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ESPERANCE TANKER JETTY CONDITION

Jetty Condition Assessment Update

Reference: R-224.07-1
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SHIRE OF ESPERANCE

ESPERANCE TANKER JETTY CONDITION

JETTY CONDITION ASSESSMENT UPDATE

Prepared for

By

BMT JFA Consultants

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1 INTRODUCTION

1.1 General

In response to a request from Shire of Esperance BMT JFA Consultants Pty Ltd (BMT JFA) were engaged to undertake a condition inspection of the Esperance Tanker Jetty.

The inspection was requested in response to ongoing deterioration of the structural condition of the Jetty. BG&E conducted a detailed condition inspection in 2010 and a structural assessment in 2011. The Tanker Jetty was closed during the Esperance seawall works, the Shire of Esperance are looking to ensure the structure is safe for public. Once the structure has been approved as safe it can be reopened. BMT JFA have been instructed to perform a follow up inspection, identifying defects that would affect the safety of the structure and recommend remedial measures to make the structure safe for public use.

The site inspection of the Tanker Jetty Structure took place on 22nd and 23rd July 2013. This inspection was undertaken by Brad Saunders (Project Director) and Justin Fifield (Project Engineer). The inspection enabled a condition assessment of the timber, concrete and steel elements of the structure above water level. The dive inspection was undertaken by Esperance Diving and Fishing on 3rd August. The dive inspection enabled condition assessment of selected piles (the most damaged piles identified in the BG&E report)

The condition assessment of the structure has been undertaken in line with the New York Waterfront Inspection Guidelines - 1999 (NYWIG). The inspection undertaken was a level I (General) inspection in accordance with NYWIG. The scale of degradation of structural elements is graded in terms of; minor, moderate, advanced, severe or failed.

1.2 Objectives and Scope of Services

The purpose of the structural inspection and assessment is to determine the general extent of defects highlighted in the BG&E Report 2010. On top of this, any further deterioration and new defects were to be identified. Advice on remedial actions required is to be provided, as well as the urgency in which these are to be undertaken to assure a safe structure for public use.

The following services have been undertaken with respect to the structure;

- Inspection of the Tanker Jetty structure (as mentioned in 1.1)
- Assessment of structural integrity and condition
- Identify necessary remedial actions
- Outline the timescale for the remedial actions.

Specific areas of the underwater structure (Timber Piles) were inspected during the dive inspection on 3rd August 2013. The chosen piles were selected based on, those identified in the BG&E Report 2010, which had suffered the most deterioration.

2 SITE DESCRIPTION

The Esperance Tanker Jetty is situated approximately 2 km north of Esperance Port. It extends approximately 700m from the beach in an easterly/south-easterly direction. It was constructed in 1934 and then refurbished in 1991 replacing the piles. Only the outer (North and South) piles were replaced during the refurbishment. The shoreward section (Pile frames 0-30) has been demolished to allow construction of a headland. The Jetty is to be joined to the headland with a pedestrian walkway span.

3 STRUCTURE

3.1 Description

The remaining section of the Tanker Jetty is approximately 600m long. The jetty was originally constructed of pile frames at 4.5m spacing made up of 3 piles. During the 1991 refurbishment, replacement piles, for a 2 pile frame, have been constructed outside, to the north and south, of the original piles. Connecting the piles, of each pile frame, are 2 half caps, which are seated into and bolted to both sides of the pile tops. The main longitudinal stringers are supported at each pile frame by corbels which are bolted onto the half caps. The two double and three single stringers support deck planks which are topped with concrete to provide a smooth surface for pedestrians.

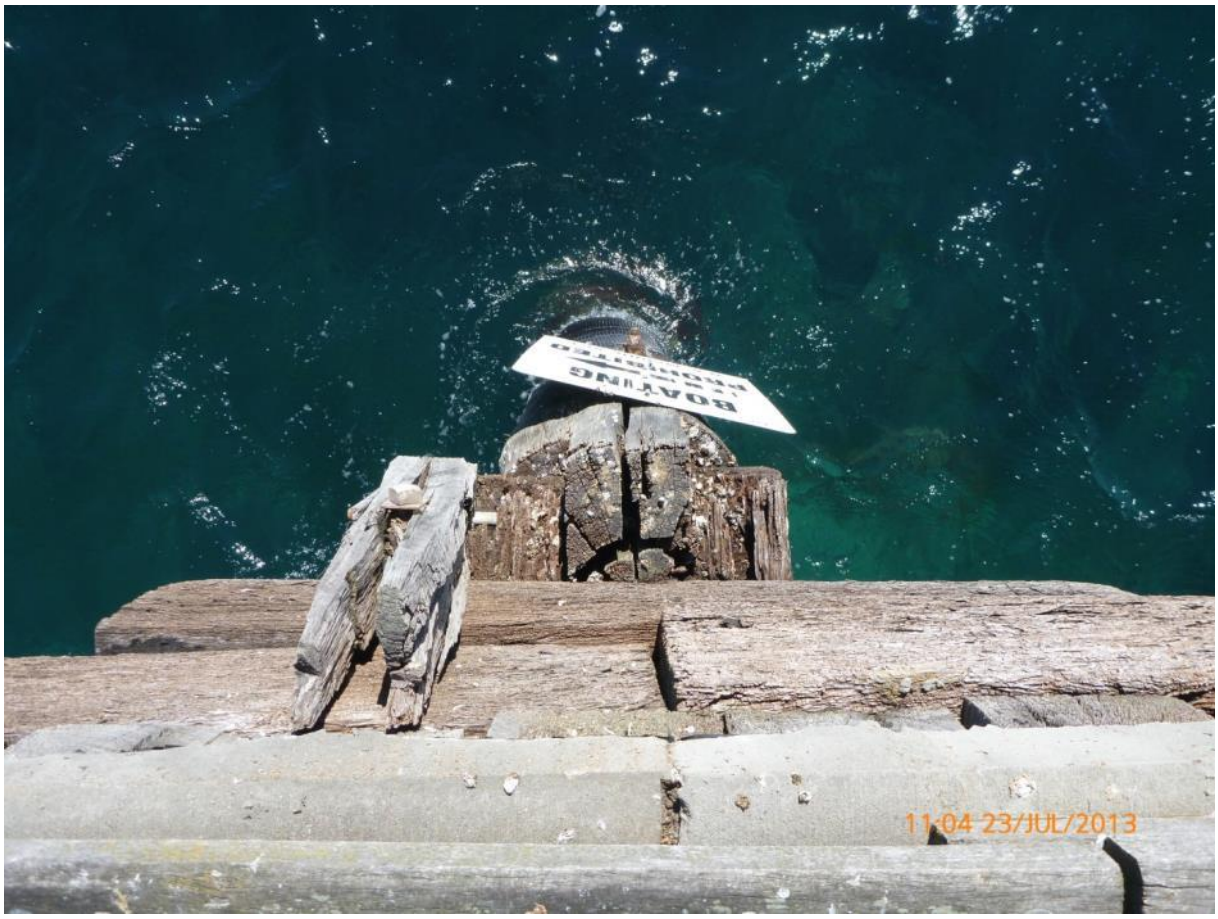
The main defects to the jetty structure are;

- Splitting of pile tops
- Teredo worm and rot damage to piles under water
- Crushing of half caps
- Shearing of end distance on half cap beams
- Crushing of corbels
- Deterioration of stringers.

3.2 Piles (Above Water)

The following piles are split at the connection with the half cap; 37 North, 40 North, 87 North, 100 North, 111 North, 113 South. There is no pile 39 North.

Figure 3-1: Pile 37 North



The top of the pile is split longitudinally. The remedial should be in order of preference where possible;

- Apply strapping to pile top. Strapping to be similar to the bracing strapping on pile 137 (See Figure 3-2).
- Resin fill spaces with Epigen 0301MRD

Figure 3-3: Pile 40 North

The top of the pile has lost section at the bolted interface with the half caps. The remedial should be in order of preference where possible;

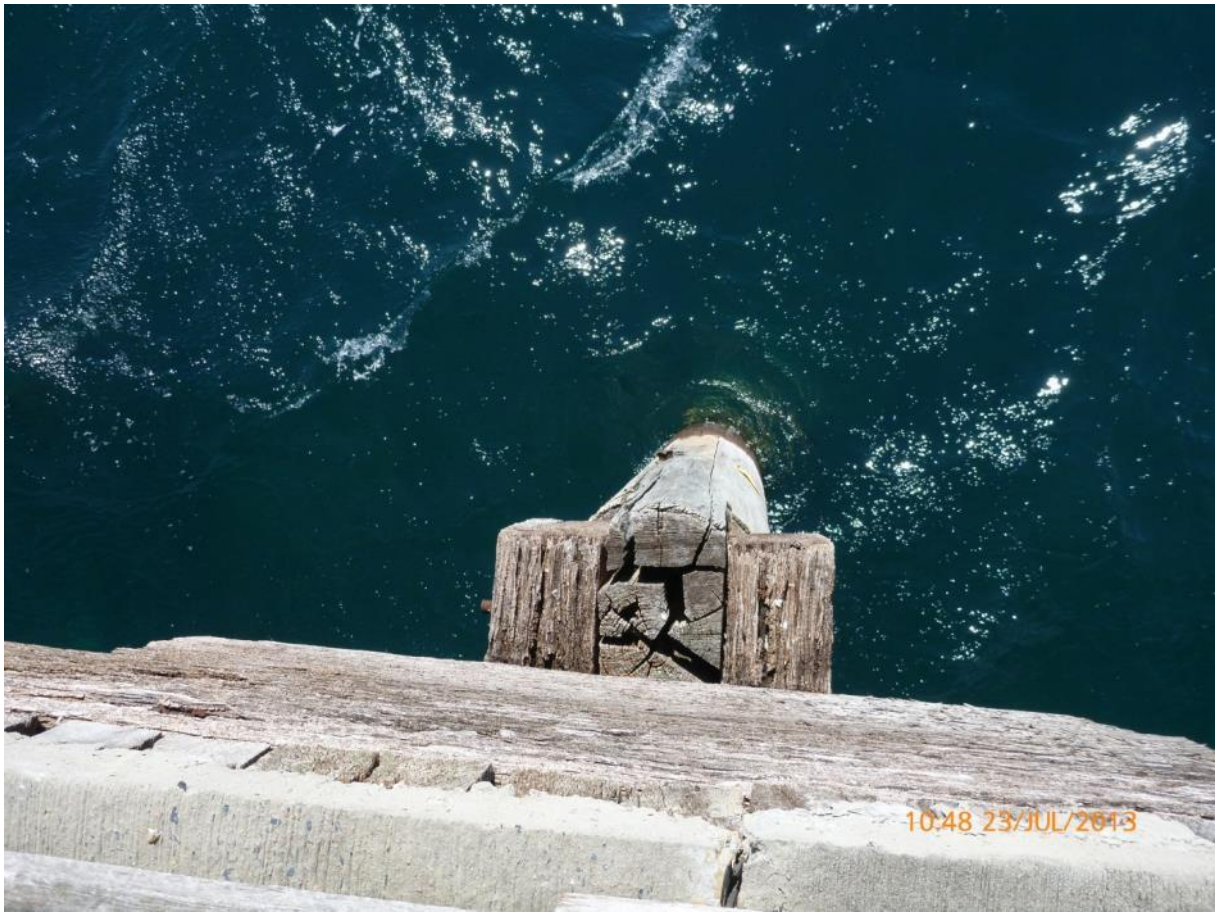
- Fill spaces with Epigen 0301MRD.

Figure 3-4: Pile 87 North

The top of the pile has split. The remedial should be in order of preference where possible;

- Apply tightened strapping to pile top and fill remaining spaces with Epigen 0301MRD. Strapping to be similar to the bracing strapping on pile 137.

Figure 3-5: Pile 100 North



The top of the pile has split at the bolted interface with the half caps. The remedial should be in order of preference where possible;

- Fill spaces with Epigen 0301MRD.

Figure 3-6: Pile 111 North

The top of the pile has split. The remedial should be in order of preference where possible;

- Apply tightened strapping to pile top and fill remaining spaces with Epigen 0301MRD. Strapping to be similar to the bracing strapping on pile 137.

Figure 3-7: Pile 113 South

The top of the pile has split. The remedial should be in order of preference where possible;

- Apply tightened strapping to pile top and fill remaining spaces with Epigen 0301MRD. Strapping to be similar to the bracing strapping on pile 137.

3.3 Piles (Below Water)

Piles require repair at the following locations; 31 South, 39 South, 49 North, 49 South, 61 South, 62 South, 75 North, 91 North, 93 North, 96 North, 101 North, 105 South, 106 South 112 North, 115 South, 118 North.

The BG&E report (2010) identified that the majority of piles are in a reasonable condition. In the sample of 25 piles, inspected for this update condition report, those identified as being in a good condition previously had no serious defects apparent, with only surface rot or minor teredo deterioration. The piles which the BG&E report (2010) had identified as deteriorated were investigated in greater detail. Pile 39 North was identified as being in a poor condition but has subsequently failed completely (extra bridging structure between the 38 North and 40 North is in place to span this).

The critical piles identified in this update are; 39 South, 106 South, and 115 South, which will require immediate repair.

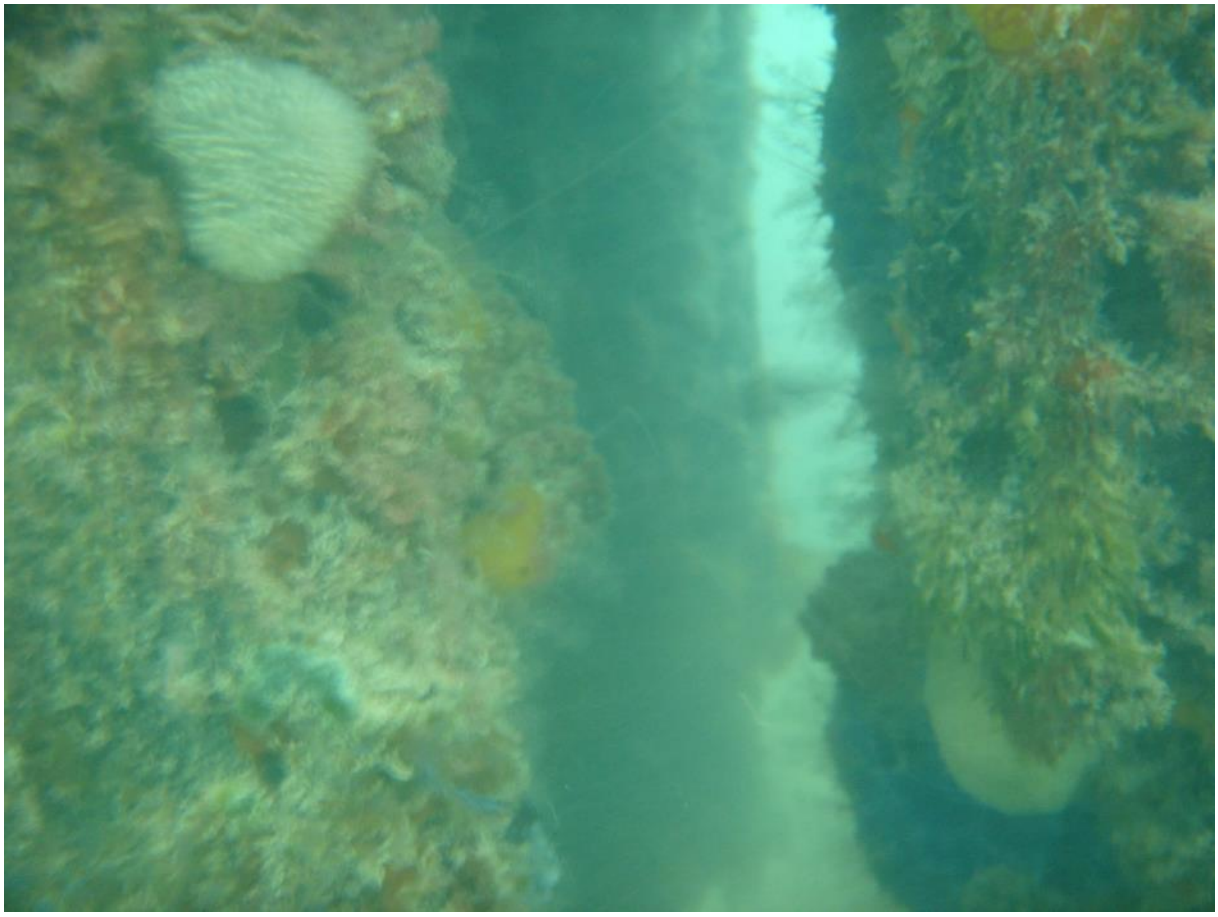
Piles 61 South and 62 South have not suffered such severe damage, but their proximity warrants immediate attention. This is because spanning two missing piles would very difficult to achieve.

Pile 31 South has deteriorated and the concrete repair has failed. This pile will carry increased load from the walkway span, therefore, it is advised a full repair be undertaken prior to landing the walkway.

Pile 31 South was previously wrapped. Visibility was poor during the dive investigation but the divers determined that the pile was partially hollow. This corresponds with the BG&E report that there was teredo action and a hollow section.

The recommended repair is; for the current concrete wrapping to be removed and a new complete wrap fitted to the affected area. The wrap should be a zipped jacket, which surrounds the affected pile length. This jacket and internal voids are then filled with grout. As this defect is apparent down to bed level some air lifting of sand to excavate down to good pile will be required.

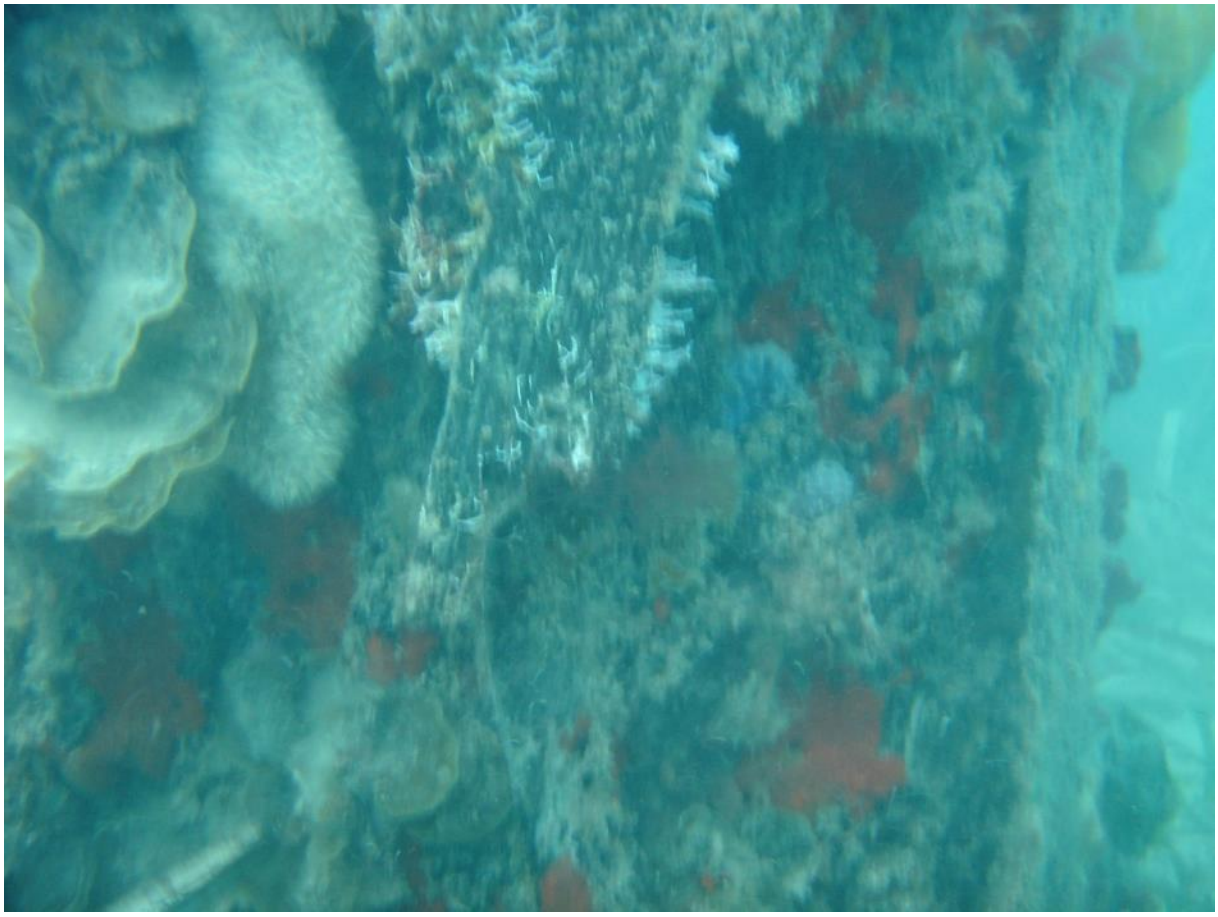
Figure 3-8: Pile 39 South



Pile 39 South has a hole through the centre of the pile (This was first encountered on the previous dive inspection – BG&E report 2010). The size of hole appears similar in size. Diver's reported that pieces of rotten timber could be broken away with fingers on one side, other side firm.

The repair at this pile is to wrap the affected length of pile in a zipped jacket. The jacket and internal voids are to be filled with grout. The location of deterioration is close to the seabed, therefore, some excavation using an air lift may be required.

Figure 3-9: Pile 49 North



Pile 49 North has suffered some visible section loss. There is likely to be further section loss due to Teredo worm that is not visible.

The repair at this pile is to wrap the affected length of pile in a zipped jacket. The jacket and internal voids are to be filled with grout.

Figure 3-10: Pile 49 South

Pile 49 South has suffered some visible section loss. There is likely to be further section loss due to Teredo worm that is not visible.

The repair at this pile is to wrap the affected length of pile in a zipped jacket. The jacket and internal voids are to be filled with grout.

Figure 3-11: Pile 61 South

Pile 61 South has suffered visible section loss. There is likely to be further section loss due to Teredo worm that is not visible.

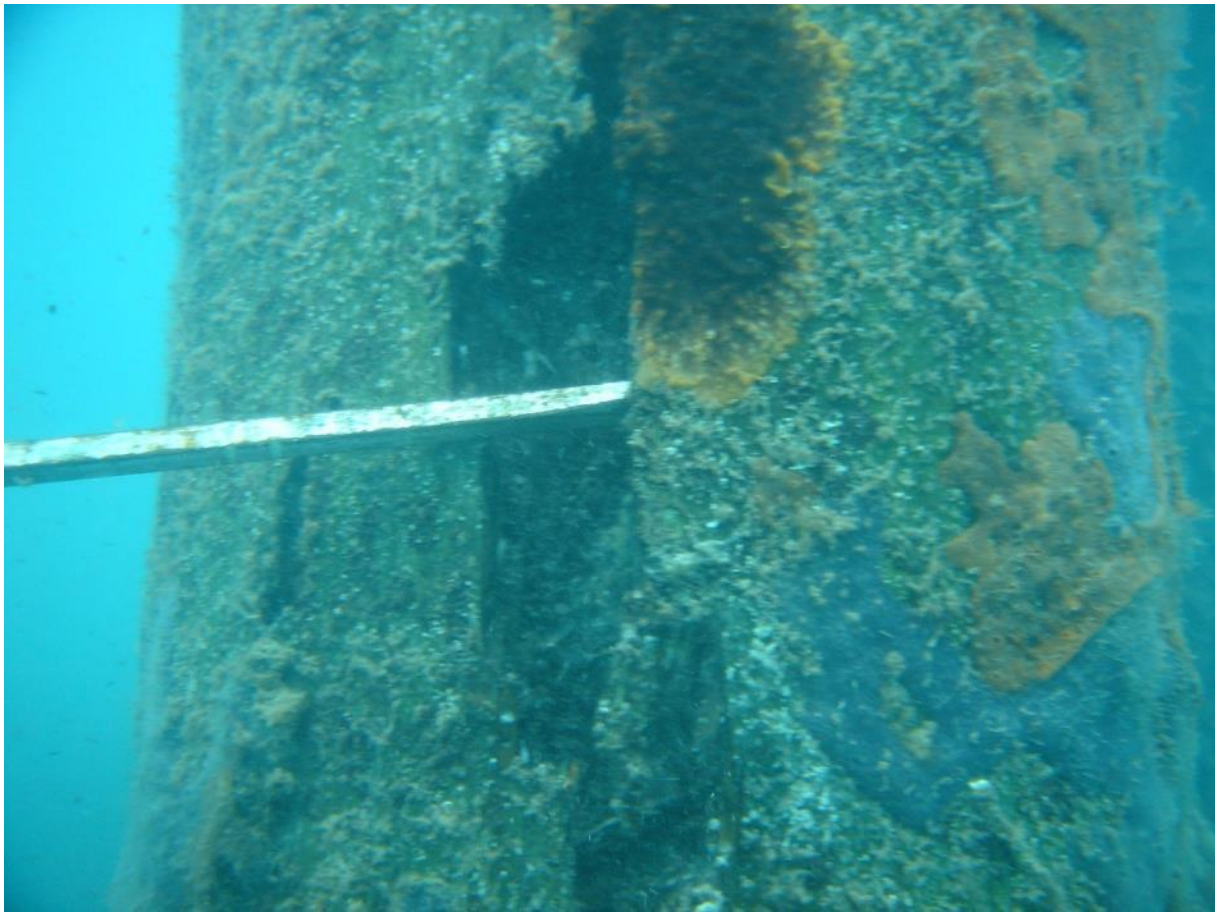
The repair at this pile is to wrap the affected length of pile in a zipped jacket. The jacket and internal voids are to be filled with grout. The location of deterioration is close to the seabed, therefore, some excavation using an air lift may be required.

Figure 3-12: Pile 62 South

Pile 62 South has suffered significant visible section loss. There is likely to be further section loss due to Teredo worm that is not visible. A screwdriver was pushed into rotten section approximately 50mm.

The repair at this pile is to wrap the affected length of pile in a zipped jacket. The jacket and internal voids are to be filled with grout.

Figure 3-13: Pile 75 North



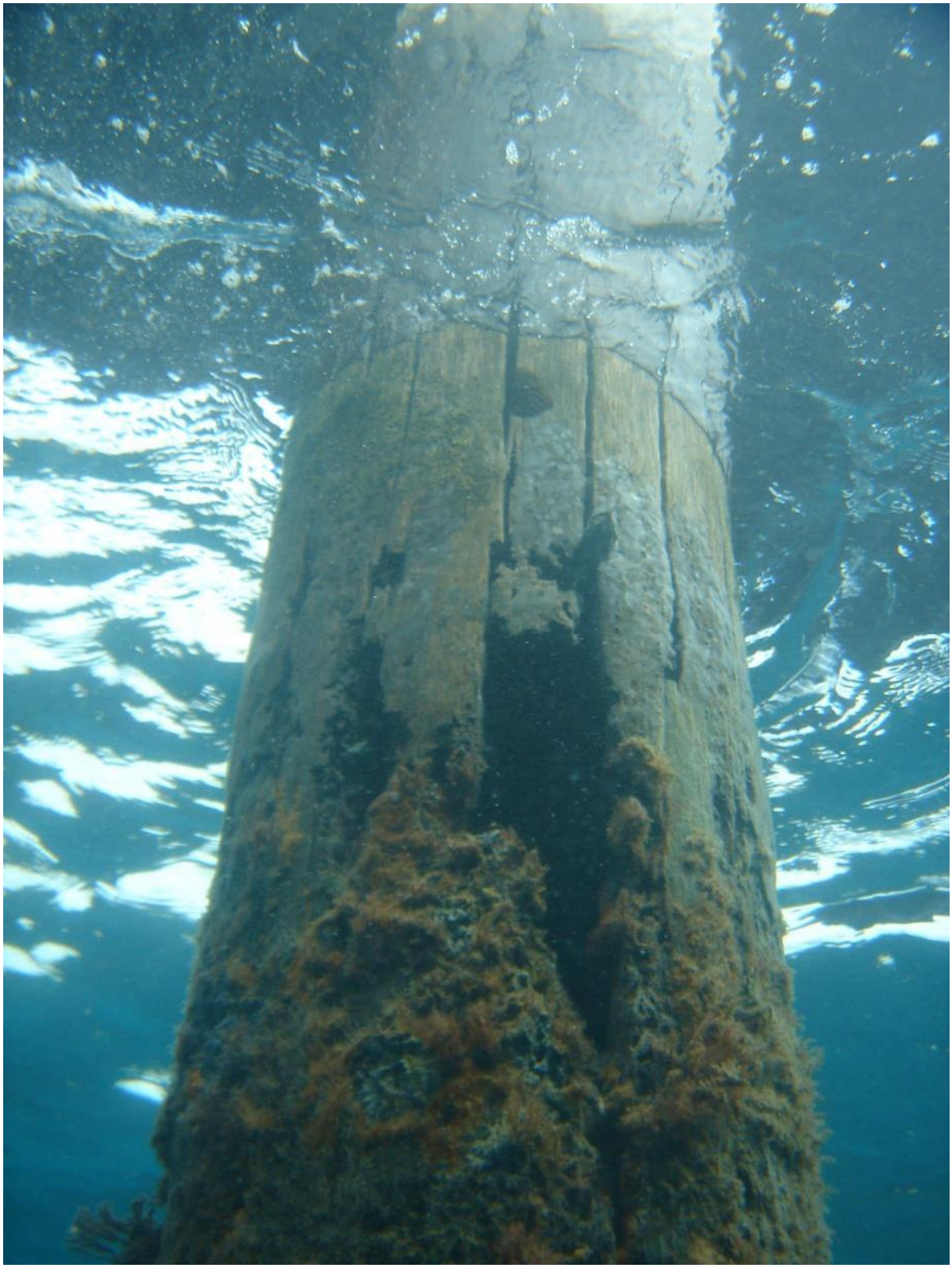
Pile 75 North has minor section loss locally a screw driver can be driven in 25mm. This pile will require remediation within 24 months, if left untreated.

Figure 3-14: Pile 91 North

Pile 91 North has suffered significant visible section loss. There is likely to be further section loss due to Teredo worm that is not visible. Pieces of rotten timber were able to be broken off.

The repair at this pile is to wrap the affected length of pile in a zipped jacket. The jacket and internal voids are to be filled with grout.

Figure 3-15: Pile 93 North



Pile 93 North was reported as having holes over its submerged length to bed level. There is likely to be significant section loss.

The repair at this pile is to wrap the affected length of pile in a zipped jacket. The jacket and internal voids are to be filled with grout.

Figure 3-16: Pile 96 North

Pile 96 North has minor section loss. This pile will require remediation within 24 months, if left untreated.

Figure 3-17: Pile 101 North

Pile 101 North has suffered significant visible section loss. Divers reported a solid centre.

The repair at this pile is to wrap the affected length of pile in a zipped jacket. The jacket and internal voids are to be filled with grout.

Figure 3-18: Pile 105 South

Pile 105 South has suffered significant visible section loss. Divers reported a solid centre.

The repair at this pile is to wrap the affected length of pile in a zipped jacket. The jacket and internal voids are to be filled with grout. The location of deterioration is close to the seabed, therefore, some excavation using an air lift may be required.

Figure 3-19: Pile 106 South

Pile 106 South has suffered significant visible section loss. There is likely to be further section loss due to Teredo worm that is not visible.

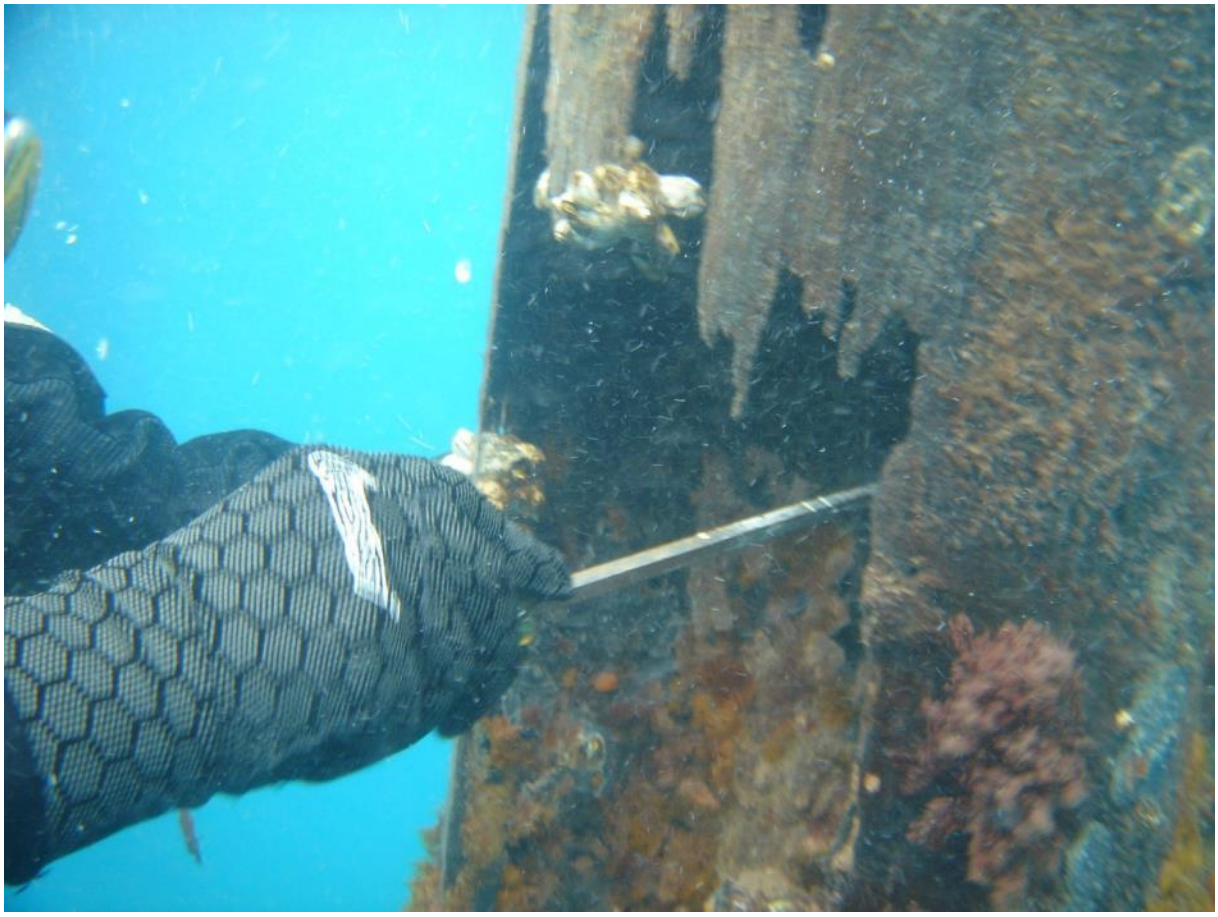
The repair at this pile is to wrap the affected length of pile in a zipped jacket. The jacket and internal voids are to be filled with grout.

Figure 3-20: Pile 112 North

Pile 112 North has suffered some visible section loss. Divers found the affected area to be rotten and a screwdriver could be pushed approximately 40mm into pile.

The repair at this pile is to wrap the affected length of pile in a zipped jacket. The jacket and internal voids are to be filled with grout. The location of deterioration is close to the seabed, therefore, some excavation using an air lift may be required.

Figure 3-21: Pile 115 South



Pile 115 South has suffered very severe section loss. Divers found the affected area to be rotten and a screwdriver could be pushed into remaining section pile.

The repair at this pile is to wrap the affected length of pile in a zipped jacket. The jacket and internal voids are to be filled with grout.

Figure 3-22: Pile 118 North

Pile 118 North has minor section loss. Divers found the affected area to be relatively solid timber with no screwdriver embedment possible.

A repair for this pile isn't necessary immediately but within 24 months it should be wrapped and grouted.

3.4 Half Caps

The following half caps are split, rotten or crushed at the connection with the pile; 33 northwest, 35 north both, 36 north both, 37 north both, 40 north both, 43 northwest, 60 northwest, 63 northwest, 71 northeast, 73 northwest, 82 northwest, 91 northwest, 93 southeast, 95 southeast, 98 southwest, 108 south both, 126 northwest, 132 north both, 133 north both, 137 both.

Figure 3-23: Half cap 33 Northwest

The end distance on the half cap to pile bolt connection is insufficient, and with the weathering to the half caps, the connection is no longer effective. The remedial should be in order of preference where possible;

- Bolt through both half caps and pile top, diagonally inboard from existing bolt, maintaining allowable hole spacing and edge and end distances to half caps and pile. (See Attachment 1)
- Where the pile connection edge and end distances cannot meet AS 1720 (Timber Structure) standards, a combination of two bolts will provide a suitable solution where; there is a bolt through the half caps inboard of pile, and there is a bolt through the pile and half caps (as bullet point above).
- Where the two half caps can be bolted together inboard of the pile but no effective bracing exists, channel bracing should be fitted.

Figure 3-24: Half cap 35 North both

The end distance on the half cap to pile bolt connection is insufficient, and with the weathering to the half caps, the connection is no longer effective. In addition, the rot to the northern half caps has reduced the bearing strength sufficiently for crushing to occur. The remedial should be in order of preference where possible;

- Insert haunch and bracing as Pier 31 SK01 Rev C. (See Attachment 2)
- Insert channel section (PFC) splice on outside with plate bolt connections to half cap at 3, quarter points along half cap to support the member. (See Attachment 1)
- Bolt through both half caps and pile top, diagonally inboard from existing bolt, maintaining allowable hole spacing and edge and end distances to half caps and pile. (See Attachment 1)
- Where the pile connection edge and end distances cannot meet AS 1720 (Timber Structure) standards, a combination of two bolts will provide a suitable solution where; there is a bolt through the half caps inboard of pile, and there is a bolt through the pile and half caps (as bullet point above).

Figure 3-25: Half cap 36 North both

The end distance on the half cap to pile bolt connection is insufficient, and with the weathering to the half caps, the connection is no longer effective. In addition the rot to the northern half caps has reduced the bearing strength sufficiently for crushing to occur. The remedial should be in order of preference where possible;

- Insert haunch and bracing as Pier 31 SK01 Rev C. (See Attachment 2)
- Insert channel section (PFC) splice on outside with plate bolt connections to half cap at 3, quarter points along half cap to support the member. (See Attachment 1)
- Bolt through both half caps and pile top, diagonally inboard from existing bolt, maintaining allowable hole spacing and edge and end distances to half caps and pile. (See Attachment 1)
- Where the pile connection edge and end distances cannot meet AS 1720 (Timber Structure) standards, a combination of two bolts will provide a suitable solution where; there is a bolt through the half caps inboard of pile, and there is a bolt through the pile and half caps (as bullet point above).

Figure 3-26: Half cap 37 North both

The end distance on the half cap to pile bolt connection is insufficient, and with the weathering to the half caps, the connection is no longer effective. The remedial should be in order of preference where possible;

- Bolt through both half caps and pile top, diagonally inboard from existing bolt, maintaining allowable hole spacing and edge and end distances to half caps and pile.
- Where the pile connection edge and end distances cannot meet AS 1720 (Timber Structure) standards, a combination of two bolts will provide a suitable solution where; there is a bolt through the half caps inboard of pile, and there is a bolt through the pile and half caps (as bullet point above).

Figure 3-27: Half cap 40 North both

The end distance on the half cap to pile bolt connection is insufficient, and with the weathering to the half caps, the connection is no longer effective. In addition the rot to the northern half cap has reduced the bearing strength sufficiently for crushing to occur. This pier is adjacent to the missing pile which adds extra load to all elements below the bridging beam increasing the chance of failure. The remedial should be in order of preference where possible;

- Insert haunch and bracing as Pier 31 SK01 Rev C. (See Attachment 2)
- Insert channel section (PFC) splice on outside with plate bolt connections to half cap at 3, quarter points along half cap to support the member. (See Attachment 1)
- Bolt through both half caps and pile top, diagonally inboard from existing bolt, maintaining allowable hole spacing and edge and end distances to half caps and pile. (See Attachment 1)
- Where the pile connection edge and end distances cannot meet AS 1720 (Timber Structure) standards, a combination of two bolts will provide a suitable solution where; there is a bolt through the half caps inboard of pile, and there is a bolt through the pile and half caps (as bullet point above).

Figure 3-28: Half cap 43 Northwest

The end distance on the half cap to pile bolt connection is insufficient, and with the weathering to the half caps, the connection is no longer effective. In addition, the rot to the northwestern half cap has reduced the bearing strength sufficiently for crushing to occur. The remedial should be in order of preference where possible;

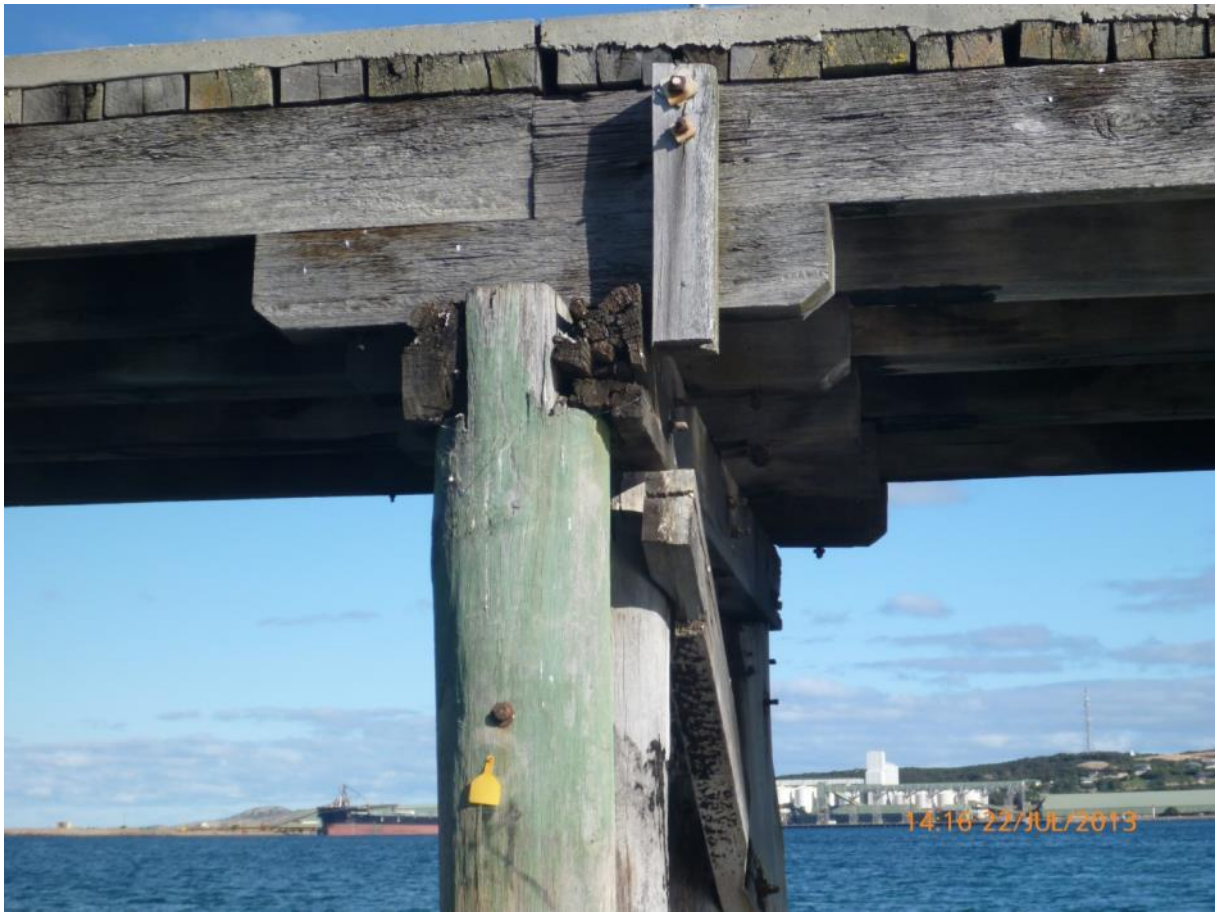
- Insert haunch and bracing as Pier 31 SK01 Rev C. (See Attachment 2)
- Insert channel section (PFC) splice on western side with plate bolt connections to half cap at 3, quarter points along half cap to support the member. (See Attachment 1)
- Bolt through both half caps and pile top, diagonally inboard from existing bolt, maintaining allowable hole spacing and edge and end distances to half caps and pile. (See Attachment 1)
- Where the pile connection edge and end distances cannot meet AS 1720 (Timber Structure) standards, a combination of two bolts will provide a suitable solution where; there is a bolt through the half caps inboard of pile, and there is a bolt through the pile and half caps (as bullet point above).

Figure 3-29: Half cap 60 Northwest

The end distance on the half cap to pile bolt connection is insufficient, and with the weathering to the half caps, the connection is no longer effective. The remedial should be;

- Bolt through both half caps and pile top, diagonally inboard from existing bolt, maintaining allowable hole spacing and edge and end distances to half caps and pile. (See Attachment 1)

Figure 3-30: Half cap 63 Northwest



The end distance on the half cap to pile bolt connection is insufficient, and with the weathering to the half caps, the connection is no longer effective. In addition, the northwestern half cap has crushed. The north-eastern half cap appears in good condition so the bearing loads can be transferred to this element. The remedial should be in order of preference where possible;

- Bolt through both half caps and pile top, diagonally inboard from existing bolt, maintaining allowable hole spacing and edge and end distances to half caps and pile. (See Attachment 1)
- Where the pile connection edge and end distances cannot meet AS 1720 (Timber Structure) standards, a combination of two bolts will provide a suitable solution where; there is a bolt through the half caps inboard of pile, and there is a bolt through the pile and half caps (as bullet point above).

Figure 3-31: Half cap 71 Both

The end distance on the half cap to pile bolt connection is insufficient, and with the weathering to the half caps, the connection is no longer effective. The remedial should be in order of preference where possible;

- Bolt through both half caps and pile top, diagonally inboard from existing bolt, maintaining allowable hole spacing and edge and end distances to half caps and pile. (See Attachment 1)
- Where the pile connection edge and end distances cannot meet AS 1720 (Timber Structure) standards, a combination of two bolts will provide a suitable solution where; there is a bolt through the half caps inboard of pile, and there is a bolt through the pile and half caps (as bullet point above).

Figure 3-32: Half cap 73 Northwest

The end distance on the half cap to pile bolt connection is insufficient, and with the weathering to the half caps, the connection is no longer effective. The remedial should be in order of preference where possible;

- Bolt through both half caps and pile top, diagonally inboard from existing bolt, maintaining allowable hole spacing and edge and end distances to half caps and pile. (See Attachment 1)
- Where the pile connection edge and end distances cannot meet AS 1720 (Timber Structure) standards, a combination of two bolts will provide a suitable solution where; there is a bolt through the half caps inboard of pile, and there is a bolt through the pile and half caps (as bullet point above).

Figure 3-33: Half cap 82 Northwest

The end distance on the half cap to pile bolt connection is insufficient, and with the weathering to the half caps, the connection is no longer effective. There is evidence that the west half cap bolt has slipped in relative to the pile. The remedial should be in order of preference where possible;

- Bolt through both half caps and pile top, diagonally inboard from existing bolt, maintaining allowable hole spacing and edge and end distances to half caps and pile. (See Attachment 1)
- Where the pile connection edge and end distances cannot meet AS 1720 (Timber Structure) standards, a combination of two bolts will provide a suitable solution where; there is a bolt through the half caps inboard of pile, and there is a bolt through the pile and half caps (as bullet point above).

Figure 3-34: Half cap 91 Northwest

The end distance on the half cap to pile bolt connection is insufficient, and with the weathering to the half caps, the connection is no longer effective. The remedial should be in order of preference where possible;

- Bolt through both half caps and pile top, diagonally inboard from existing bolt, maintaining allowable hole spacing and edge and end distances to half caps and pile. (See Attachment 1)
- Where the pile connection edge and end distances cannot meet AS 1720 (Timber Structure) standards, a combination of two bolts will provide a suitable solution where; there is a bolt through the half caps inboard of pile, and there is a bolt through the pile and half caps (as bullet point above).

Figure 3-35: Half cap 93 Southeast

The end distance on the half cap to pile bolt connection is insufficient, and with the weathering to the half caps, the connection is no longer effective. In addition, the rot to the south-eastern half caps has reduced the bearing strength sufficiently for crushing to occur. The remedial should be in order of preference where possible;

- Insert haunch and bracing as Pier 31 SK01 Rev C. (See Attachment 2)
- Insert channel section (PFC) splice on outside with plate bolt connections to half cap at 3, quarter points along half cap to support the member. (See Attachment 1)
- Bolt through both half caps and pile top, diagonally inboard from existing bolt, maintaining allowable hole spacing and edge and end distances to half caps and pile. (See Attachment 1)
- Where the pile connection edge and end distances cannot meet AS 1720 (Timber Structure) standards, a combination of two bolts will provide a suitable solution where; there is a bolt through the half caps inboard of pile, and there is a bolt through the pile and half caps (as bullet point above).

Figure 3-36: Half cap 95 Southeast

The end distance on the half cap to pile bolt connection is insufficient, and with the weathering to the half caps, the connection is no longer effective. In addition, the rot to the south-eastern half cap has reduced the bearing strength sufficiently for crushing to occur. The remedial should be in order of preference where possible;

- Insert haunch and bracing as Pier 31 SK01 Rev C. (See Attachment 2)
- Insert channel section (PFC) splice on eastern side with plate bolt connections to half cap at 3, quarter points along half cap to support the member. (See Attachment 1)
- Bolt through both half caps and pile top, diagonally inboard from existing bolt, maintaining allowable hole spacing and edge and end distances to half caps and pile. (See Attachment 1)
- Where the pile connection edge and end distances cannot meet AS 1720 (Timber Structure) standards, a combination of two bolts will provide a suitable solution where; there is a bolt through the half caps inboard of pile, and there is a bolt through the pile and half caps (as bullet point above).

Figure 3-37: Half cap 98 Southwest

The end distance on the half cap to pile bolt connection is insufficient, and with the weathering to the half caps, the connection is no longer effective. The remedial should be in order of preference where possible;

- Bolt through both half caps and pile top, diagonally inboard from existing bolt, maintaining allowable hole spacing and edge and end distances to half caps and pile. (See Attachment 1)
- Where the pile connection edge and end distances cannot meet AS 1720 (Timber Structure) standards, a combination of two bolts will provide a suitable solution where; there is a bolt through the half caps inboard of pile, and there is a bolt through the pile and half caps (as bullet point above).

Figure 3-38: Half cap 108 Both

The end distance on the half cap to pile bolt connection is insufficient, and with the weathering to the half caps, the connection is no longer effective. The remedial should be in order of preference where possible;

- Bolt through both half caps and pile top, diagonally inboard from existing bolt, maintaining allowable hole spacing and edge and end distances to half caps and pile. (See Attachment 1)
- Where the pile connection edge and end distances cannot meet AS 1720 (Timber Structure) standards, a combination of two bolts will provide a suitable solution where; there is a bolt through the half caps inboard of pile, and there is a bolt through the pile and half caps (as bullet point above).

Figure 3-39: Half cap 126 Northwest

The end distance on the half cap to pile bolt connection is insufficient, and with the weathering to the half caps, the connection is no longer effective. The remedial should be in order of preference where possible;

- Bolt through both half caps and pile top, diagonally inboard from existing bolt, maintaining allowable hole spacing and edge and end distances to half caps and pile. (See Attachment 1)
- Where the pile connection edge and end distances cannot meet AS 1720 (Timber Structure) standards, a combination of two bolts will provide a suitable solution where; there is a bolt through the half caps inboard of pile, and there is a bolt through the pile and half caps (as bullet point above).

Figure 3-40: Half cap 132 and 133 North both

Pier 132, the north end of both half caps the pile bolt connection has insufficient end distance, and with the weathering to the half caps, the connection is no longer effective. The remedial should be in order of preference where possible;

- Bolt through both half caps and pile top, diagonally inboard from existing bolt, maintaining allowable hole spacing and edge and end distances to half caps and pile. (See Attachment 1)
- Where the pile connection edge and end distances cannot meet AS 1720 (Timber Structure) standards, a combination of two bolts will provide a suitable solution where; there is a bolt through the half caps inboard of pile, and there is a bolt through the pile and half caps (as bullet point above).

Pier 133, the end distance on the half caps to pile bolt connection is insufficient, and with the weathering to the half caps, the connection is no longer effective. In addition, the rot and lack of bearing length of the northern half caps has reduced the bearing strength sufficiently for crushing to occur. The remedial should be in order of preference where possible;

- Insert haunch and bracing as Pier 31 SK01 Rev C. (See Attachment 2)
- Insert channel section (PFC) splice on the outside with plate bolt connections to half cap at 3, quarter points along half cap to support the member. (See Attachment 1)

- Bolt through both half caps and pile top, diagonally inboard from existing bolt, maintaining allowable hole spacing and edge and end distances to half caps and pile. (See Attachment 1)
- Where the pile connection edge and end distances cannot meet AS 1720 (Timber Structure) standards, a combination of two bolts will provide a suitable solution where; there is a bolt through the half caps inboard of pile, and there is a bolt through the pile and half caps (as bullet point above).

Figure 3-41: Half cap 137 North both

The end distance on the half cap to pile bolt connection is insufficient. There has been a shear failure of the timber suggesting that the half caps have been sliding relative to the piles. The remedial should be in order of preference where possible;

- Insert haunch and bracing as Pier 31 SK01 Rev C. (See Attachment 2)
- Bolt through both half caps and pile top, diagonally inboard from existing bolt, maintaining allowable hole spacing and edge and end distances to half caps and pile. (See Attachment 1)
- Where the pile connection edge and end distances cannot meet AS 1720 (Timber Structure) standards, a combination of two bolts will provide a suitable solution where; there is a bolt through the half caps inboard of pile, and there is a bolt through the pile and half caps (as bullet point above).

3.5 Corbels

The following corbels have defects; 41 North, 51 North, 52 North, 53 North, 54 South, 57 North and South, 59 South, 78 North, 85 North, 86 North, 88 North, 93 North, 94 North, 96 North, 97 North, 101 North, 102 North, 103 South, 104 North, 110 North, 111 North, 112 North, 114 North, 126 North, 130 South, 131 North, 132 South, 133 North, 134 North, 136 North. The defects to the corbels are less critical as there is some redundancy in the structure;- the deck beams have sufficient strength to carry the cantilever moments. The crushing and rolling of corbels is likely to be due to jetty movement during storms rather than overloading from dead and pedestrian loads.

Figure 3-42: Corbel 41 North

The corbel has split and crushed. The remedial should be in order of preference where possible;

- Replace corbel
- Reinforce corbel with steel plates.

Figure 3-43: Corbel 51 and 52 North

The corbels have split and rotated about the longitudinal axis. The remedial should be in order of preference where possible;

- Replace corbel.

Figure 3-44: Corbel 54 South

The corbel has split. The remedial should be in order of preference where possible;

- Bolt corbel together at split.

Figure 3-45: Corbel 57 South

The corbel has split. The remedial should be in order of preference where possible;

- Bolt corbel together at split.

Figure 3-46: Corbel 58 North

The corbel has split. The remedial should be in order of preference where possible;

- Bolt corbel together at split end(s).

Figure 3-47: Corbel 59 South

The corbel has split. The remedial should be in order of preference where possible;

- Bolt corbel together at split end(s).

Figure 3-48: Corbel 78 North

The corbel has split. The remedial should be in order of preference where possible;

- Bolt corbel together at split end(s).

Figure 3-49: Corbel 85 North

The corbel has split. The remedial should be in order of preference where possible;

- Bolt corbel together at split.

Figure 3-50: Corbel 93 North

The corbel has split with loss of half of section. The remedial should be in order of preference where possible;

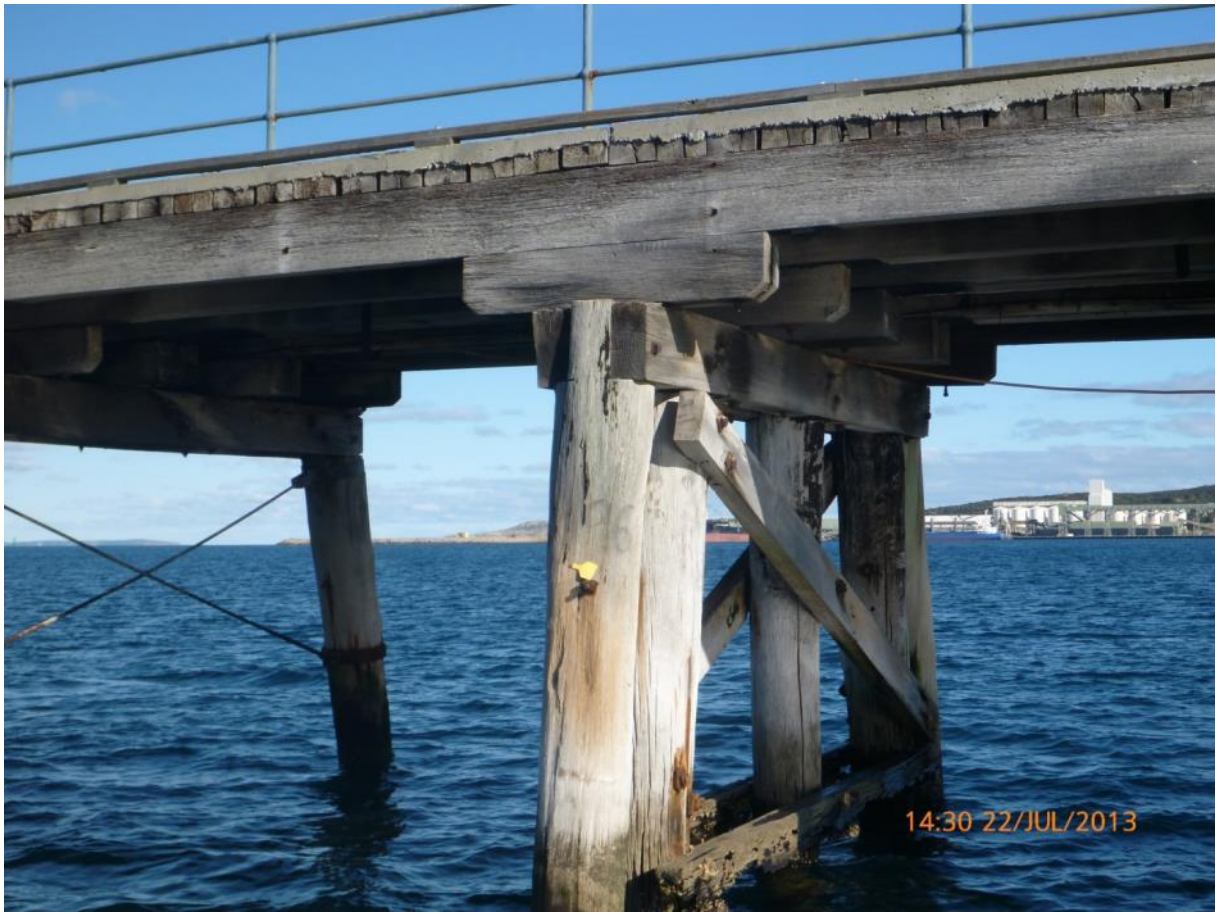
- Replace corbel.

Figure 3-51: Corbel 94 North

The corbel has split. The remedial should be in order of preference where possible;

- Bolt corbel together at split.

Figure 3-52: Corbel 96 North



The corbel has split. The remedial should be in order of preference where possible;

- Bolt corbel together at split.

Figure 3-53: Corbel 101 North

The corbel has split. The remedial should be in order of preference where possible;

- Bolt corbel together at split.

Figure 3-54: Corbel 102 North

The corbel has split. The remedial should be in order of preference where possible;

- Bolt corbel together at split.

Figure 3-55: Corbel 103 South

Corbel has rotated on plan. . The remedial should be in order of preference where possible;

- Slide corbel back into position and bolt with steel plates back into alignment (this should help to realign east stringer as well).

Figure 3-56: Corbel 104 North

The corbel has split with loss of half of section. The remedial should be in order of preference where possible;

- Replace corbel.

Figure 3-57: Corbel 110 and 111 North

The corbels have split. The remedial to the corbels should be in order of preference where possible;

- Bolt corbel together at split.

Figure 3-58: Corbel 114 North

The corbel has split and rotated about the longitudinal axis. The remedial should be in order of preference where possible;

- Replace corbel
- Bolt corbel together at each end.

Figure 3-59: Corbel 126 North

The corbel has split, has rotted and rotated about the longitudinal axis. The remedial should be in order of preference where possible;

- Replace corbel.

Figure 3-60: Corbel 130 South

The corbel has split. The remedial should be in order of preference where possible;

- Bolt corbel together where split.

Figure 3-61: Corbel 132 South

The corbel has split. The remedial should be in order of preference where possible;

- Bolt corbel together where split.

Figure 3-62: Corbel 136 North

The corbel has rotated. The remedial should be in order of preference where possible;

- Reposition corbel vertically.

130,131,133,139,140,141 and 143 all North, have split corbels The remedial should be in order of preference where possible;

- Bolt corbel together where split.

3.6 Stringers

Stringers require replacement or remedial action at the following locations; 72-74 North,134-136 South, 139-141 South.

Figure 3-63: Stringer 72-74 North

Stringer has weathered and deteriorated beyond repair. The remedial should be in order of preference where possible;

- Replace stringer.
- Reinforce stringer with new member on inside.

Figure 3-64: Stringer 134-136 South

Stringer has weathered and deteriorated beyond repair. The remedial should be in order of preference where possible;

- Replace stringer.
- Reinforce stringer with new member on inside.

Figure 3-65: Stringer 139-141 South

Stringer has weathered and deteriorated beyond repair. The remedial should be in order of preference where possible;

- Replace stringer.
- Reinforce stringer with new member on inside.

4 DISCUSSION

4.1 Overview

The overall Jetty condition may be described as severe but sound in calm to moderate conditions. A storm event could cause the weak and damaged sections of the jetty to fail. The location of such a failure would depend on the particular characteristics of the storm. A lesser storm could also cause significant damage to the weak points in the structure.

The weak points in the structure identified in the BG&E report and backed up by this condition assessment are;

- The piles
- The connection between the piles and half caps.
- The lack of effective bracing in much of the structure.

4.2 Piles

The pile condition above water appears to be in good condition. There are some cases of splitting at the top of the pile which can be repaired. The remedial actions required have been set out in section 3. There are many positions where the original pile frames including bracing are still in situ in part. In this instance the obsolete members provide no structural benefit to the structure, but do add surface area for increased wave loading.

The follow up dive inspection of the piles investigated the piles, which in BG&E's 2010 report had been noted as having deteriorated. Those piles which require repair have been identified in section three. There were 3 piles (39 South, 106 South and 115 South) in a very poor condition as well as 2 piles (61 South and 62 South) in a poor condition adjacent to each other and 31 South which will receive increased load as the abutment support to the walkway. It is recommended that these piles be repaired prior to reopening the Jetty.

All the piles which require repair have lost cross-sectional area at one or more locations along the submerged length. To compensate for this loss of section the recommended repair is to wrap the pile in a HDPE jacket over the affected length, seal and fill with either epoxy or cementitious grout. The grout should be pumped in to ensure that all voids are filled to attain original sectional area. Where necessary excavation may have to be undertaken to ensure the seal of the wrap is against good timber.

4.3 Pile to Half cap Connection

The weakness of the pile to half cap connection is a result of the 1991 refurbishment replacing the outer piles. Using this method to insert piles outward of the original piles and using the original half caps meant that there was a short bearing length and only sufficient room for a single 20mm diameter bolt to be fitted with insufficient (to be in accordance with AS 1720 Timber Structures) end distance. The insufficient end distance in combination with deterioration of the timber due to weathering has caused the shear failures (Example is Fig 3-24) when storm conditions have caused lateral pile movement.

There is no easy fix for this situation as the lack of length of the half caps prevents good end distance on the pile connections. The best repair for this is set out in Drawing 224.06-SK01

(Attachment 2). Ideally this repair would be carried out for all piles to maximise the life of the structure. BMT JFA are aware that budget constraints on the Shire of Esperance require cheaper alternatives to be used, which will help to prevent the structure from deteriorating further, until greater funding is forthcoming. These alternatives are stated in section 3.

4.4 Lack of Effective Bracing

During storm conditions the requirement for effective load sharing between piles is vital to the performance of the structure as the loads at one point may be very high (For instance during wave breaking) therefore by sharing the load the stress in individual elements is reduced. The original structure of 3 piles had significant timber bracing, however, the refurbished 2 pile structure had tension only bracing and that was not included in many locations. There are currently sections of the jetty where there is no bracing for many consecutive piers. Where there is bracing, at locations where it is only tie bars, it is not effective in sharing load between the piles.

The bracing should be capable of taking compression forces to allow loads to be shared effectively between the piles and reduce stresses in the pile to half cap connections. It is advised that effective bracing be installed on all piers, however, to prevent the structure deteriorating further bracing should be installed at every 4 piers and where there is evidence of shear failure at the bolts on the half caps.

4.5 Superstructure

The superstructure (above half caps – the corbels, stringers, decking planks and concrete topping) is in largely in a good condition. The outer corbels and stringers have weathered heavily particularly on the north side. The superstructure was originally designed for the significantly greater loading of a working jetty. Under the reduced loading regime that BG&E suggested of 3kPa, which BMT JFA believes is justifiable if crowd loading is prevented, there is significant redundancy.

An example of this redundancy is that, should the outer corbels or stringers be ineffective due to weathering or rot, the deck planks have sufficient strength to cantilever from the inner stringers. The deflection could, however, be great enough to cause cracking in the unreinforced concrete topping.

The superstructure deformation in the form of rotated corbels and stringers is most likely due to the movements of unbraced piers (or a section of unbraced piers) moving during storm events. The current damage to the superstructure is unlikely to affect the use of the structure during calm to moderate seas due to the redundancy in the structure.

5 RECOMMENDATIONS

Following inspection of the above water structure and deteriorated sections of the below water structure the following recommendations are made;

- The Jetty may be reopened following repair of the 6 piles outlined in section 4 and with conditions outlined below
- The advised minimum remedial actions be undertaken over the year following reopening.
- The reduced loading be noted on a plaque on the walkway access to the Jetty
- The Jetty be inspected periodically once every two months and following all storms which cause overtopping of the Headland rock armour. (This inspection should constitute a walkover assessing if the cracking to the concrete topping has worsened) If this is the case investigation into the cause should be sought before reopening.

DRAWINGS

Drg No.	Revision	Title
224.07-SK01	A	Half Cap Repair
224.06-SK01	C	Timber Abutment

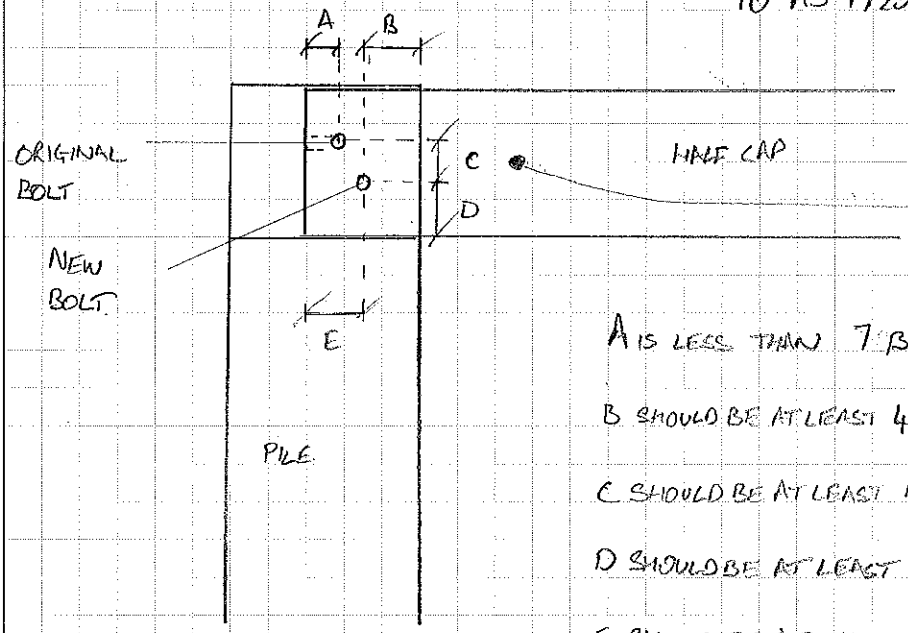
BMT JFA Consultants "Where will our knowledge take you?"	Project Name: ESPERANCE TANKER JETTY	Job Code: 224.07	Page: Of:
	Activity: INSPECTION REPORT.	By: JF	Date: 2/9/13
	Title/Purpose: HALF CAP.	REV: CKD:	App'd:

224.07-SK01

Reference / Comments:

HALF CAP REPAIR. - BOLT ONLY

EDGE AND END DISTANCES TO AS 1720: 2010 — TIMBER STRUCTURES



A IS LESS THAN 7 BOLT DIAMETERS (ϕ)

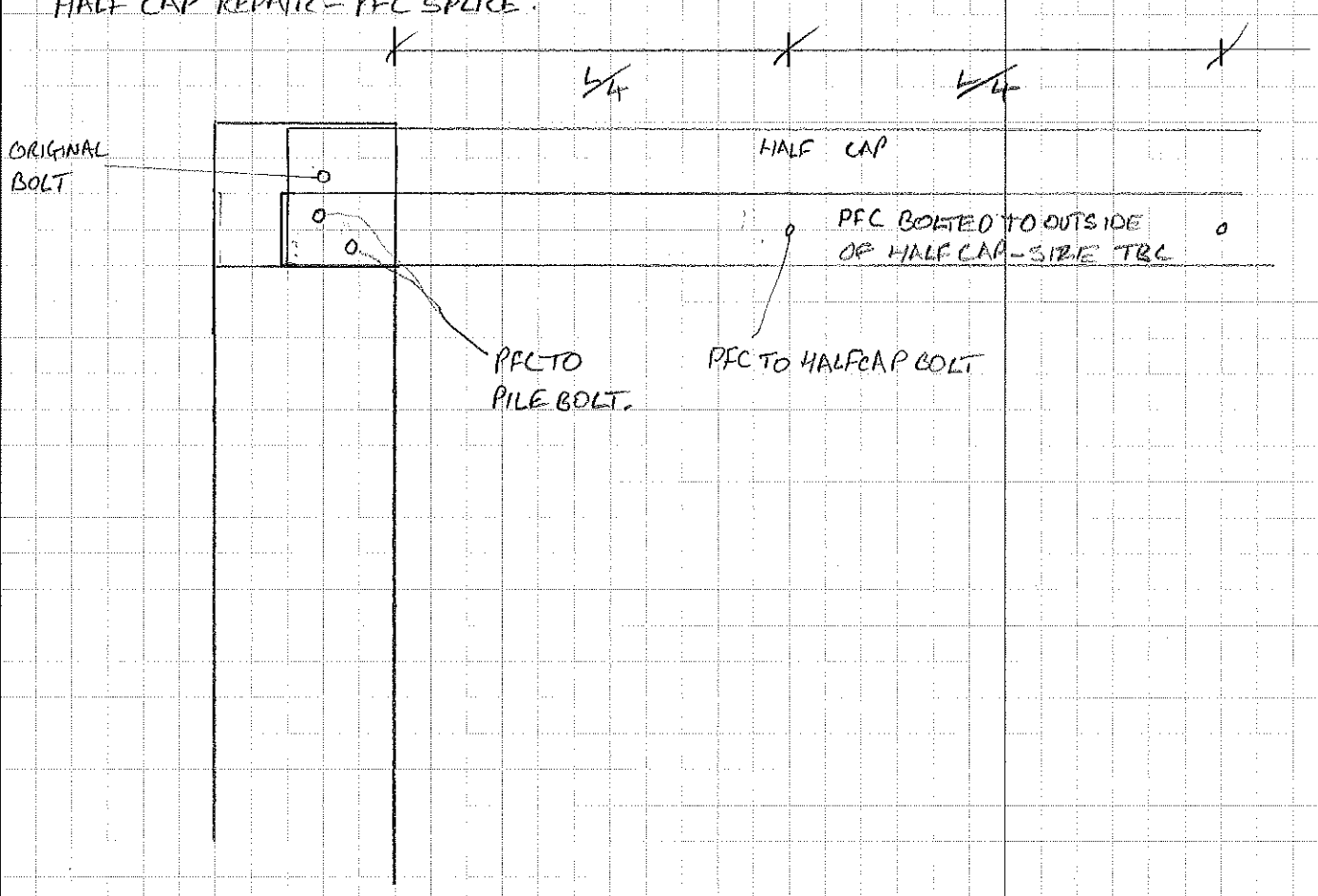
B SHOULD BE AT LEAST 4ϕ

C SHOULD BE AT LEAST 4ϕ

D SHOULD BE AT LEAST 2ϕ

E SHOULD BE AT LEAST 7ϕ

HALF CAP REPAIR - PFC SPLICE.



ESPERANCE JETTY WALKWAY

TIMBER ABUTMENT

EMAILED 28/6/2013

SK01 REVC

REAMOUT FRIABLE TIMBER EPIGEN IN HOLE + GAPS

FILL ANY GAP BETWEEN HAUNCH AND HALFCAP. WITH EPIGEN.

EAGEN IN GAPS.

150
90
140

300

150

250

A

A

GALVANISED M30 BOLTS WASHERS 90x90x8

REINFORCE HALFCAP ENDS WITH TIMBER HAUNCHES

75.

75mm

2400mm

REMOVE EXISTING STEEL BRACINGT AND REPLACE WITH TIMBER.

150

M30 GALVANISED BOLTS WITH 90x90x8 GALVANISED SQUARE WASHERS.

PILE.

HAUNCH PLANED FLAT ON CONTACT SIDE

PILE PLANED LOCALLY TO RECEIVE WASHER PLATE

PILE LOCALLY PLANED FLAT TO PROVIDE 75mm. WIDE SHELF FOR HAUNCH.

SECTION A-A

ALL BOLT HOLES TO BE FILLED WITH BITUMINOUS SEALANT.

ALL TIMBER TO TIMBER SURFACES TO BE FILLED WITH BITUMINOUS SEALANT UNLESS NOTED OTHERWISE

Reference / Comments:

BMT JFA Consultants

"Where will our knowledge take you?"

Project Name:	Activity:	Job Code:	Page: Of:
Title/Purpose:	By:		
	REV:		
	CKD:		
	App'd:	Date:	