

**ORE Catapult**

**Levenmouth Demonstration  
Turbine**

**Revetment Inspection Report**

**DID/125740/01**

**June 2024**



**CONTROL SHEET**

**CLIENT:** ORE Catapult

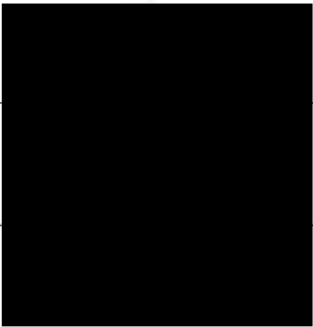
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## 1.0 Introduction

Fairhurst were engaged by ORE Catapult (The “Client”) to undertake a visual inspection of the existing revetment adjacent to the Levenmouth Demonstration Turbine site (constructed in 2016), located on the Fife Coastline within the Energy Park, Fife, to the South West of Methil Docks. The revetment provides coastal protection of the site from an existing quayside within the neighbouring leasehold operator, to the southern boundary of the site.

The aim of this inspection, was to visually assess and record the condition of the existing revetment within the jurisdiction of ORE Catapult, as well as identify any defects within the structure, and provide outline recommendations as to potential monitoring, maintenance and repair works, where deemed required.

In the preparation of this report, the construction information as enclosed within Appendix 2, has been provided by the client. This information relates specifically to the section of revetment most recently constructed, and which provides coastal protection in the area adjacent to the retaining wall constructed to support the site storage and maintenance compound. This report is informed by this information as well as the visible condition of the structure as observed on site from the observed tide level.

## 1.1 Methodology

This report is based principally upon the findings of the visual inspection undertaken by Fairhurst on 22<sup>nd</sup> November 2023, the findings of which are set out within the subsequent sections of this report. The weather during the inspection was generally cloudy, albeit with light cloud and some precipitation in a moderate southerly breeze. The inspection was undertaken from the revetment, as well as the deck and access bridge to the turbine transition piece. The inspection of the structure was timed to coincide with the forecasted low tide of +1.90mCD at 1600H GMT. The timing of this was undertaken to maximise the visible extent of the structure that would be visible to be inspected. It should be noted that due to the nature of the existing structure, tactile inspection was difficult and hence some areas could not be inspected in detail.

In addition to this inspection, during a subsequent meeting on site (29<sup>th</sup> February 2024), the structure was also inspected to enable identification of further deterioration of the structure, when compared with observations made within the inspection of 22<sup>nd</sup> November 2023. This meeting and inspection coincided with the forecasted low tide of +1.20mCD at 1042H GMT, and was undertaken in dry conditions with a strong breeze from a southerly direction.



## 2.0 Site Location & Description

The site address is as follows:

ORE Catapult  
Levenmouth Demonstration Turbine  
Energy Park Roundabout (*Energy Park, Fife*)  
Links Dr.  
Buckhaven  
Fife  
KY8 3RA

The existing revetment structure is located within Energy Park, Fife, located on the northern side of the Firth of Forth. The revetment is bound to the North by the ORE Catapult site storage and maintenance compound, and to the East by a quayside, and to the West by a continuation of the revetment, whilst the Firth of Forth forms the southern boundary of the site. The construction date of the existing revetment structure is unknown, however following previously identified scouring of the site compound adjacent to the transition piece, revetment re-construction works were undertaken in 2018. These modifications are detailed within the record drawings enclosed within Appendix 2 of this report, and encompassed construction of a new sheet pile retaining wall to the site compound, as well as associated upgrading of the pre-existing revetment structure within the area of the retaining wall. The accuracy of these drawings has not been verified, although from observations, are considered to be reflective of the existing construction. It is understood the works previously undertaken, were required due to previous coastal erosion in the area immediately landward of the demonstration turbine.

The following admiralty data is applicable to the site:

• Highest Astronomical Tide (HAT)	+6.16mCD	(+3.26mOD)
• Mean High Water Springs (MHWS)	+5.45mCD	(+2.55mOD)
• Ordnance Datum (Newlyn)	+2.90mCD	(+0.00mOD)
• Mean Low Water Springs (MLWS)	+0.72mCD	(-2.18mOD)
• Lowest Astronomical Tide (LAT)	-0.21mCD	(-3.11mOD)

From inspection, it is recognised the wider revetment provides protection against coastal erosion throughout the seaward boundary of the site, and protects the recently constructed King-Post retaining wall, as well as the earth retaining structure constructed to the North-East of the demonstration turbine. Both these retaining structures support the southern end of the site storage and maintenance compound, containing turbine components.

The bathymetric level within the vicinity of the test turbine is unknown, however it is known this inclines steeply towards the coastline, hence induces large, steeply inclined waves.

## 2.1 Existing Construction

The following description of the revetment should be read in conjunction with the existing record information enclosed within Appendix 2:

The existing revetment structure within the area immediately seaward of the King-Post retaining wall, as detailed by Arch Henderson, was understood to comprise from two layers of 3-6Te primary armourstone overlain on secondary armourstone ( $M_{50} = 400\text{kg}$ ) of unknown grading range. These layers encase rockfill with a grading criteria which appears to be consistent with

the Specification for Highway Works (Series 600) specification of Class 6A material. It is understood the parent rock for this material was dolerite.

The wider revetment structure, out with the area previously repaired in 2018, appears to comprise a comparable construction with the revetment core overlain by two layers of secondary armourstone, in-turn overlaid by two layers of primary armourstone. The grading and weight range of these layers are unknown, however the primary and secondary armourstone within this area appear to be of a smaller grading when compared with the material utilised for the repairs undertaken in 2016.

### 3.0 Visual Inspection of Structure

The inspection findings are summarised within the following sub-sections of the report, based on the differing constructions within the revetment. A photographic record of the inspection is incorporated within Appendix 1, and should be referenced in conjunction with the following sub-sections to this report.

#### Revetment (re-constructed in 2016):

The existing rock armour within this area of the structure was generally observed to be in good condition, however some areas of the structure were considered to be fair to poor due to the localised exposure of the secondary armour layers and revetment core (Figures 1-4).

Within the western section of the revetment, adjacent to the King-Post retaining wall, it was evident some stones from the upper layer of primary armourstone have been displaced towards the toe of the revetment as a result of wave action, subsequently exposing the lower layer of primary armourstone as well as the secondary layers. This localised mobilisation of the primary armourstone also appears to have resulted in movement of the secondary armourstone, and hence isolated sections of rockfill have become exposed. The more finely graded material can be readily mobilised from the revetment under wave action (Figures 1-2).

Within the eastern section of the revetment adjacent to the King-Post retaining wall, it was apparent that some material has been lost from the crest of the revetment, resulting in the displacement of a palisade fence post foundation. Similarly, within the area at approximately mid-tide, it was evident some of the material from the upper layer of primary armourstone has been displaced towards the toe of the revetment under wave action. Within this area, this has also resulted in some movement of the secondary armourstone and the exposure of rockfill, which can be readily mobilised from the revetment (Figures 3-4).

The revetment profile observed during the inspections was generally consistent with that of the original design drawings, with no significant areas of settlement or flattening of the profile or crest. It should be noted that some flattening of the revetment toe has occurred, to both sections of revetment, as a result of some primary armourstone units migrating towards the toe under wave action. From inspection, no apparent indications of breakage to individual stones were observed indicating a high degree of durability of the selected source material (Figures 5-6).

#### Revetment (pre-existing structure):

The rock armour forming the existing revetment was generally observed to be in a fair condition, however some areas of the structure were considered poor due to the areas of secondary armour and revetment core, which has become exposed (Figures 7-10).

The westernmost section of structure within the jurisdiction of ORE Catapult, was observed to contain areas where the primary armourstone units have been mobilised towards the toe of the revetment or lost completely. This is resulting in the loss of the secondary armourstone due to the ability of incoming waves to mobilise these secondary units, as well as the progressive flattening of the revetment toe, as armourstone units migrate from the revetment crest towards the toe of the structure under wave action (Figures 7, 8, 11 & 12).

Furthermore, the loss of primary and secondary armourstone from this area has resulted in localised sections of exposed revetment core, being subjected to prevailing wave action. This has caused localised areas of scour to occur within and around the remaining sections of secondary armourstone, in areas where the primary layer has been lost. This action will continue to exponentially progress, with the extent and areas of scour increasing due to the particularly

aggressive wave climate observed at the site. This progressive loss of material from the revetment can be deduced between Figures 7 & 8.

Similarly, within the eastern section of the structure, distinct areas of the revetment were observed to be largely unprotected as a result of the loss and migration of primary armourstone units, towards the toe of the revetment, resulting in the toe flattening. This loss is particularly prevalent in front of the earth retaining structure, where sections of the revetment core are exposed, and the loss of material is ongoing. In addition, further areas of exposed core were noted adjacent to the boundary with the neighbouring leaseholder, which is resulting in further ongoing scour (Figures 9, 10 & 12).

#### 4.0 Conclusions & Recommendations

In conclusion, the global condition of the revetment structure is considered fair, however there are localised areas which are subject to ongoing material loss which are considered poor. From observations made, it is considered the loss, and migration of material from primary armourstone layers towards the toe of the revetment, have reduced the structures effectiveness to protect the site from the effects of coastal erosion. The mobilisation of the primary armourstone has resulted in the accelerated rate of deterioration of localised within the structure, as the weights of the secondary armour and rockfill can be more readily mobilised by incoming waves. These actions are collectively resulting in the flattening of the revetment profile, as well as the scouring of material from the revetment core.

Following review of the structures condition during both inspections, it is strongly recommended the primary armourstone units which have been mobilised towards the toe of the revetment, are recovered and repositioned within the revetment, to ensure the secondary armourstone and core are not directly exposed to incoming breaking waves. These stones will need to be repositioned in a manner which ensures the apertures between primary and secondary armourstones are insufficient to allow the migration of material from the layer below, under breaking waves. Subsequent to this, a further evaluation should be undertaken to assess the extent of protection which has been provided from recovery of existing material, and the requirement for the further importing of armourstone to further strengthen the existing revetment structure, notably within the areas which were not re-constructed in 2018.



## Appendix 1 – Inspection Photographs



Figure 1: Western section of revetment reconstructed in 2016 (taken: 22/11/2023)



Figure 2: Western section of revetment reconstructed in 2016 (taken: 29/02/2024)





Figure 3: Eastern section of revetment reconstructed in 2016 (taken: 22/11/2023)



Figure 4: Eastern section of revetment reconstructed in 2016 (taken: 29/02/2024)





Figure 5: Western section of revetment reconstructed in 2016 (taken: 22/11/2023)



Figure 6: Eastern section of revetment reconstructed in 2016 (taken: 22/11/2023)





Figure 7: Western section of existing revetment (taken: 22/11/2023)



Figure 8: Western section of existing revetment (taken: 29/02/2024)





Figure 9: Eastern section of existing revetment (taken: 22/11/2023)

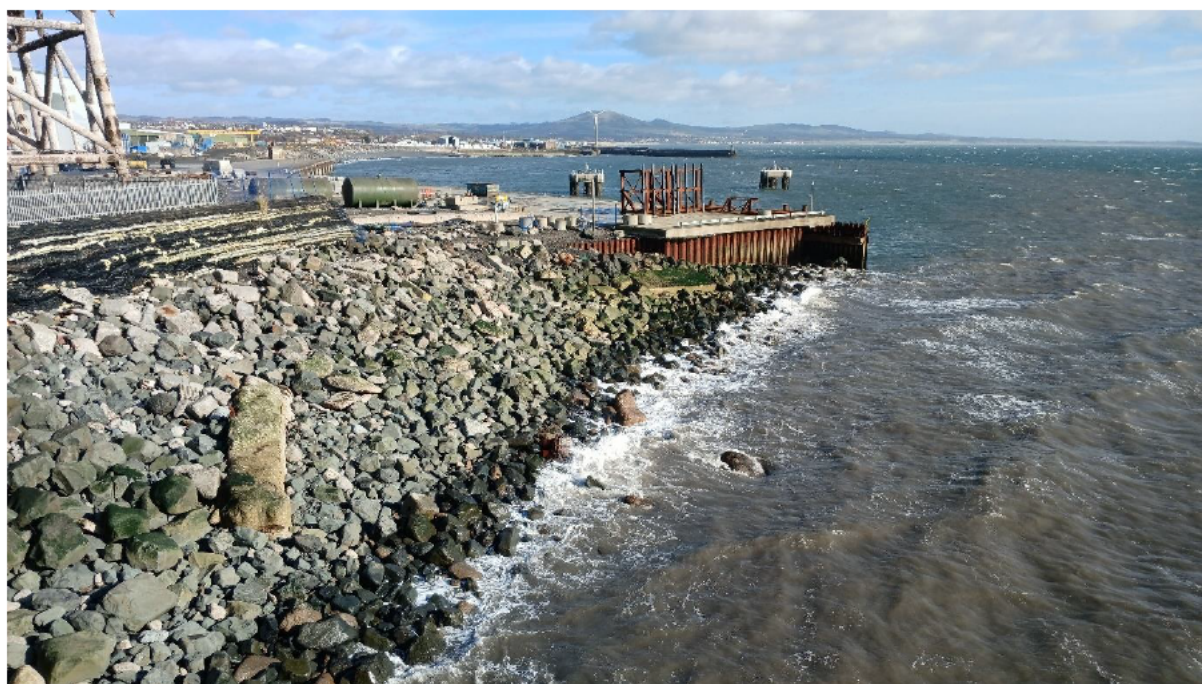


Figure 10: Eastern section of existing revetment (taken: 29/02/2024)





Figure 11: General profile of western section of existing revetment (taken: 22/11/2023)

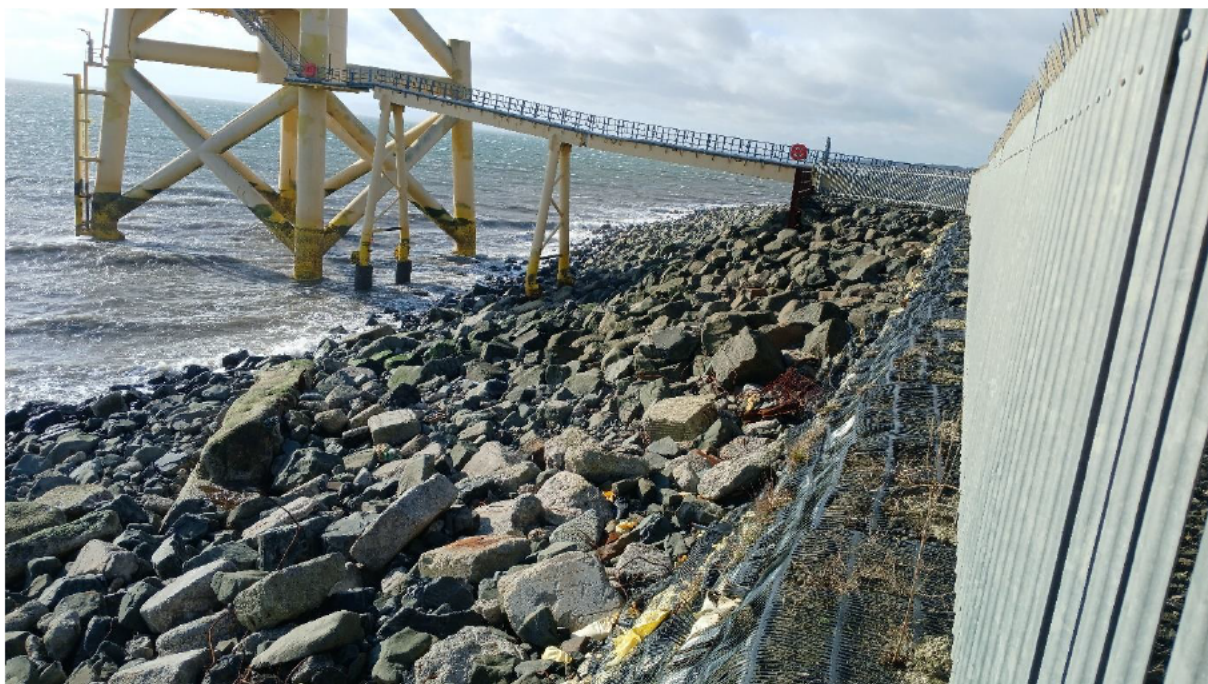


Figure 12: General profile of eastern section of existing revetment (taken: 29/02/2024)

**Appendix 2 – Existing Information**Arch Henderson:

## Methil Crane Platform Stabilisation

Drawing No: 171096 - 10

Status: For Information

Plan on Proposed Works (West End)

Dated: 4<sup>th</sup> June 2018

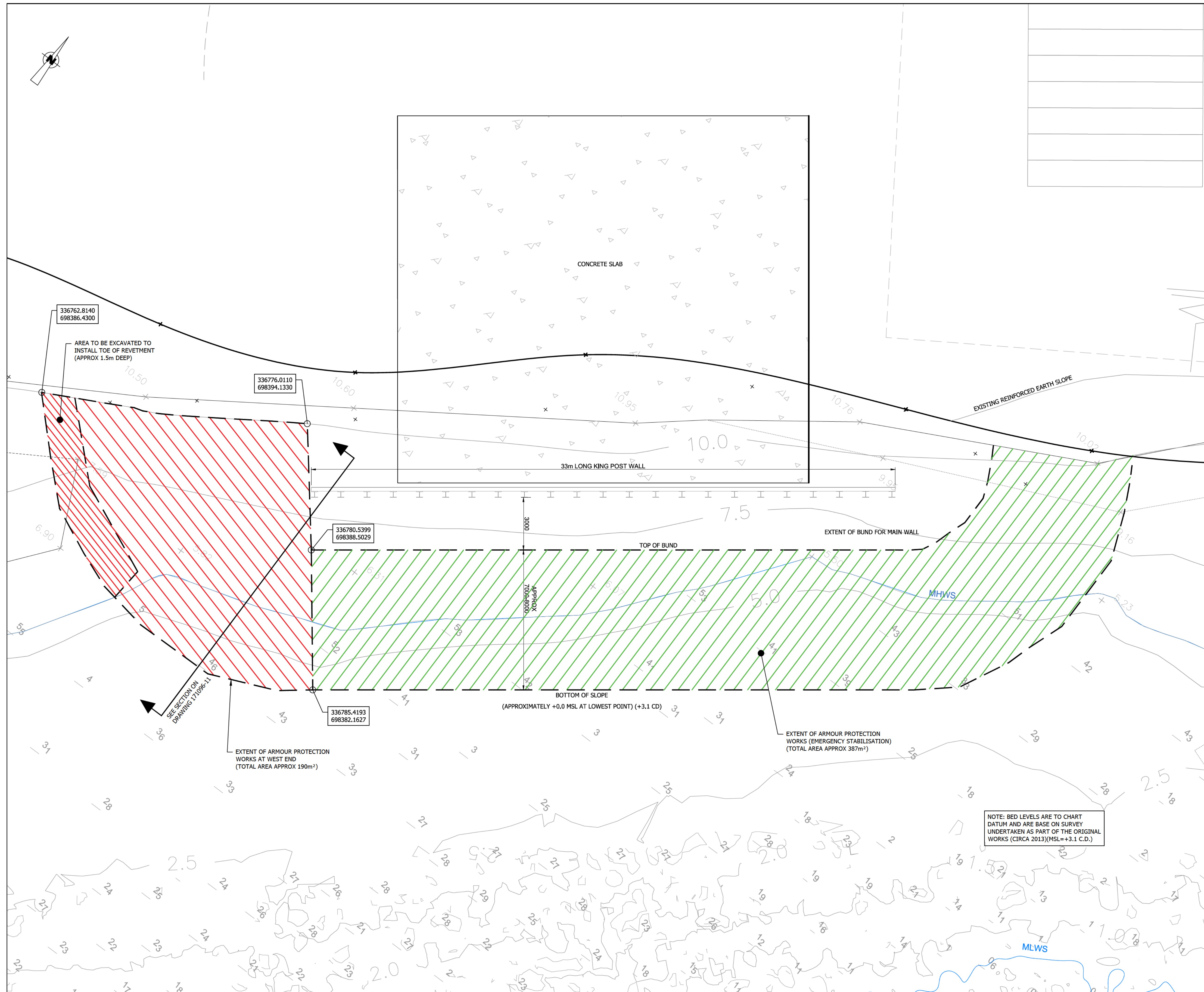
Drawing No: 171096 - 11

Status: For Information

Cross Section through Proposed Works (West End)

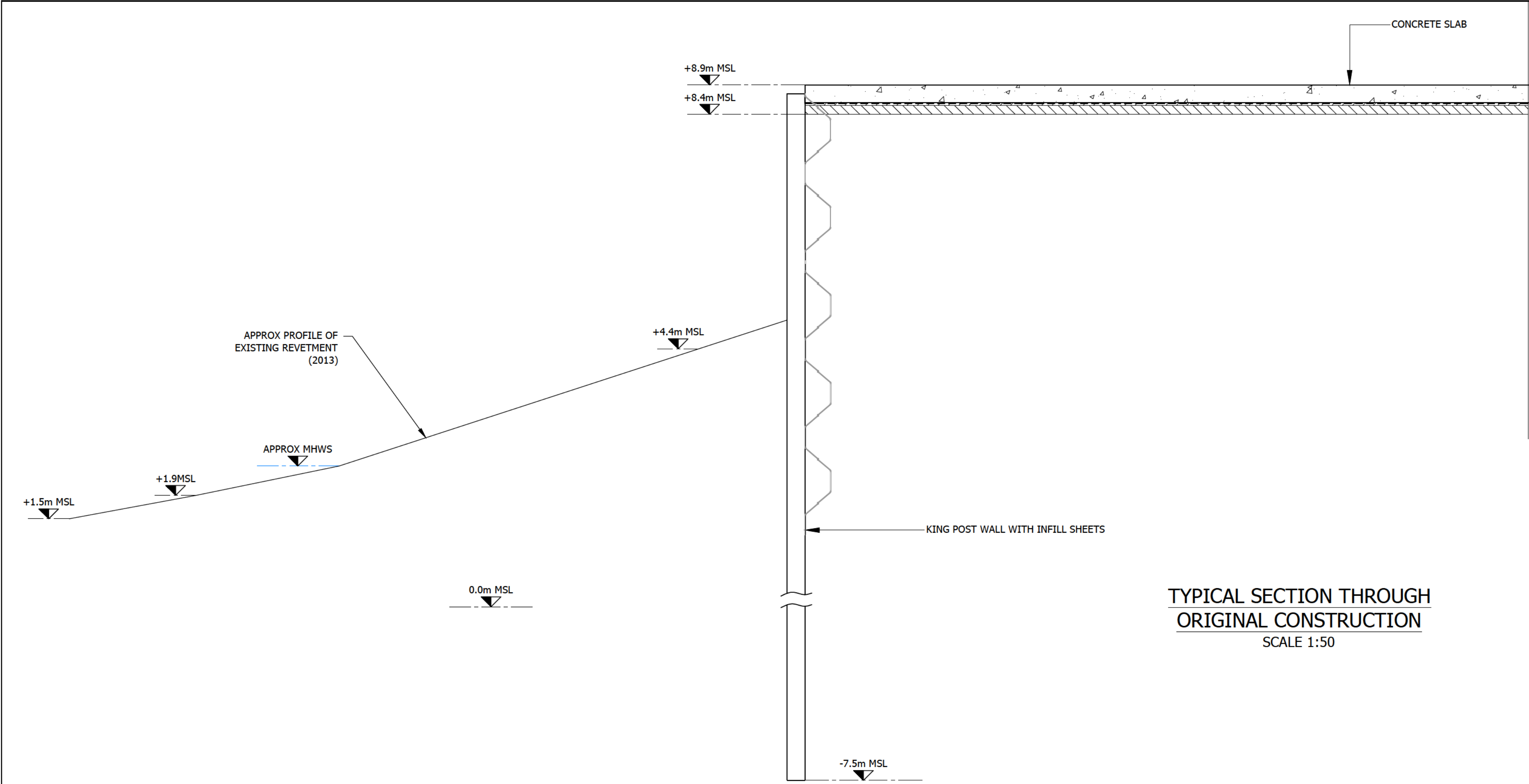
Dated: 4<sup>th</sup> June 2018





DRAWING No :	171096 - 10	REV :	-
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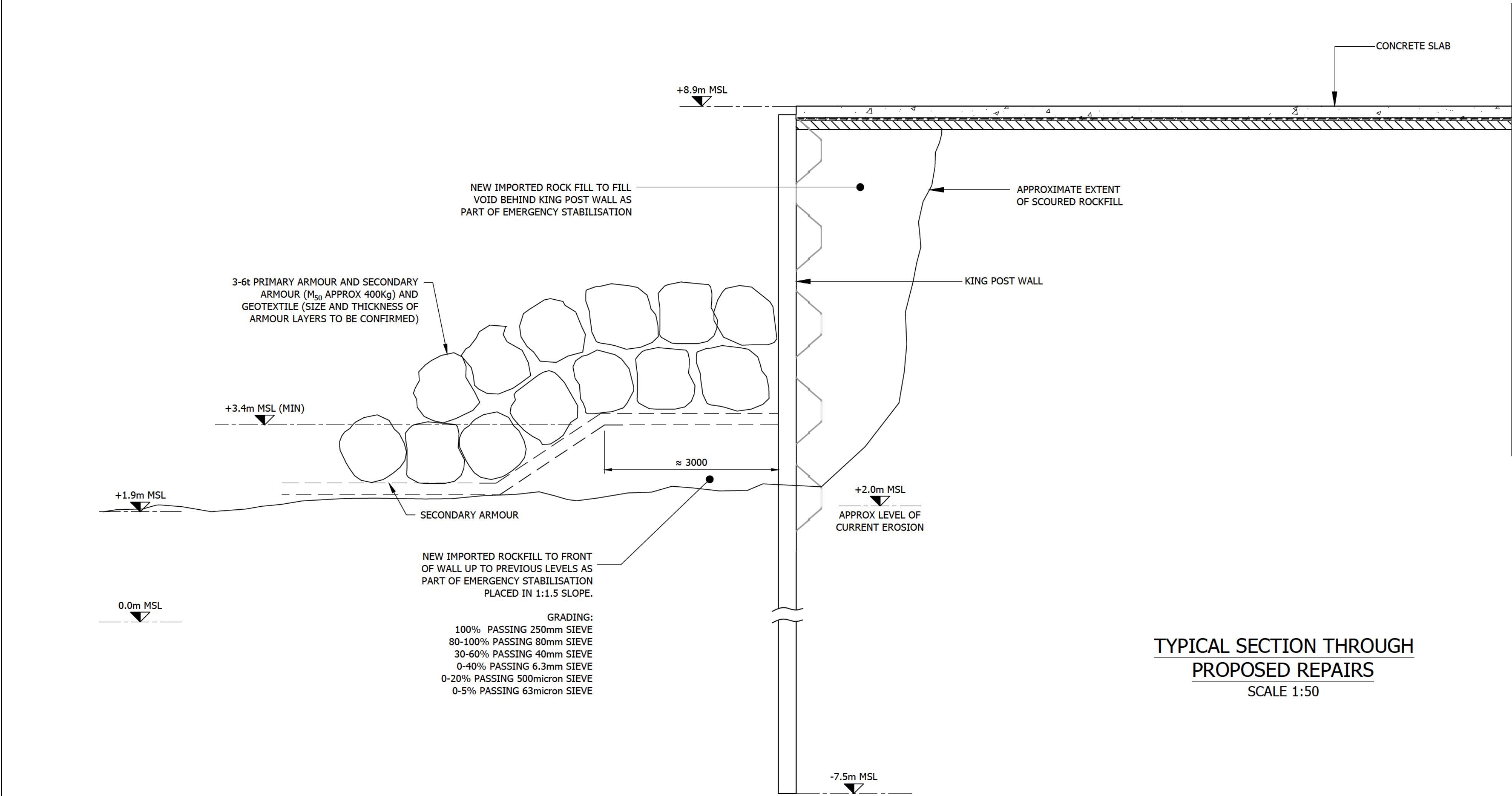




TYPICAL SECTION THROUGH  
ORIGINAL CONSTRUCTION  
SCALE 1:50



PHOTO TAKEN MAY 2015



TYPICAL SECTION THROUGH  
PROPOSED REPAIRS  
SCALE 1:50



PHOTO TAKEN MARCH 2018

- NOTES:**
1. ALL DIMENSIONS ARE IN MILLIMETRES U.N.O..
- REFERENCE DRAWINGS:**
- 171096 - 10 PLAN ON PROPOSED WORKS

REV	DATE	REVISION	DRN	CHK
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PROJECT : METHIL CRANE PLATFORM STABILISATION ORE CATAPULT				
TITLE : CROSS SECTION THROUGH PROPOSED WORKS (WEST END)				
DRAWN : TAP	DATE : 01.06.18	CHECKED : GC	DATE : 04.06.18	
SCALE : (A1) 1:50		DRAWING STATUS : FOR INFORMATION		
DRAWING No : 171096 - 11			REV : -	



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