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R967 Rev 1

October 2017

360 Environmental

Subsea 7 Bundle Facility
Shoreline Movement Assessment

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Form 035 18/06/2013

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1. Introduction

Subsea 7 propose to construct a new pipeline bundle fabrication facility in north-west Western Australia. The proposed location of this facility is within the Exmouth Gulf, on the eastern side of the North West Cape. The location is adjacent to the Learmonth Airport, which is approximately 35 km south of Exmouth, as shown in Figure 1.1.

Figure 1.1 Proposed site location

A key element of the pipeline bundle fabrication facility is the launchway, which enables the fabricated pipeline to be launched into the ocean for subsequent shipment and installation. The launchway requires the construction of a small shore perpendicular structure to support the launch rails over the nearshore area. A similar facility has existed in Wick in the far north of Scotland since 1978. A photograph of the launchway at Wick is provided in Figure 1.2 to give an indication of the size and form of the launchway.

An assessment of the potential impacts of the launchway on the coastal geomorphology was completed by GHD (2017). The GHD assessment was largely based on numerical modelling techniques and focused on the impacts of ambient wind and wave conditions as the key driver of longshore sediment transport in the nearshore zone.

Specialist coastal and port engineers M P Rogers & Associates Pty Ltd (MRA) were engaged by project environmental consultants 360 Environmental Pty Ltd (360) to complete a review of the local shoreline behaviour in order to further assess the potential changes as a result of the proposal. Specifically, the methodology proposed by MRA involved the review of historical aerial photography to determine the characteristics of previous shoreline change at the site. Additionally, the extent of shoreline change observed adjacent to an abutment structure associated with the Learmonth Jetty has also been reviewed to provide an indication of the potential shoreline changes that could occur due to the construction of the launchway.

Figure 1.2 Indicative image of launchway structure from Wick with pipeline being launched

The Learmonth Jetty and abutment was first constructed in 1955 for use in the oil drilling operations in the area. The design drawing of the original Learmonth Jetty is included in Appendix A and shows a total abutment length of approximately 80 m. For the purposes of this assessment it is assumed that the shoreline changes that have occurred due to the construction of the abutment will be similar to those that occur as a result of the launchway. This assumption is based on the fact that the exposure, aspect and nearshore bathymetry are similar at both sites, as shown in Figure 1.3.

This report presents the results of the above assessments.

Figure 1.3 Location of Learmonth Jetty in relation to the propose bundle facility

2. Site Characteristics

Beaches adjacent to the Learmonth Jetty and the proposed bundle facility are characterised by southerly sediment transport (Short 2005). This southerly sediment transport is predominately due to the increased exposure and fetch to the north when compared to the relatively protected waters of the Exmouth Gulf to the south of the sites. Short (2005) notes that the beaches are very low energy and often calm, with sand flats extending around 100 m offshore and patchy fringing reef beyond. This is consistent with the results of the benthic habitat mapping completed by 360 in the vicinity of the proposed bundle site, as presented in Figure 2.1.

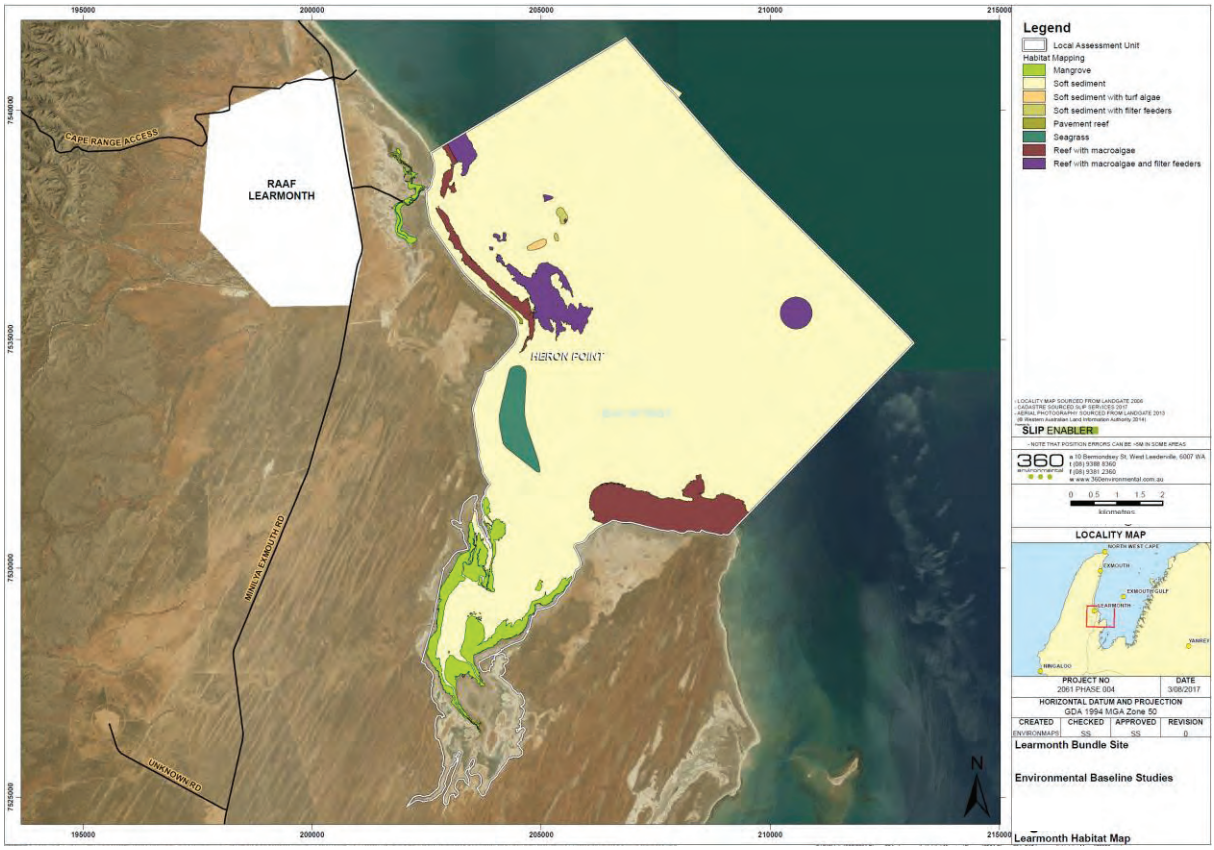


Figure 2.1 Benthic habitat mapping (Source: 360 Environmental)

Sediment samples were also collected by 360 at locations along the shoreline. Particle size distribution analysis of these samples indicates that the shoreline is predominately comprised of medium grained sands with median grain sizes (d_{50}) ranging from 0.15 to 0.5 mm. The predominately sandy nature of these beach materials, coupled with their medium size, means that longshore sediment transport processes would be expected along these shorelines, albeit the sediment transport quantities would be expected to be small given the calm nature of the site.

Evidence of net longshore sediment transport is observed at the Learmonth Jetty abutment. Photographs of the jetty abutment and the beaches north and south are presented in Figures 2.2 and 2.3. These images clearly show the presence of a wide sandy beach on the northern side of the abutment, with a much narrower beach present on the southern side of the structure. This is indicative of southerly sediment transport.

Figure 2.2 Photograph looking seaward from the base of the Learmonth Jetty abutment

Figure 2.3 Photographs looking landward from the end of the Learmonth Jetty abutment

3. Shoreline Movement Assessment

3.1 Shoreline Adjacent to Learmonth Jetty

Historical aerial imagery was obtained to help understand the impacts that the construction of the Learmonth Jetty abutment had on the shoreline. In order to provide meaningful results, the historical imagery was required to predate the construction of the abutment so that changes to the shoreline as a result of the construction could be measured.

Aerial imagery was available from 1949, with additional imagery available through the 1960's and 1970's to provide an indication of the changes in the period after the construction. Images from 2001 and 2013 were also included in the assessment to provide an indication of the longer term shoreline changes that have been experienced.

Figure 3.1 presents extracts from each of the aerial images for the shoreline adjacent to the abutment. It is evident from these images that the abutment has had an impact on the shoreline through the trapping of sediment on its northern side, however it is also evident that the vegetation line has advanced seaward on both sides of the abutment over the period of record. This is better demonstrated in Figure 3.2 which presents a shoreline movement plan for the area. This shoreline movement plan was prepared by mapping the position of the coastal vegetation line in accordance with the methodology outlined in DoT (2009).

This shoreline movement plan shows that, whilst there has been some degree of fluctuation in the shoreline position, the shoreline adjacent to the abutment has experienced a net accretion trend. Notwithstanding, the extent of the accretion is much greater on the northern side of the abutment than on the southern side.

The average accretion experienced on the northern side of the abutment has varied between 70 to 100 m over the 800 m north of the structure between 1949 and 2013, whilst the accretion on the southern side has been in the order of 20 m over a 700 m length of shoreline for the same period. This suggests that, whilst the structure does provide an impediment to longshore transport of sediment, its construction on what appears to have been an accreting shoreline has resulted in no net erosion over the longer term. Nevertheless, it is important to note that over interim periods in the couple of decades following the construction, erosion of the southern shoreline was experienced. This erosion appeared to peak around 1968 prior to the shoreline rebounding slowly over time. This rebound of the shoreline position presumably occurred as the rate of sediment feed around the abutment began to increase. The extent of this interim erosion may have been as much as 40 m in places.

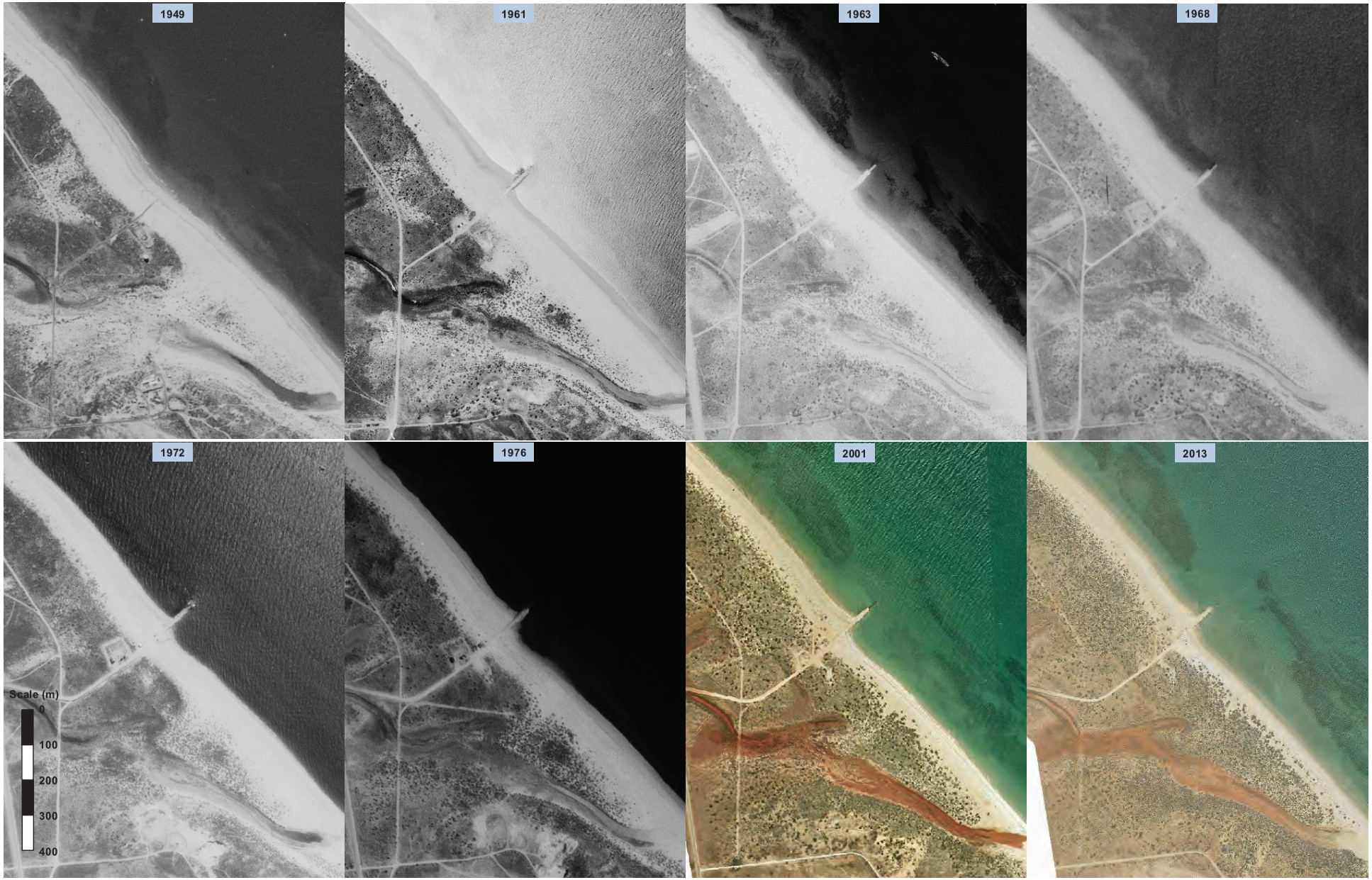


Figure 3.1 Historical shoreline positions adjacent to Learmonth Jetty

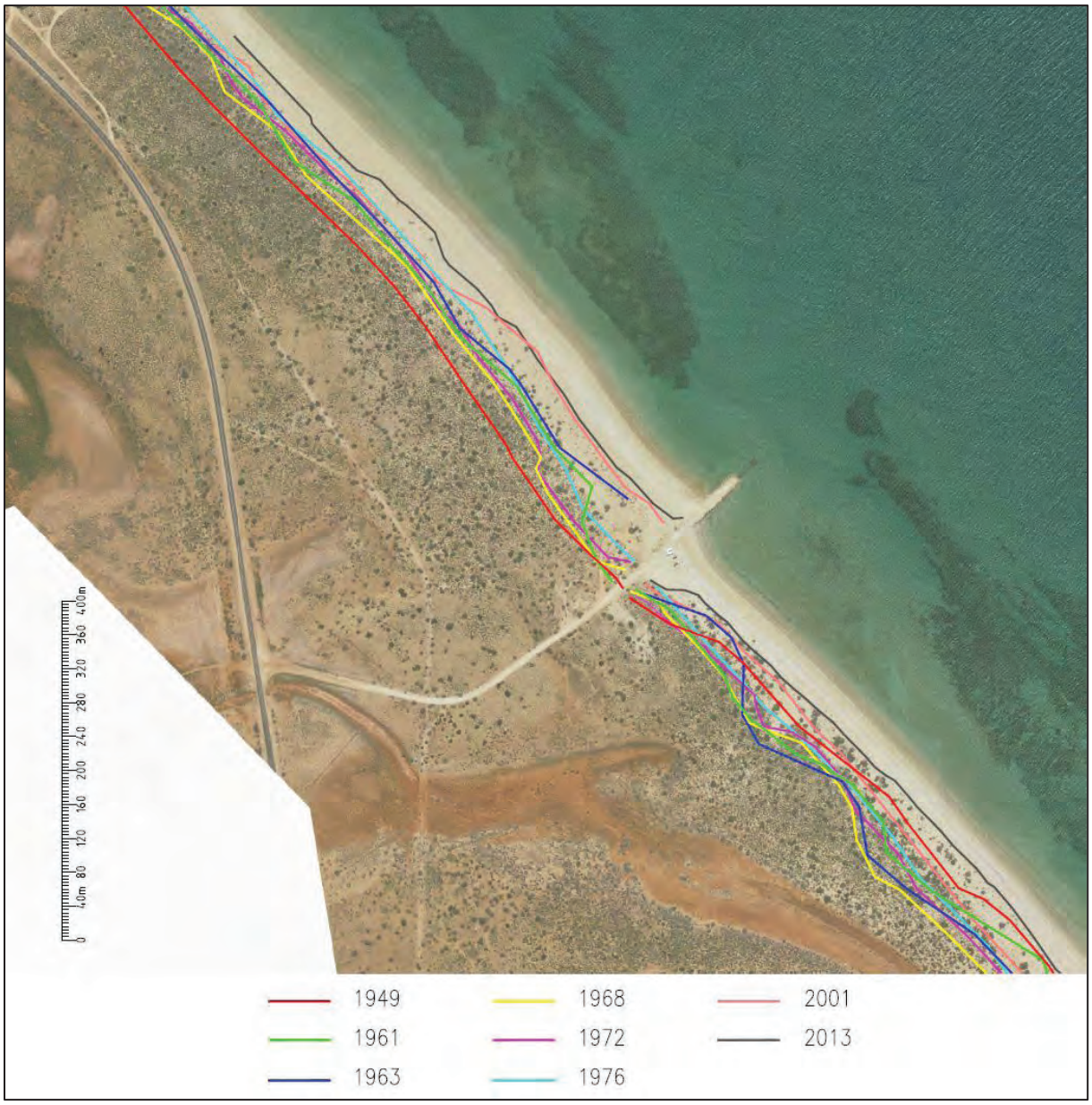


Figure 3.2 Shoreline movement plan for shoreline adjacent to Learmonth Jetty

3.2 Proposed Bundle Facility Location

A similar review of aerial photography was completed for the shoreline adjacent to the proposed bundle facility location, with vegetation lines mapped from the imagery to provide an indication of the historical shoreline movement. The shoreline movement information is presented in Figure 3.3.

Similar to the Learmonth Jetty site, the shoreline along this stretch of coast has experienced net accretion over the longer term. The rate of accretion for the period between 1949 and 2013 varies from approximately 30 m at the proposed bundle facility location to around 50 m in the area around 1 km north. Nevertheless, it should be noted that at this northern location the bulk of the apparent accretion appears to have occurred in the period between 2001 and 2013 and may therefore be the result of ephemeral vegetation coverage due to a calm period prior to the capture of the 2013 photography. Excluding the 2013 shoreline position, the average accretion on this shoreline was around 20 m for the period between 1949 and 2001.

Figure 3.3 Shoreline movement plan for proposed bundle facility location

4. Potential Impacts of Launchway Construction

The results of the above review indicate that the shoreline at the location of the proposed bundle facility has experienced a long term accretion trend, with an average of around 20 m of accretion occurring in the period between 1949 and 2001. This accretion trend is similar to that experienced adjacent to the Learmonth Jetty, albeit the construction of the jetty abutment has resulted in increased accretion rates on the northern side of the abutment due to the partial capture of the southerly longshore sediment transport.

Whilst the rates of longshore sediment transport along this coastline are relatively small in magnitude, this means that the full extent of changes caused by an interruption to the sediment transport pathway can take decades to be fully realised. This is evidenced in part by the apparent erosion on the southern side of the Learmonth Jetty abutment between its construction in 1955 and sometime around 1968 when the shoreline apparently began to rebound. This change in dynamics was likely driven by the build-up of sediment north of the jetty to the extent that the sediment began to bypass the abutment.

On the basis of the information presented above, it is expected that the construction of the launchway will have some effect on the adjacent shoreline. Based on the observations from the Learmonth Jetty, it is expected that the following shoreline behaviour could be experienced. Since the final design and characteristics of the launchway structure are not known at this point in time, the information presented below should be treated as indicative.

- Accelerated accretion would likely be experienced on the shoreline north of the launchway. The extent of this accretion along the shoreline could easily extend for more than 1 km along the shoreline over the longer term.

- The shoreline south of the launchway would likely experience erosion in the first 1 to 2 decades following construction. Based on the observations at Learmonth Jetty, the extent of this erosion could be as much as 40 m and could extend for 1 km or more along the shoreline. However, this assertion is complicated by the fact that the shoreline to the south experiences a change in alignment and may be impacted by the presence of rock outcrops, which could exhibit a degree of shoreline control and potentially limit the extent of erosion (as shown in Figures 4.1 and 4.2).

- At some stage after the construction (one to two decades), it is expected that the shoreline south of the launchway would begin to accrete and rebound from its eroded location. This rebound in shoreline position would be fed by the natural bypassing of material around the launchway, particularly given the long term characterisation of the shoreline as an accretionary area.

It should be noted that the potential impacts of sea level rise could also alter the shoreline response, however these sea level rise impacts could be expected to occur regardless of whether the development proceeds.

Figure 4.1 Shoreline south of the proposed bundle facility

Figure 4.2 Ground level photograph of the rocky outcrop on the shoreline south of the proposed bundle facility

5. References

Department of Transport, 2009. *Coastal Demarcation Lines for Administrative & Engineering Purposes: Delineation Methodology & Specification*. Government of Western Australia, Perth.

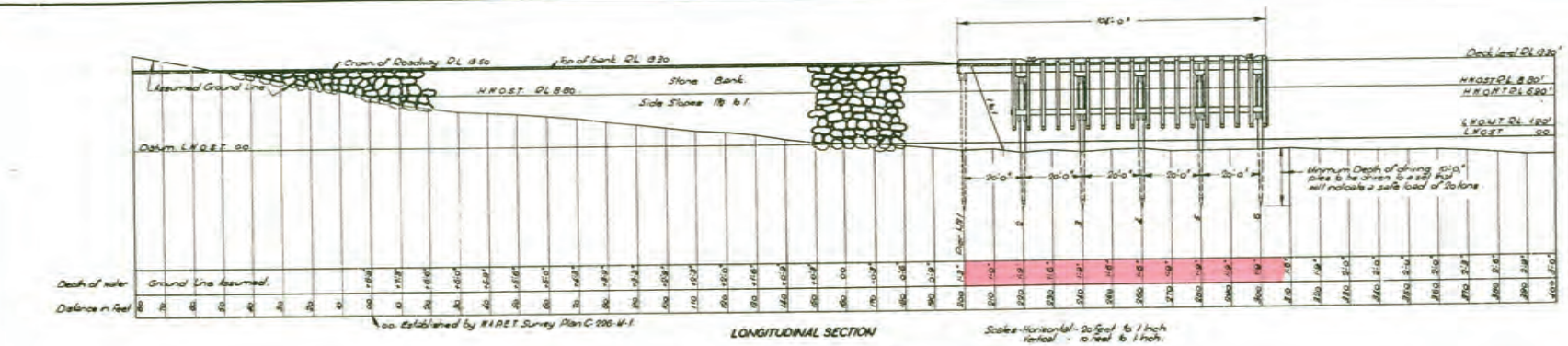
GHD, 2017. WA Bundle Fabrication Facility – Site Designs: Design Report (Drainage & Coastal Engineering). Report APFAC017-233385-ENG-50001 Rev A prepared for Subsea 7 Australia Contracting Pty Ltd.

Short, A. 2005, *Beaches of the Western Australian Coast: Eucla to Roebuck Bay. A guide to their nature, characteristics, surf and safety*, Sydney University Press.

6. Appendices

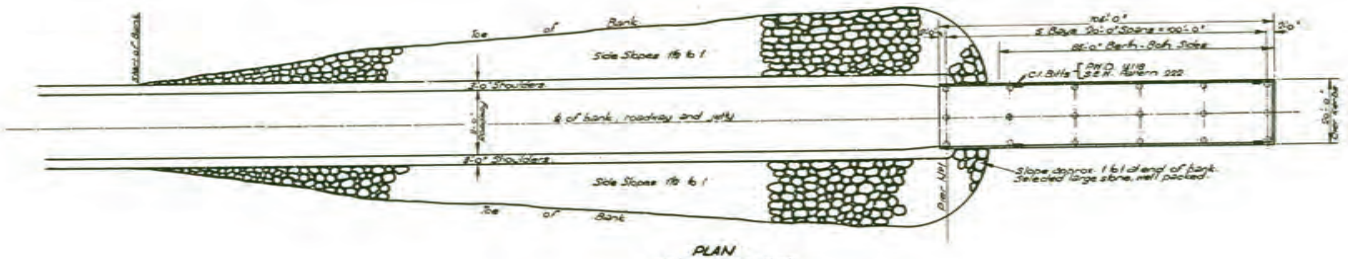
Appendix A Design Drawing for Learmonth Jetty

Appendix A Design Drawing for Learmonth Jetty



LONGITUDINAL SECTION

Scales - Horizontal - 20 feet to 1 inch
Vertical - 10 feet to 1 inch.

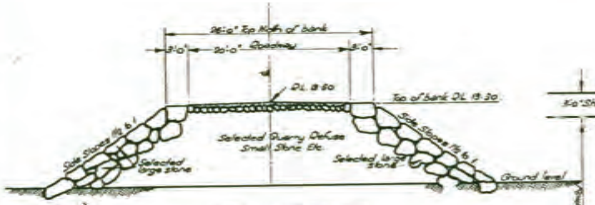


PLAN

Scale: 20 Feet to 1 inch

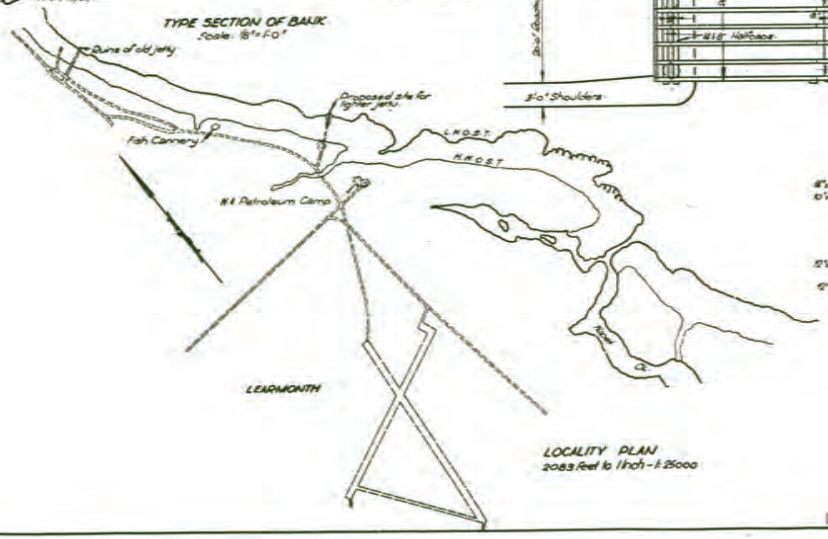
Extract from Letter dated 23rd. NOVEMBER, 1954.
From Captain G.D. TANCRED, R.A.N. to W.A. Petroleum Pty. Ltd.

The bench-mark near the ruined jetty at Learmonth, Exmouth Gulf, is 21'08 above Indian Spring Low Water, so the chart datum. Army heights are normally referred to Mean Sea Level which is 4'9 feet above Indian Spring Low Water.
Navy heights are referred to Mean High Water Springs which is 8'3 feet above Indian Spring Low Water.



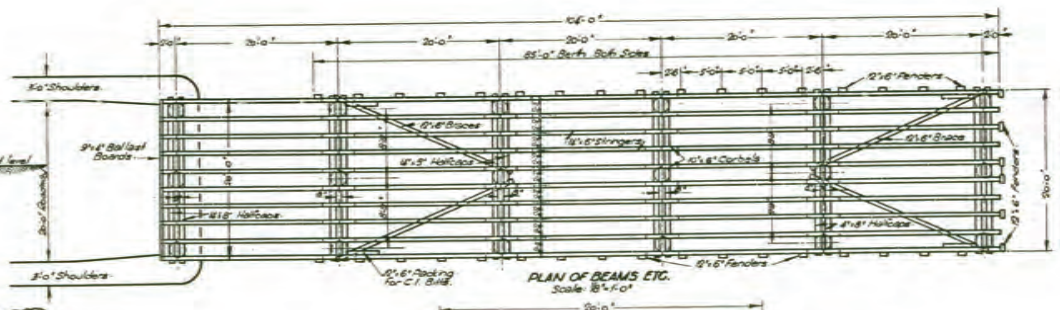
TYPE SECTION OF BANK

Scale: 16'' = 1'0"



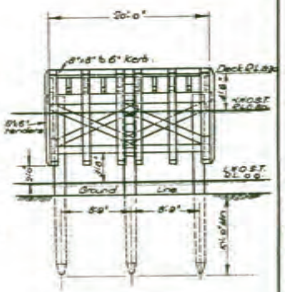
LOCALITY PLAN

2089 Feet to 1 inch - 1: 25000



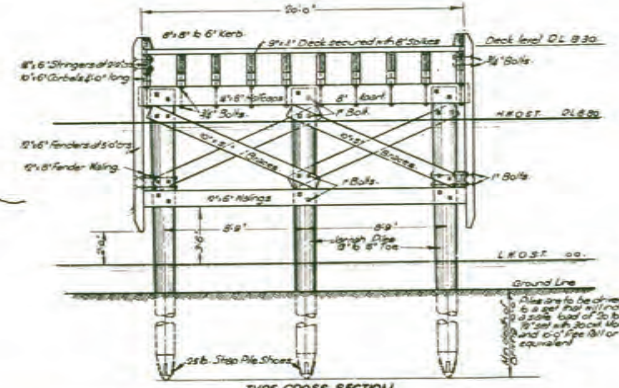
PLAN OF BEAMS ETC.

Scale: 16'' = 1'0"



END ELEVATION

Scale 16 Inch = 1 Foot



TYPE CROSS SECTION

Scale: 16 Inch = 1 Foot.

Note. This jetty has been designed for dual axle load of 20,000 lbs. Axle loads not to exceed 20 tons.

EXMOUTH GULF PROPOSED LIGHTER JETTY FOR W.A.P.E.T.	
Drawn by: A.C.I. Examd by: Traced by: H.S.M. Examd by: A.C.A. 12-5-54	Scales: As Shown
	Approved: Date: 24.9.54 Engineer for Works Dept.
Drg No. 1	Sht No. 1
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