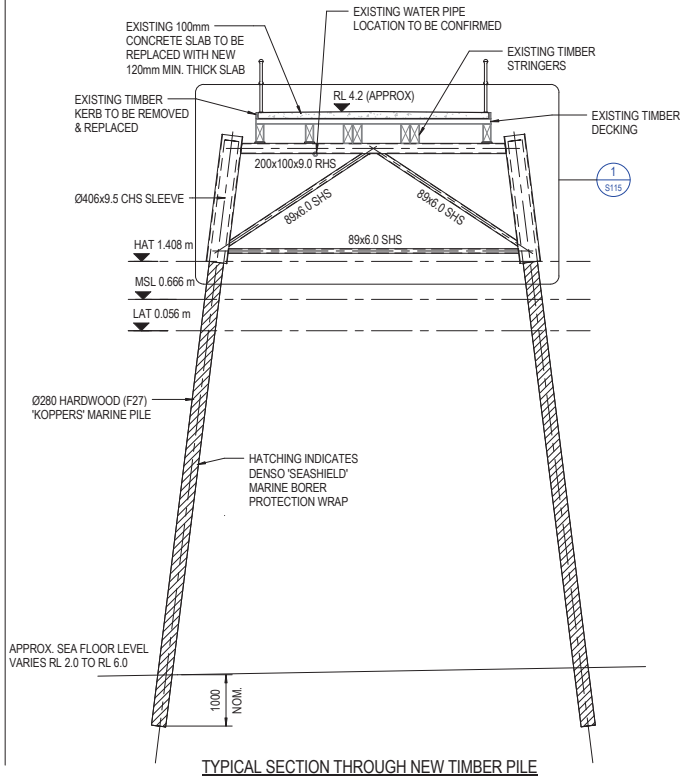
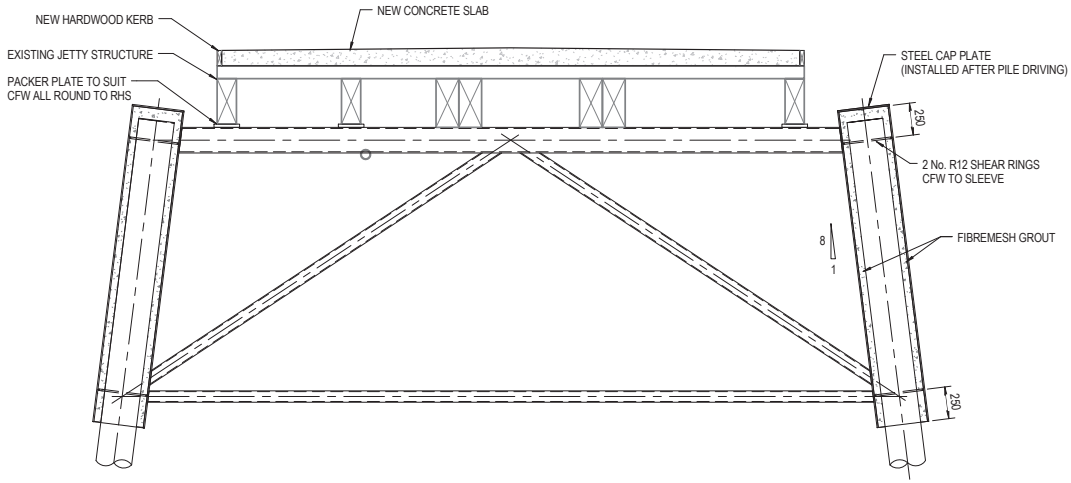


TYPICAL SECTION THROUGH NEW TIMBER PILE CONSTUCTION OPTION

SCALE 1 : 50

3D-NEW SUPPORT STRUCTURE-TIMBER PILE OPTION



DETAIL 1 S115

SCALE 1 : 20

Issue	Revision	Date	By	App.
P1	PRELIMINARY ISSUE	09.09.16	FS	TJM

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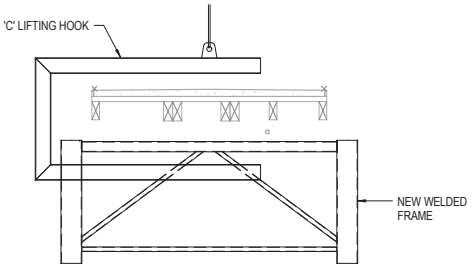
Project
TANKER JETTY REHABILITATION

Drawing Title
TYPICAL BENT AT 4.57m CRS NEW TIMBER PILE OPTION

PRELIMINARY

Designed	TJM	Project Director Approved	Date	North
Drawn	FS		AUG 2016	
Scale	AS SHOWN	Project Ref	Drawing No	Issue
Date		B4222	S115	P1

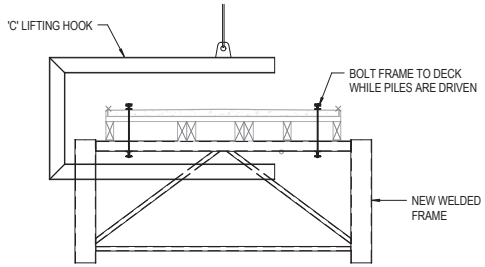
Plotted on: 9/09/2016 5:31:12 PM



STAGE 1

SCALE 1 : 50

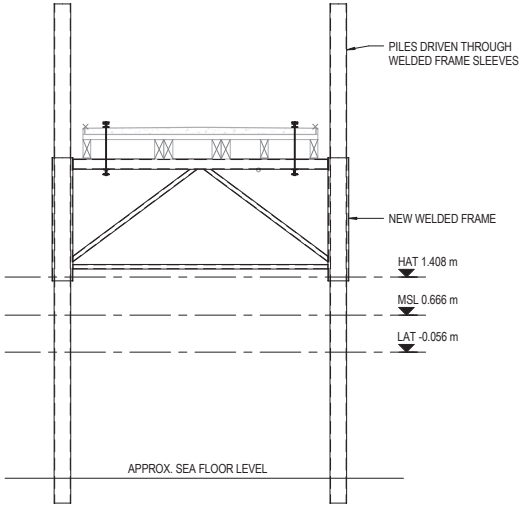
- ATTACH 'C' HOOK TO CRANE.
- ATTACH HOOK TO NEW WELDED FRAME.
- LIFT INTO POSITION.



STAGE 2

SCALE 1 : 50

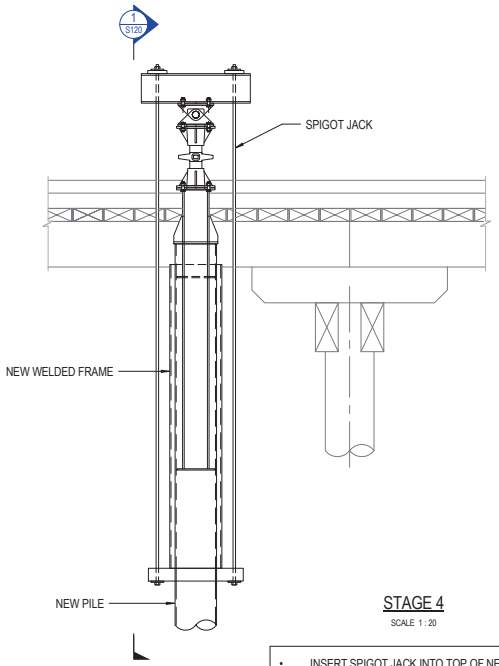
- TEMPORARILY CLAMP NEW WELDED FRAME TO EXISTING STRUCTURE UNTIL NEW WORKS ARE COMPLETED.
- UN-ATTACH & REMOVE 'C' HOOK.



STAGE 3

SCALE 1 : 50

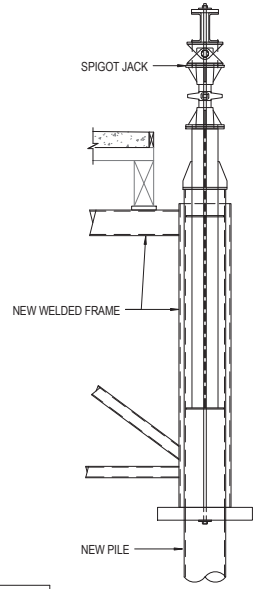
- INSTALL NEW PILES THROUGH SLEEVES IN WELDED FRAME.
- DRIVE NEW PILES UNTIL FOUNDING DEPTH HAS BEEN ACHIEVED.



STAGE 4

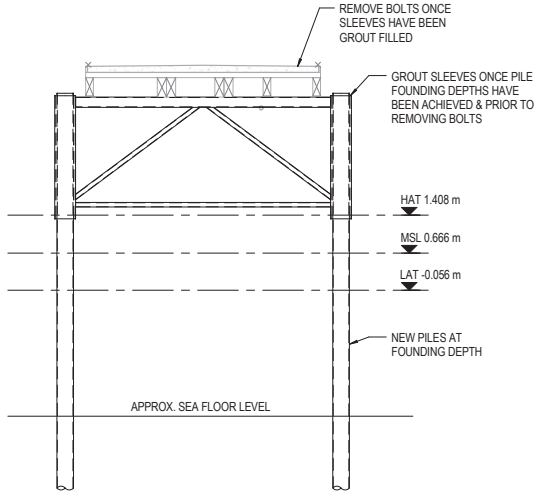
SCALE 1 : 20

- INSERT SPIGOT JACK INTO TOP OF NEW PILE.
- ATTACH JACK.
- ATTACH COLLAR TO BASE OF WELDED FRAME.
- ADJUST JACK UNTIL EXISTING STRUCTURE IS LEVEL.



SECTION 1

SCALE 1 : 20 — S120



STAGE 5

SCALE 1 : 50

- GROUT FILL SLEEVES.
- ATTACH SPLICE PLATES AT EACH DECKING/RAIL BEAM JOINT.
- REMOVE TEMPORARY FIXINGS & CLAMPS TO EXISTING STRUCTURE ONCE GROUT HAS ACHIEVED WORKING STRENGTH.
- DECOMMISSION & REMOVE EXISTING PILES & HEADSTOCKS.

Issue	Revision	Date	By	App.
P1	PRELIMINARY ISSUE	07.09.16	FS	TJM

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Project
TANKER JETTY REHABILITATION

Drawing Title
CONSTUCTION SEQUENCE

PRELIMINARY

Designed	TJM	Project Director Approved	Date	North
Drawn	FS		AUG 2016	
Scale	AS SHOWN	Project Ref	Drawing No	Issue
Date		B4222	S120	P1

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Appendix B: Denso Seashield series 60 system

40 YEARS OF MARINE PROTECTION

APPLICATION INSTRUCTIONS

Seashield Series 60 System

for Timber Pile Protection

1. SCOPE:

The Series 60 system consists of Denso Seal T or Marine Piling Tape and Ultraflex 1500 or Densopol 80 tape, Primer, Mastic and Pilemesh outer protection all fastened with Smartband strapping and buckles.
Designed to protect timber piles and surrounding areas from the environment. The tape covers and makes intimate contact with the entire surface of any substrate in the splash or tidal zone.

2. USES:

For splash or tidal zone protection of timber piles which are subject to organism attack in sheltered environments. Easily applied to pilings that have a constant outside diameter (OD) throughout the length of the protection zone. For pilings without a constant OD Denso Seashield primer and mastic can be used to create a profile which enables the use of the system.
Used in sheltered environments by yacht clubs on marinas and mooring berths. By road authorities on bridges and jetties. By local councils on bridges jetties, navigation aids and piers.

▲ ***Figure 1***. *Denso Seashield Series 60 system (excluding Pilemesh) .*

3. EQUIPMENT LIST:

- Wire brush, powered wire brush, scraper, water blasting equipment (optional).
- Brush cleaning solvent, utility knife, cleaning cloth, hand cleaner, barrier cream.
- Diving gear and equipment or overalls, gloves and any other personal protection equipment deemed necessary by the Safety Data Sheets and Job Safety Analysis conducted prior to the commencement of any work undertaken.

4. MATERIALS LIST:

- Denso Seashield Primer.
- Denso Seashield Mastic for filling and profiling irregular surfaces.
- Denso Seal T or Marine Piling Tape corrosion protection layer.
- Denso Ultraflex 1500 or Densopol 80 Tape and Pilemesh for mechanical protection of the system.
- Smartband strapping, buckles and fitting tool supplied by Denso to secure and hold Pilemesh in place.

5. APPLICATION of TAPE SYSTEM:

a) Surface Preparation:

Surfaces to be protected must free from all marine growth, perished timber, previous coatings, dirt etc.
The surface can be prepared by high pressure water jetting and hand tools such as wire brushes and scrapers.
The choice of method will depend on a number of factors and will need to take into account the most practical with regard to site conditions and any environmental constraints imposed due to site location.

Figure 2. *Timber piles protected in the splash zone.* ▶

5. APPLICATION of TAPE SYSTEM (continued):

- Remove all marine growth from the area to be protected .
- Remove any sharp splints. Trim around holes, cavities and sudden changes of profile.
- Wash down surface, seawater will suffice.

Precautions may need to be taken during the preparation process due to environmental concerns. Measures should be taken to minimise the amount of debris being deposited into the marine environment. Local regulations may dictate specific precautions and conditions that need to be met as part of these works. A job site Environmental Management Plan may be available for guidance in these matters.

First Inspection:
When all marine growth has been removed a close examination must be made of the surface area that has been prepared to ensure a thoroughly clean surface without growth, sharp or protruding surfaces is obtained.

b) Priming:

Priming is always required when using Seal T Tape. Marine Piling Tape is regarded as self priming for new substrates. Denso Seashield Primer is applied to the surface area by gloved hand, cloth, roller or brush, at a spreading rate of 1.0kg/m². It is applied in a circular motion obtaining an even film. All voids, concaves, holes should be filled. Denso Seashield Primer can be applied above and below the water's surface.

Primer is required in;

- *Areas with deep cracks or crevices:* Defined as areas of at least 2.0mm wide or deep where there is a danger of the tape wrapping 'bridging' the and leaving a void. These areas must be treated with a liberal coating of Seashield Primer to fill up any voids. If a very deep void occurs, such as holes, then after priming cut a patch of Seashield Mastic and press firmly into the area.
- *Irregular pile surfaces:* Apply a liberal amount of primer to the surface. Use Mastic or tape to create fillets which provide a profile to the substrate that can accommodate the smooth application of tape. Sufficient should be used to avoid any bridging when the tape is applied.
- *Remaining Pile:* Apply a thin coat of primer to the remaining exposed pile surface to be protected.

Second Inspection:
The primed area must be thoroughly inspected to ensure that all the surface area has been properly coated with the primer, including voids, concaves and holes. A smooth profile must be evident to ease tape application and prevent bridging.

c) Tape Wrapping:

It is important to apply the tape with the correct side facing the pile. The outside of the tape is to make intimate contact with the piling substrate. The pile is wrapped from the bottom up

▲ ***Figure 3***. *Tape being applied under water.*

Application of Seal T or Marine Piling Tape:

In the pile protection zone apply the tape by starting with two full circumferential wraps then proceed spirally along the pile progressing with a 55% overlap, giving effectively a double layer of tape. This will ensure a minimum double thickness of tape all the way. Carry on until the roll runs out.

Commence each new roll by overlapping the last roll by the same length as the tape width, for example if the tape is 150mm wide then the overlap will be about 150mm.

As wrapping proceeds smooth by gloved hand to exclude water, air bubbles and wrinkles from under the tape and to aid sealing of overlaps. Any overlapped edges are to be moulded and blended together by hand. This process is repeated all the way along the protection zone finishing again with two complete horizontal turns of the tape.

Third Inspection:
It is imperative to thoroughly inspect the wrapped pile surface area ensuring it has been wrapped with the specified 55% overlap, that all water, air bubbles and wrinkles are excluded from under the tape and that all overlaps are sealed, moulded and blended together.

5. APPLICATION of TAPE SYSTEM (continued):

c) Tape Wrapping (cont):

◀ ***Figure 4.*** *Model of the Series 60 system. Visible is the strapping and Pilemesh with sections removed to show the outer tape.*

Application of Ultraflex 1500 or Densopol 80 Tape Outer Tape:

In the pile protection zone apply the Ultraflex 1500 or Densopol 80 Tape in a similar fashion to the Seal T or Marine Piling Tape by starting with two full circumferential wraps then proceed spirally along the pile progressing with a 55% overlap, giving effectively a double layer of tape. This will ensure a minimum double thickness of tape all the way. Carry on until the roll runs out.

Commence each new roll by overlapping the last roll by the same length as the tape width, for example if the tape is 150mm wide then the overlap will be about 150mm.

As wrapping proceeds smooth by hand to exclude water, air bubbles and wrinkles from under the tape and to aid sealing of overlaps. Any overlapped edges are to be moulded and smoothed down by hand. This process is repeated all the way along the protection zone finishing again with two complete horizontal turns of the tape.

Fourth Inspection:

It is imperative to thoroughly inspect the Ultraflex 1500 or Densopol 80 Tape surface area ensuring it has been wrapped with the specified 55% overlap, that all water and air bubbles are excluded from under the tape and that all overlaps are sealed, moulded and blended together.

6. APPLICATION of PILEMESH:

A sheet of Denso Pilemesh is cut to suit the circumference of the pile and tape with allowance for a 100 to 150mm overlap.

Denso Smartband strapping is then used to secure the Pilemesh at the top and bottom 50mm from its edge and in between at gaps of no more than 500mm apart.

Insert the Smartband strap teeth uppermost into one end of the buckle. Wrap the strap around the outside of the Pilemesh and insert into the opposite end of the buckle. Pull the buckle through hand tight before reverting to the Smartband fitting tool to complete tightening. Use the cutter blade on the fitting tool to remove excess strapping.

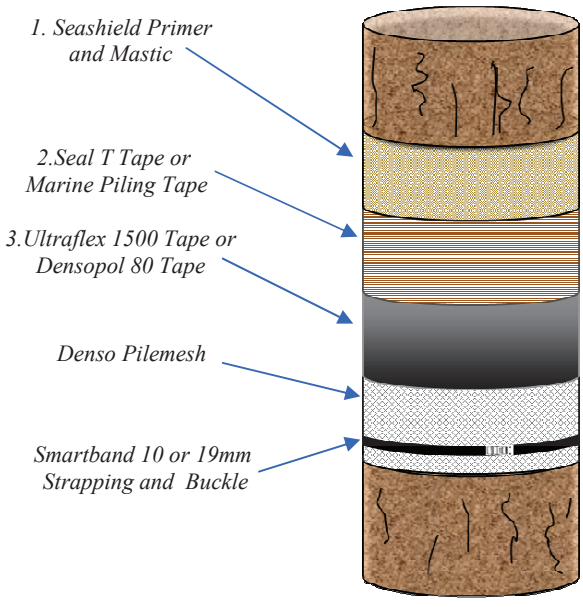
Ensure that all buckles are in the same vertical position on the pile near or on the overlap.

If possible the position of the overlap and buckles should be located on any sheltered side of the piles..

Final Inspection:

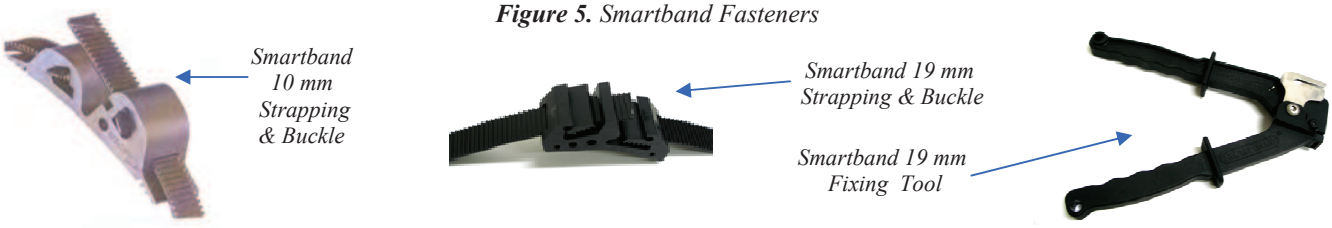
Check that all Pilemesh surfaces are smooth and flat around the pile, all strapping is not loose, that the Pilemesh is securely fixed to the pile and is not able to be moved in any direction.

Diagram 1. *Illustrated example of the Series 60 System*



▲ *Timber Pile*

Figure 5. *Smartband Fasteners*



7. SAFETY DATA:

Storage:	Denso Primer, Mastic and tapes shall be stored in a cool dry place out of direct sunlight between 5° and 25°C. Denso Pilemesh shall be stored the way they arrive and kept out of direct sunlight until they are required.
Transport:	Avoid prolonged exposure to high temperatures during transit, preferably in an enclosed vehicle.
Handling:	Denso Pilemesh shall be kept rolled and taped to prevent damage ready for transportation to the installation site. Care shall be taken to avoid sudden impact that may tear or damage the material.
Action in case of fire:	Extinguish with water fog, dry powder, carbon dioxide or chemical foam. Self-contained breathing apparatus may be required.
Skin Contact:	Wash with warm water and mild soap. Use pumiced heavy duty hand cleaner for stubborn stains.
Swallowing:	If feeling unwell, seek medical advice.
Inhalation:	In a fire situation avoid inhaling fumes.
Spillage:	No materials classified as hazardous. Pick up and collect material by hand or with absorbent rags or pads.
Disposal:	Incineration or landfill in accordance with local regulations.
Other:	For more information please refer to Denso safety data and technical data sheets. Available for all system components.

Approved Quality Management System
AS/NZS ISO 9001:2008
Lloyds Register – Certificate Nº Mel 0927759

Denso (Australia) Pty Ltd

411 - 413 Victoria Street,
Brunswick, Vic 3056
Australia

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Tel: + 61 3 93567600 or 1300 658 590 (toll free) ♦ Email: denso@densoaustralia.com.au ♦ Web: www.densoaustralia.com.au

Denso (New Zealand) Limited

Tel: + 64 21 304 660 ♦ Email: info@denso.co.nz

A MEMBER OF WINN & COALES INTERNATIONAL

Appendix C: Company capability brochures

Marine and Mining

Our Expertise

Bonacci Infrastructure is an engineering consultancy who provides structural and civil design services across a broad range of infrastructure types, including: marine; mining and resources; transport; water treatment; defence and industrial. Below is a snap shot of our Marine and Mining experience only. The designers at Bonacci are passionate about design solutions being easy and safe to construct, and the final solution being “fit for purpose”. To achieve this, our design teams are led by a group of very experienced Directors and Associates, all of whom are hands on designers. We are therefore in a unique position to offer our clients’ the benefit of over 120 years of collective design experience from our senior staff, all of whom are dedicated to “Perfecting the art of engineering”.

The concept development stage of any design is of critical importance to Bonacci Infrastructure. We firmly believe this is the stage where major benefits can be delivered to a project through the development of clever ideas that bring together construction methodology, creativity, and technical skill. Unlike most other structural design consultancies, Bonacci Infrastructure also specialises in construction engineering and soil-structure interaction modelling. This means that we always approach, and develop our permanent works designs from the point of view of a preferred construction methodology and enjoy reducing complex problems to simple solutions. That is, we seek to couple our construction “know how” with technical skill to deliver simple and hopefully clever solutions, linked to our client’s preferred construction methodology.

We operate with a variety of high end software such as:

- Strand 7 Finite element analysis (FEA) software, complete with all non-linear functions and moving load modules for bridge design
- D-Sheet Piling, state of the art software developed by Delft University for cantilevered or anchored retaining wall analysis and design.
- Phase 2, 2D elastic continuum FEA analysis for slope analysis, tunnel design and rock mechanics
- Slide, 2D classic static equilibrium method analysis software for all types of slope stability assessments.
- An extensive library of in-house software and design tools used to benchmark more complex analyses and for the fast feasibility assessment of concept ideas.
- Autocad (2D and 3D), Revit Structures (3D) and 12D Civil terrain drafting and modelling software.

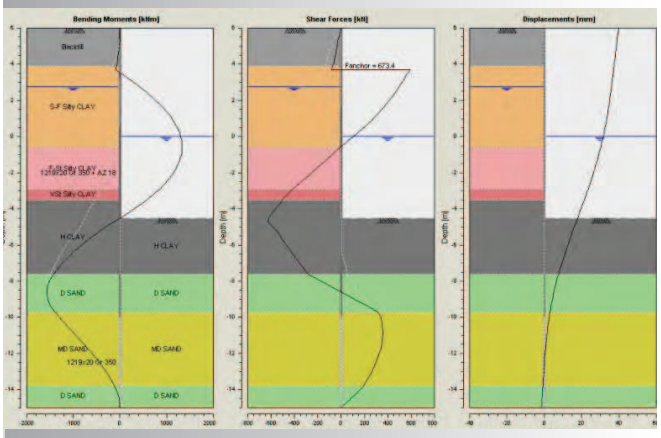
QCLNG – Ferry Dock and Floating RoRo Facility

BONACCI INFRASTRUCTURE

Marine

Including RoRo, Linkspan, LoLo, MOF, Product loading and Container Wharves

GLNG – RG Tanna - RoRo Facility during construction
Superlift Manitowwoc crane installing the linkspan bridge (110t) as a single crane lift

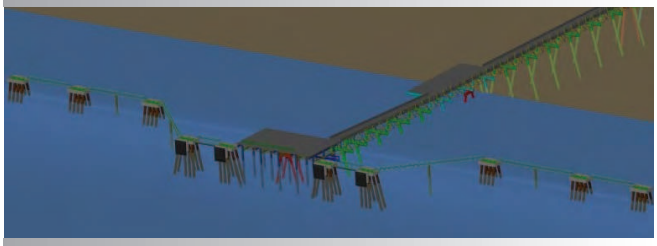


GLNG – RG Tanna - RoRo king pile wall design output

GLNG – RG Tanna - LoLo Facility during construction

GLNG – Port Central - Linkspan Bridge in operation

GLNG – Port Central - RoRo Facility c/w hydraulically controlled linkspan bridge.



QCLNG , GLNG and APLNG Vessel Loading Facility tender designs

Alcan Gove - Material Offloading Facility (MOF)

GLNG – Fisherman's Landing - Temporary RoRo Facility

BONACCI INFRASTRUCTURE

Self Elevating Platforms (SEP)

Certification and Risk Analysis

SEP Santa Fe - under tow

SEP Ensung - used for Tugun Desalination Plant

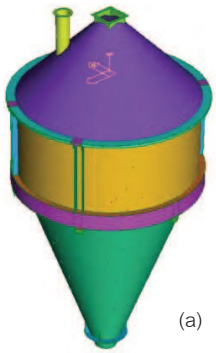
Ensung - in storm tie down mode

SEP Santa Fe - under tow fitted with Favco Crane

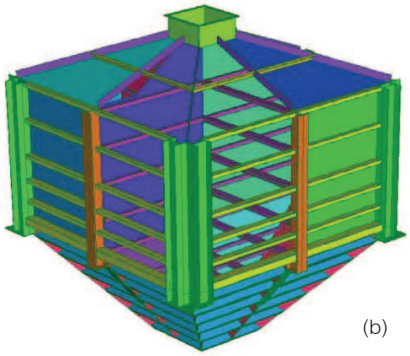
SEP Seafox - fitted with new Helipad

BONACCI INFRASTRUCTURE

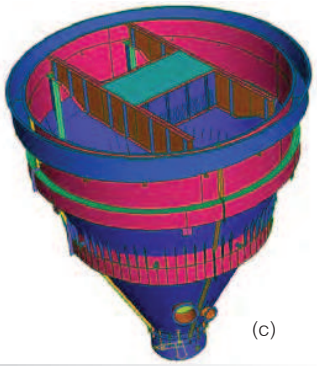
Silos, Stockpiles and Conveyors



(a)



(b)



(c)

(a) 2000t Mineral Sand Silos
(b) 800t square Silo
(c) FEA Model of Mineral Sand vortex separation silo designed and constructed for Illuka Project

WMC - Phosphate Hill Plant

Lake Lindsay – Oak Park Small ROM

WMC – Fertilizer Stockpile Building

Lake Lindsay – Overland Conveyor

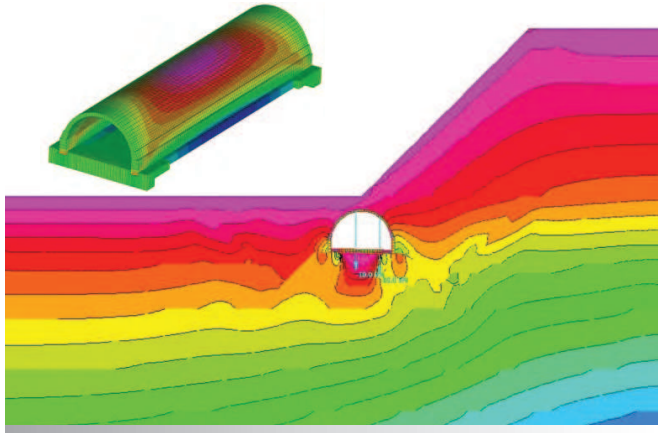
BONACCI INFRASTRUCTURE

Ban Houayxai - Gold and Silver Plant

Burnett Dam – RCC Delivery Conveyor

Newpac – Coal Stockpile Basin

WICET – Coal Reclaim Tunnel



WICET – Reclaim Tunnel - FEA Model of tunnel

BONACCI INFRASTRUCTURE

PERFECTING THE ART OF ENGINEERING

Awards

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Contact Information

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Email bonq@bon-infra.com

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As with all consultants, it is neither the name nor reputation of the company that defines the quality of the design, but rather the talents and experience of the individual staff involved.

Terry Memory BEng, MEng, RPEQ, NPER

Director

With over 20 years of experience across the maritime sector, the water industry structures and construction engineering, Terry draws upon his strong technical background and breadth of experience to develop simple and effective design solutions for large and small engineering problems alike.

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Dan has 20 years of experience in civil, and 10 years in structural engineering. He has specific design experience in water treatment structures and marine temporary works. His work is characterised by his ability to bring together the complexities of design projects to form practical and buildable design solutions.

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Associate

With a focus on ensuring technical excellence in all his designs, George applies his detailed expertise in the design and detailing of structural steel to ensure that the transition from design to fabrication and erection is as seamless as possible.

Houghton Highway Bridge Duplication

Construction Engineering

Our Design Philosophy

Ingenious temporary works designs offer many savings to a Contractor because they facilitate the timely and safe execution of work. When designing temporary works, Bonacci Infrastructure focuses on three key issues; safety, functionality and versatility.

Versatility/adaptability is considered because purpose made construction plant represents both a short and long term investment for the purchaser. From a design point of view we therefore detail in a manner that is economical for the project at hand, but not restrictive or onerous for future modifications.

The design of temporary works offers both the Client and Designer opportunities to “think outside of the square”. Typically, the functional requirements are reasonably well understood and definable by the Principal or Contractor. The challenge lies in developing an efficient structural system that fulfils the functional requirements, is relatively easy to fabricate, has a degree of robustness that is appropriate for the circumstances, is easy to commission and safe to use.

At Bonacci Infrastructure we embrace this challenge because it represents pure engineering and draws on the innovative skills and construction experience of individuals within the Company.

Below is a collage of the temporary works designs which Bonacci Infrastructure have executed. The commissions are typically associated with either:

- Complete construction systems, methodologies and associated purpose design plant for the construction of major infrastructure
- Temporary ground and/or ocean/river retention systems such as sheetpile walls, cofferdams. These designs typically including seepage assessments.
- Purpose design crane platforms, mobile bridges.
- Slope stability, often for cranes on an embankment.
- Specialist form systems, personnel access and lifting studies for major infrastructure
- Specialist design work for pontoons, barges, self-elevating platforms (SEP) and cranes on barges
- Specialist design work for piling leaders and pile gates.

Wiggins Island Jetty Traveller

Wiggins Island Wharf Traveller and piling frames

Project Experience

- Wiggins Island Coal Export Terminal (WICET)
  - Marine construction
  - Stockpile gantry erection
- GLNG, Gladstone – Marine Construction
- QCLNG, Gladstone – Marine Construction
- APLNG, Gladstone -Marine Construction
- Ocean intake pipe line, Gladstone
- Exxon Mobile PNG LNG
- Houghton Highway Bridge Duplication
- Port Connect - cofferdams
- Calliope Bridge restoration
- Captain Cook Bridge – Enclosed access platform underneath the entire bridge
- Abbott Point Coal Terminal, incl MOF
- Dalrymple Bay Coal Terminal
- Dalrymple Bay Rail Receival Pit (RRP3)
- FMG ore loadout wharf, WA
- Darwin LNG Wharf – SEP Margret
- RG Tanna Wharf
- Douglas Arterial Upgrade, Townsville
- Tugun Desalination Plant – SEP Ensung
- St Lawrence Rail Bridge Duplication
- Abbot Point and Dalrymple Bay Coal Termination Expansion
- Sydney Desalination Project (Blue Water Alliance) – SEP Seafox
- Adelaide Desalination Plant – SEP Santa Fe
- Wivenhoe Dam Upgrade
- Port of Brisbane Seawall Alliance
- SEP Fuji Piling Gate
- Nerang Rail Bridge Duplication
- Doyles Rock Road Bridge Duplication
- Burnett Dam
- Forgan Bridge Duplication – Mackay
- Presentation of numerous training workshops for the Engineers of Contracting Companies

Wiggins Island Coal Export Terminal (WICET)

Contractor: Monadelphous Muhibbah Joint Venture

Bonacci Infrastructure continues to provide extensive construction planning and design services for the jetty and wharf structures on this project, including:

- Self-launching jetty cantitraveller *(pictured below)* fitted with a 300t overhead crane and 2 internal gantry cranes. The structure cantilevers 24m to drive the jetty piles, with piling gates fitted to accommodate both typical and anchor bent piles
- Wharf traveller fitted with a 300t overhead crane
- Wharf dolphin piling frames and wharf strong point piling towers
- Miscellaneous access platforms and paint cages
- Onshore temporary works for jetty cantitraveller including earthworks, concrete foundations and piles
- Cyclone contingency and launch planning
- Miscellaneous lift studies

Houghton Highway Bridge Duplication

Contractor: John Hull and Albem JV

Bonacci Infrastructure provided extensive construction planning and the detailed design services of this project.

This included the temporary access bridge complete with its own piling gate, the multileveled piling gate arrangement for the permanent piles, purpose made headstock form system and the

GLNG and QCLNG LNG Gladstone

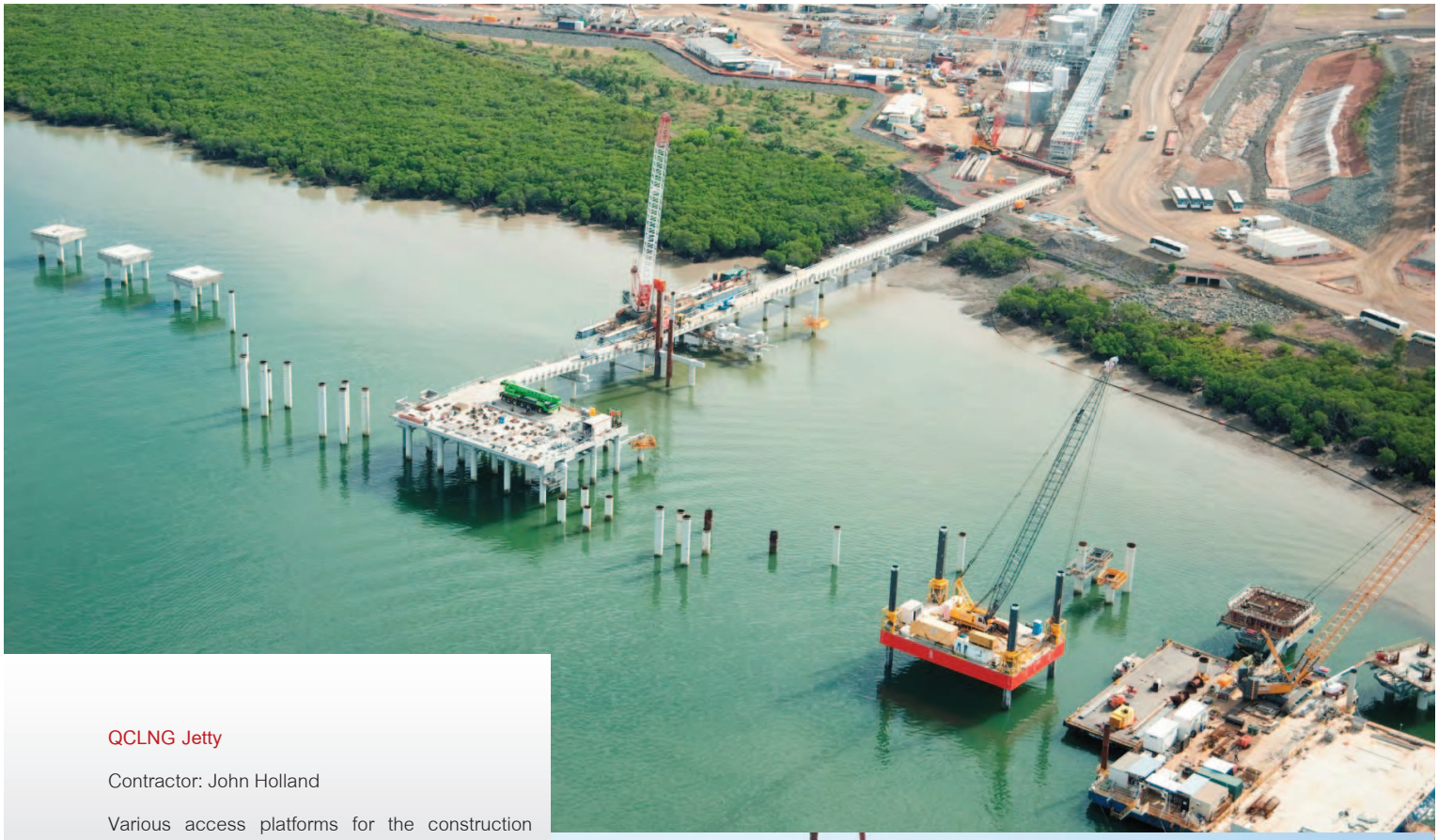
Contractor: Golding Contractors

Bonacci Infrastructure has an extensive involvement in the Gladstone LNG projects and this includes the following:

- GLNG Mainland: RoRo and LoLo facilities at both Auckland Point, RG Tanna berth and Fisherman's Landing
- QCLNG Mainland: RoRo facility at Auckland Point
- QCLNG RG Tanna: MOF facility travelling piling frame and barge "A" frame piling gate

Pictured:
Cantilevered piling gate mounted off a travelling crane platform. The arrangement was used to drive a tubular pile wall.

BONACCI INFRASTRUCTURE



QCLNG Jetty

Contractor: John Holland

Various access platforms for the construction of the Jetty headstocks and loading platform.

Project included a suspended soffit form system for the casting of the mooring and berthing dolphin pile caps.

Both berthing and mooring dolphin caps were cast in one pour with a maximum supported mass of 600 tonnes.

BONACCI INFRASTRUCTURE

SEP Fuji Universal Piling Gate System

Contractor: Walz Construction

Bonacci Infrastructure designed the universal piling gate system fitted to the SEP Fuji (shown adjacent working on the Dalrymple Bay Coal Terminal project).

Nerang Rail Bridge Duplication

Contractor: Golding Contractors

This project was particularly successful in that the 7No. x 25m spans of the bridge were installed within 72 hours. Such an achievement required careful planning and comprehensive design and staging documentation.

The girder installation involved a twin travelling gantry with one edge supported on a rail beam that was launched (pulled) across the river.

The fact the bridge was curved served only to complicate matters, however, in the end the engineering prevailed.

Darwin LNG Wharf

Exxon Mobile – Mubi River Cable Ferry System

Exxon Mobile – Piling Leader

St Lawrence Bridge Duplication

Darwin LNG Wharf

Contractor: Thiess

Detailed design piling frame fit-out for Thiess's jack-up platform - the "Margret". Both dual upper and lower gates are hydraulically operated and capable of rotating from 0-90 deg about the vertical tube. The entire head can rotated about the horizontal tube to enable various pile rakes. The complete frame is mounted on a sliding table to enable lateral translations both forward-aft and left and right.

Exxon Mobile PNG LNG

Contractor: Clough Curtain

Bonacci Infrastructure provide all the major temporary works for this project with included the design of two new piling leaders that were fitted to 16000 Manitowoc Cranes. In addition to this we also design a cable guided ferry system across the Mubi River, barge mounted piling frame, an extensive and detailed peer review of a 116m long bridge launch procedure, and numerous other smaller tasks associated with crane-slope stability and pile driving.

St Lawrence Rail Bridge Duplication

Contractor: Seymour Whyte and Piling Contractors

Bonacci Infrastructure provided unified temporary works solution for both head and sub-contractor on this project. The temporary access bridge design was provided for Piling Contractors, whilst the bridge girder gantry system and headstock form system were commissioned by Seymour Whyte. The use of 3D drawings was also used as a visual aid to explain staging and critical issues to construction personnel.

BONACCI INFRASTRUCTURE

Calliope River Bridge Headstock Replacement

Contractor: Golding

Bonacci Infrastructure provided formwork design for the construction of a 2.7m deep x 15m long concrete headstock completed in a single pour.

The form spanned between 2 permanent 1500mm diameter bored piles which formed part of the replacement abutment.

Oxley WWTP Digester Lid Retrofit

Contractor: John Holland Group

Bonacci Infrastructure performed a comprehensive lift study of 4 digester roof structures to permit their extraction.

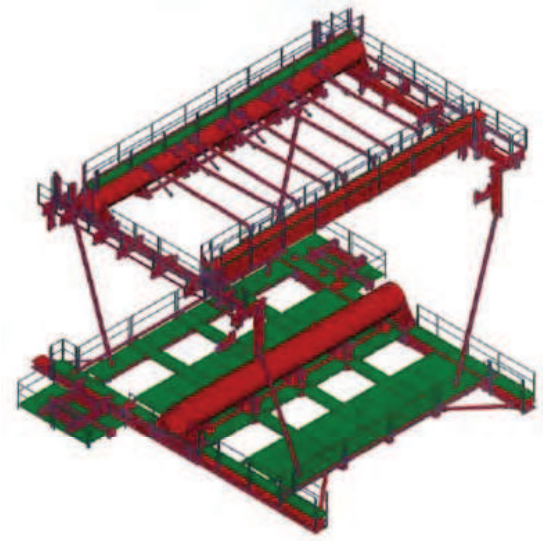
Services for this project included a condition assessment and strengthening review in compliance with current Australian standards.

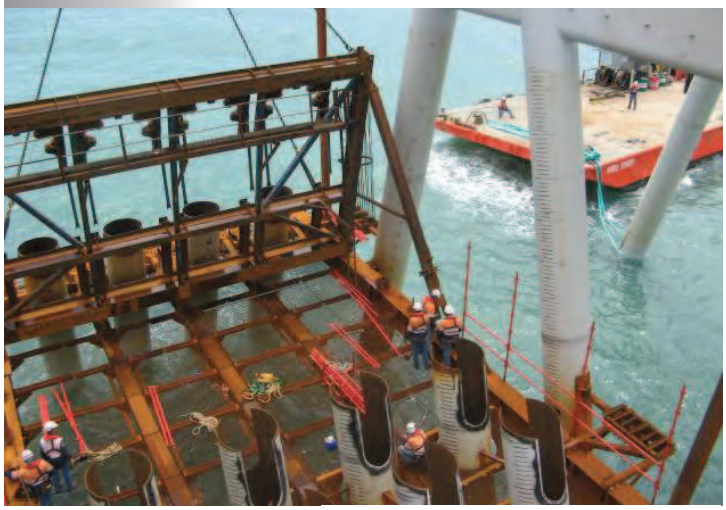
Oxley WWTP Digester Lid Retrofit

Abbot Point and Dalrymple Bay Coal Terminal Expansion

Contractor: John Holland Group

Sophisticated temporary works designs and for both of these wharf expansion projects. Our primary effort was focused on the methodology for the construction of the berthing/mooring dolphins which are a skeletal assembly containing 14No. x 1200 dia piles. The system developed was essentially suspended from the upper wharf structure and purpose designed for monolithic installation and segmental extraction from under the completed dolphin.





Abbot Point and Dalrymple Bay

Forgan Bridge Duplication

Forgan Bridge Duplication

Contractor: Golding Contractors

Bonacci Infrastructure provided the temporary works design for the crane access bridge used to construct the new bridge. The access bridge was built over the top of the new bridge, as oppose to beside it, which was largely due to drill reach limitations. The temporary headstock system developed by Bonacci Infrastructure involved driving temporary piles through a suspended sleeve and then hanging the headstock from the installed pile. This system meant that temporary pile cut-off levels were not critical and the headstock was also the gate arrangement for driving the temporary piles.

RG Tanna Wharf

Contractor: Golding Walz

Bonacci Infrastructure provided continuous design and technical support for the duration of the project. Design activities included the main piling frame which cantilevers 14m from a previous bent, and the dolphin concrete form system (130m^3 in a single pour) which accommodated two different dolphin configurations.

The upper and lower piling gates are hydraulically operated with the lower gate concealed within the floor frame. The upper gate is fully detachable for use in different configurations, whilst the entire head frame is detachable for reverse usage.

RG Tanna Wharf

BONACCI INFRASTRUCTURE

Tugun Desalination Plant

Contractor: Golding

Bonacci Infrastructure undertook extensive engineering reviews and strengthening of this jack-up barge to enable this vessel to construct the 3.1m diameter x 46m long ocean intake and outfall risers for the project. The vessel deck loading included a 600t crawler, 125t drill rig, 140t liner, 120t hydraulic hammer and a 35t mobile crane. In addition to these works.

Bonacci Infrastructure also undertook a comprehensive study on the risk of jacking failure and a storm survivability study that quantify structural capacity as a function of operating height and wave size. During operation the vessel was exposed to peaks waves in the range of 7-8m.

Sydney Desalination Project (Blue Water Alliance)

Contractor: John Holland Group

Bonacci Infrastructure provided the planning and detailed design of the helipad that was retro-fitted to the Seafox 6 S.E.P.

The helipad was installed with the vessel operational and in the position shown. The pad extends 26m off the hull.

Wivenhoe Dam Upgrade

Contractor: Leighton

Bonacci Infrastructure provided concrete form designs for the ogee weir
and 14m high tapered fuse walls as shown in the adjacent photo.

Burnett River Dam (Paradise Dam)

Contractor: McMahon

Bonacci Infrastructure provided continuous construction advice to this project
with the key features being the certification of the main RCC feed conveyor, shown adjacent, and the spillway ogee weir form system which was flush with the face of the dam wall and elevated some 40m above ground level.

Doyles Rock Road Bridge Duplication

Contractor: John Holland Group

Bonacci Infrastructure provide engineering designs for the fit-out of a new piling leader onto an existing barge owned by JHG and also a purpose made girder placement gantry, see photo below. The gantries were in two portions to enable it to be partially assembled over the new works in preparation for the 4hours lane closure when an entire bridge span would be placed.

The pre-assembled configuration meant more time in the 4hr window was available for girder installation, as opposed to gantry setup. The middle image below shows the preassembled gantry. The column next to the existing bridge was on skates and it was literally pushed out of the way once the other gantry end was connected.

Soil Retention System

Bonacci Infrastructure has extensive experience in the design of both permanent and temporary ground retention systems, a collage of images is provided below.

In particular, Bonacci Infrastructure has extensions experience in the design of:

- Deep (up to 26m to date) anchored walls
- Secant pile, contiguous piles and diaphragm walls
- Sheet pile walls, cofferdams (rectangular, circular and elliptical) and cellular cofferdams

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Appendix D: Terry Memory CV

Terry Memory

Director

DATE OF BIRTH 5 October 1968

QUALIFICATIONS

Master of Civil Engineering (by thesis) Queensland University of Technology, Brisbane
Bachelor of Civil Engineering with first class honours, Queensland University of Technology, Brisbane
Member, Institution of Engineers, Australia
Past Chairman, Queensland Division Structural Branch, Institution of Engineers, Australia

CAREER

2005 to date	Director, Bonacci Infrastructure
2000 to 2005	Associate Director, Bonacci Infrastructure
1998 to 2000	Senior Design Engineer, Bonacci Winward (Qld)
1993 to 1998	Design Engineer, Madsen Giersing
1992 to 1993, 1997 to 1998	Queensland University of Technology Full time and part-time Civil Engineering Lecturer

MARINE AND MINING EXPERIENCE

WICET
Detailed design of 2km of reclaim tunnel

APLNG Marine Terminal
Tender design

Santos GLNG Marine Terminal and MOF
Tender design

Santos GLNG Mainland Facility
RG Tanna, Port Central and Fishermans Landing

British Gas QCLNG Marine Terminal and MOF
Tender design

British Gas QCLNG Mainland Facility
Detailed design floating RoRo facility and ferry terminal

Abbot Point MOF
Material load-out facility

LNG Wharf Darwin
Design Review

East Arm Common User Wharf
Stage 1 and 2 and multi-user wharf tender design. Stage 2 design review.

Hamilton Mineral Separation Plant
Surge Bin, 1000t Silo, 800t Silo.

Glebe Island Sea Wall
Detailed design of seawall revetment and culvert outfall

Portside Wharf Development
Tender alternative

Otomona Bridge
100m clear span, West Papua

P.T. Freeport Gold and Copper
Coal storage cover foundation design, Indonesia.

Western Mining Company, Townsville
Fertiliser receival, storage and reclaim facility.

Quezon Power Station
Marine Facility, Philippines.

MARINE AND MINING EXPERIENCE (CONT.)

Marine Facility for Ross Island Development
Department of defence, Townsville.

Shute Harbour Redevelopment
Tender Design

Ely Bauxite Project
3200m long Jetty

Lihir Project
Barge loading Wharves 1 and 2. Barge maintenance Wharf. Sea dump facility, Lihir Barge Loading Wharf. PNG.

Lihir Gold Project
PNG General Cargo Wharf Tender Design

Manila Grains Terminal
Tender design

PNG Napa Napa Oil Refinery Marine Facility
Tender design

Dredeco Wharf Facility
Detail design of Dredeco's wharf at Whyte Island, Brisbane

Southern Cross Cement Jetty
Tender design, Philippines

Burnie No.7
Berth rear deck, Tasmania

West Port – Port Klang
Tender design, Malaysia

Mount Isa Mines
Blast furnace modification

CIVIL INFRASTRUCTURE EXPERIENCE

Rubyanna STP Upgrade
($40M) Project Director

Wiggins Island Coal Export Terminal
Coal reclaim tunnel, 4x950m long in-situ design

Murrumba Alliance
(approx. $192m) - Project Director and Design lead for all structural works.

CIVIL INFRASTRUCTURE EXPERIENCE (CONT.)

Wagga Wagga Sewer 2010 Project
($130M) - Project Director and design lead for all structural works.

Mackay Water Recycling Project
($150m) - Project Director and design lead for all structural works.

Coffs Harbour Infrastructure Alliance
($154m) - Project Director and design lead for all structural works.

Pimpama Water Future Alliance
($87m) - Project Director and design lead for all structural works.

Wetalla Water Reclamation project
($36m) - Project Director and design lead for all structural works.

Merrimac Water Future Alliance
($70m) - Project Director and design lead for all structural works.

Brisbane Water Enviro Alliance
($208m) – Project Director and design lead for all structural works.

RAAF Base
Central emergency power supply bunker, Townsville

Sandgate WWTP
Stage 1 Inlet works

Bulimba Creek Trunk Sewer
Deep maintenance hole design for 1500 DN sewer

Nightcap WTP
Lime dosing tanks (Steel)

South East Transit Project (SET4)
Numerous soil retaining structures

Douglas Water Treatment Plant Upgrade
Detailed design of 7m high WTP process facility

Luggage Point Water Reclamation Project
Effluent takeoff channels and wells

Maryborough Cogeneration Power Station
Tender design including 56m high stack

South East Queensland Busway Network
5no. Transit Stations

Carol Park
60m high boiler stack Tender Design

Bond University Telecommunication Tower
Detailed design of tower using MStower software

Kangaroo Point Boardwalk
Stage 2, Brisbane

CONSTRUCTION ENGINEERING EXPERIENCE

GLNG, Gladstone
Development and design of construction method to place 400m long ocean intake and outfall pipeline.

Exxon Mobil PNG LNG
Detail design of piling leader fitted to 200t Manitowoc cranes and detailed review of 100m bridge launch.

St Lawrence Rail Bridge Duplication
Detailed design of temporary bridge, piling gates, falseworks and travelling access platforms

CONSTRUCTION ENGINEERING EXPERIENCE (CONT.)

Abbot Point Coal Terminal
Detailed design of various piling systems and the design of the MOF.

Forgan Bridge, Mackay
Detail design of all construction plant including 400m of temporary and reusable steel bridgework

Dalrymple Bay No. 7 Extension
Detailed design of construction plant including dolphin piling system

Nerang Rail Bridge Duplication
Detailed design of gantry system that enabled 7No x 28m bridge spans to be installed in 2No. 48hr shutdowns.

Gold Coast Desalination Plant
Structural certification SEP Ensung and extreme weather survivability assessment of the SEP Ensung

Brisbane Seawall Alliance
Rock impact assessment on rolling stock floor design

Burnett Dam Alliance
Detailed design of various temp works including the main ogee dam weir

Wivenhoe Dam Alliance
Alternate design for fuse gate and detailed design of final fuse gate temporary works.

LNG Wharf, Darwin
Piling gate and leader system for the SEP Margret

C.A.R. Wharf
Detailed design of all construction/piling plant

RG Tanna Wharf
Detailed design of all construction/piling plant

Port Motorway Alliance
Various temporary works including crane stability assessments

EXPERT WITNESS & FORENSIC ENGINEERING EXPERIENCE

Tanjung Bin Power Station – Malaysia.
Expert Witness for the foundation works

Port Botany Container Ship Wharf
Expert witness for structural distress

FMG Port Headland Facility – Piling works
Forensic Reporting / Expert opinion

Victorian Desalination Plant
Expert witness

Eastern Treatment Plant
Expert witness

Darwin East Arm Wharf
Expert witness

Luggage Point WWTP
Gas storage bell derailment

South East Transit Project
Report into concrete cracking of the tunnel roof

Wastewater Treatment Plants
Numerous reports into the concrete cracking and leakage

Wharf, Indonesia
Report on collapsed structure

Project Image Gallery

GLNG – RoRo Linkspan

South East Transit Project – Soil Retaining Structures

BWEA – Structural design of WWTP

Murrumba Downs Alliance – Structural Design of WWTP

WICET – Reclaim tunnels

Quezon Power – Marine Facility

Ross Island – Army Base

QCLNG – RoRo / Ferry Terminal

Project Image Gallery Cont.

Forgan Bridge – Construction Engineering

GLNG – RoRo Facility

St Lawrence – Rail Bridge Duplication

GCDP – Ensung SEP Certification

RG Tanna Wharf –Construction Engineering

Roche Minerals – 2000t Silo

Exxon PNG LNG – Bridge Launch