TECHNICAL NOTE

JBA Project Code	2022s0532
Project Title	Hordle Cliff Assessment
Subject	Preliminary Geotechnical Assessment
Client	New Forest District Council

Document control

P03	Updated 2.6 and 5 following Client's comments	24/10/2022	A Boyd	I G Johnson	I G Johnson
P02	Updated following Client's comments	12/08/2022	A Boyd	I G Johnson	I G Johnson
P01	Draft for Comment	13/06/2022	A Boyd	A V Berry	I G Johnson
Revision	**Description**	**Date**	**Originated**	**Checked**	**Approved**

1 Introduction

Following damage caused by Storm Eunice on 18th February 2022 and Storm Franklin on 20th February 2022 to the cliff and beach huts at Hordle Cliff, Hampshire, a request to undertake a preliminary geotechnical assessment of the site was submitted by New Forest District Council (NFDC) in their document 'Hordle Cliff Assessment – Background & Outline Brief, received by JBA Consulting on 30th March 2022.

Following a meeting between representatives from JBA Consulting and New Forest District Council, JBA prepared a proposal to undertake a preliminary geotechnical assessment to summarise the current situation and likely future development of the ground movement and overall risk to the site area and existing beach huts thereon. The preliminary geotechnical assessment has comprised:

- A brief desk study, to review the available site information provided by New Forest District Council and to review the local geology from the mapping of the British Geological Survey.
- A site inspection, including a meeting with Peter Ferguson and Carol Whitfield from New Forest District Council on site.
- Production of a technical note summarising the findings of the assessment.

1.1 Site Location

The site area considered in this assessment comprises part of the Hordle Cliff coastal escarpment located off Cliff Road in Milford-on-Sea (SO41 0NX) on the south coast of England near the New Forest National Park (Figure 1-1 and Figure 1-2). The site is owned by New Forest District Council and is public open space.

Figure 1-1 Ordnance Survey Map of site location

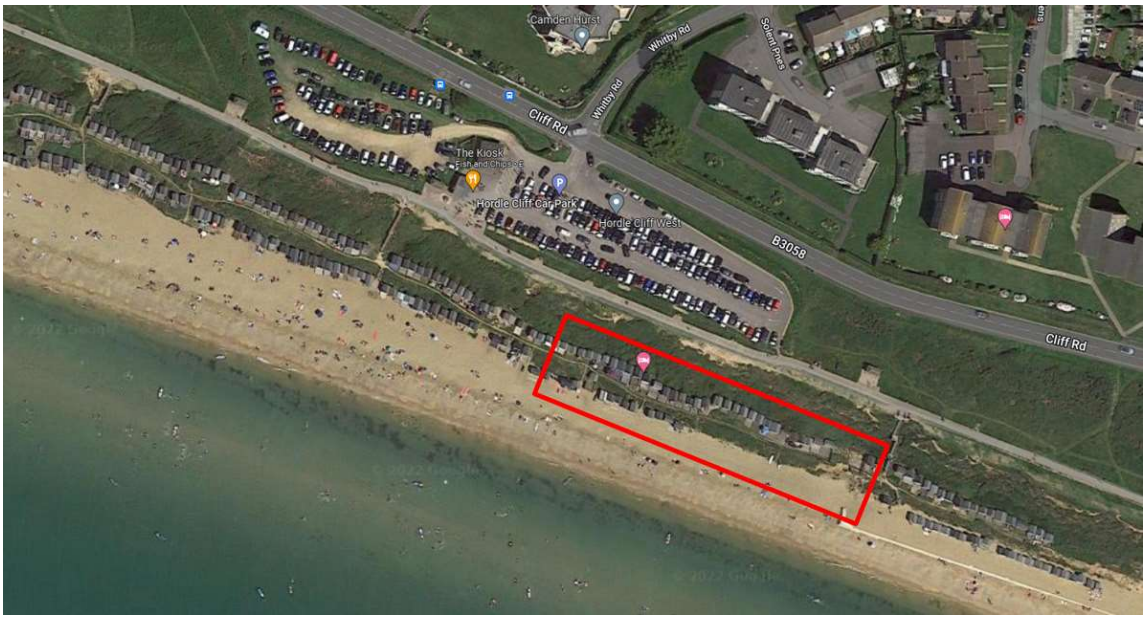


Figure 1-2 Satellite image showing section of the cliff and beach huts comprising the site

2 Available information

Available information has been collated from the Client, from online sources and from observations on site.

2.1 Site Description and Topography

The escarpment has a south, southwest facing aspect and is around 15m in height measured from beach to crest level, and an overall slope batter, toe to crest of around 1v:2h. However, in reality the escarpment has an irregular slope profile arising from a combination of factors, including artificial terracing, progressive slope movement (due to weathering and geology) and actual slope failures.

On the escarpment as a whole there are approximately 300 No. privately owned beach huts, with some 25 No. present within the site area. The beach huts are typically arranged in two rows, one along an upper beach terrace on the lower part of the escarpment slope and on another terrace further up the slope. Access to the escarpment, the beach and beach huts is provided by several sets of timber access steps extending down from the top of the escarpment slope.

Records of a topographic difference model dated April 2018 to March 2019 has been provided by the Client (see Appendix A). This shows that along the site area beach frontage there was ongoing erosion of the beach, resulting in a drop in beach levels, over the time frame of the data.

In addition to the recorded topographical difference, details of erosion at the top of the beach by Storm Eunice and Storm Franklin on 18th and 20th February 2022 respectively has been provided in the project brief provided by the Client. Notably, Storm Eunice caused an additional 1.5m (approximate) drop in the beach level where the beach meets the lower escarpment toe.

The results of a topographic UAV survey undertaken by New Forest District Council at Hordle Cliff on 25/03/22 was provided. This also provided the most recent aerial images of the cliff and includes the most recent failures.

2.2 Geological Maps

The following assessment of the geology of the site and ground conditions has been inferred from available information. No assurance is given to its accuracy.

The geology of the site and surrounding area has been derived from the 1:50,000 British Geological Survey (BGS) geology maps sheet 330 Lymington (1997) and from the BGS GeoIndex (Onshore) website.

The BGS maps indicate that the bulk of the escarpment slope comprises the exposed solid strata of undifferentiated Headon Beds and Osbourne Beds strata, comprising clay, silt and sand, dating from the Mid Eocene Epoch of some 41 to 38 million years ago. At the base of the escarpment recent Marine Beach Deposits of sand and gravel are shown, whilst at the top of the escarpment the bedrock is shown to be overlain by River Terrace Deposits, comprising sand and gravel, locally with lenses of silt, clay or peat, dating from the Quaternary Period.

In addition to the natural strata, deposits of Made Ground are also likely to be present associated with the historic terracing of the escarpment and the construction of the beach huts.

2.3 Historical maps and aerial photographs

The earliest historic map available online is dated 1885-1900 and indicates that the coastline at that time was in approximately the same alignment as currently. The coast road is also shown on this map running behind and sub-parallel to the coastline (Ref. Side by side georeferenced maps viewer - Map images - National Library of Scotland (nls.uk)).

Aerial photographs of the site from 1932 show beach huts on the cliffs and the beach (Ref. Aerial Photo Explorer – Over 400,000 aerial photos in Historic England's digitised collections | Historic England).

2.4 Existing monitoring data

Aerial photographs of damaged huts have been provided by the Client (see Appendix B). The beach huts have been marked as lost, damaged unstable, or at risk on satellite photos. Huts that have been removed following termination of licences since the date of the satellite images have also been marked.

These plans indicate that along the 250m length of the site area there has been a progressive loss of beach huts from along the upper beach terrace and with some along the upper terrace becoming 'at risk' over the time frame covered by the records.

2.5 Utilities / services information

The Client has advised that there are water supplies and drainage along the cliff but there are no available records at the time of writing.

2.6 Coastal management strategy

The current coastal management strategy for this area of coastline is **managed realignment** for all the time frames covered by the strategy (i.e. Present Day (Year 0 to 20), Medium Term (Year 20 to 50) and Long Term (Year 50 to 100)). (See Appendix C).

2.7 Designations

The Hordle Cliff site is situated within the Highcliffe to Milford Cliffs SSSI and approximately 2km west of Hurst Castle to Lymington River Estuary SSSI.

There are also other designated areas approximately 2km west of site including the Solent and Southampton Water Ramsar Site, Solent Maritime SAC (Special Area of Conservation) and the Solent and Southampton Water SPA (Special Protected Area).

3 Site Visit

A summary of the observations made on the site visit are presented in Section 3 below. Accompanying photographs are referenced and included at the back of this technical note in Appendix D.

A site visit and site meeting were undertaken on Tuesday 7th June 2022 by Alice Boyd and Ana Berry of JBA Consulting and Peter Ferguson and Carol Whitfield of New Forest District Council. The weather was overcast and dry, but the ground was damp from earlier rainfall.

The site visit comprised a walkover of the site, meeting in Hordle Cliff car park and walking around site anti-clockwise, starting down to the beach at the timber access steps opposite The Kiosk and heading back up the timber access steps near the return of the sea wall. The walkover including looking at the access path along the second row of beach huts as well as walking along the beach.

The slope was heavily vegetated (Figure 0-1). This meant that viewing the ground conditions and possible evidence of movement was not always possible. However, the ground conditions were exposed in areas of failure which was noted up at the top of the cliff as well as the larger failures along the toe.

3.1 Beach huts

There are two rows of beach huts: one along the toe of the cliff (upper beach terrace) and one up on the lower cliff terrace (Figure 0-2). The majority of the beach huts also have decking. There is slight variation in the alignments of the rows, due to the variable age of the beach huts as the positions have changed over time.

In some areas, the cliff slope had been artificially terraced to allow for the placement of the beach huts and their decking (Figure 0-3). However, in other areas the natural slope of the cliff was visible under the beach hut decking (Figure 0-2).

In places some attempts had also been made support the slope behind beach huts. These attempts were seen to typically comprise ad hoc timber post and planking retaining structures, on varying scales, with varying degrees of success. This was evident along both rows of beach huts, but it was easier to access and observe behind huts located along the beach. (Figure 0-4 and Figure 0-5).

3.2 Ground conditions

The soils making up the cliff were visible in the section of previous failure (Figure 0-6). There were 5 No. different units observed on site.

- (1) Topsoil - Dark grey sandy clay and clayey sand with abundant roots and vegetation.
- (2) Made Ground – slightly clayey very sandy Gravel with fragments of brick, plastic piping and blocks of grouted gravel.
- (3) Very sandy gravel with sub-horizontal bedding. The gravel was subrounded to rounded flint.
- (4) Yellow slightly gravelly slightly clayey Sand. Sand is medium to coarse.
- (5) Green-grey mottled red slightly sandy Clay.

3.3 Gradient of the slope

The general impression of the cliff was that the slopes were steep (Figure 0-7). It was difficult to gain an accurate impression due to the thick vegetation and limited accessibility, however measurements were made on exposed surfaces. A total of 6 No. measurements of slope angle were taken across the site, both from the beach and from

the upper terrace of beach huts. The gradient ranged from 28^0 to 48^0. In addition, terracing and retention behind the beach huts had created sub-vertical facets to the slope profile.

3.4 Visible movement

The areas of cliff instability and huts at risk was provided by New Forest District Council brief (Figure 0-8). In addition to the visible movement labelled in Figure 0-8, slips and scars were visible further up the cliff, which can also be seen on aerial photographs.

3.4.1 Cracks

There were some visible cracks along the footpath in the areas labelled 'cracks' (Figure 0-9) and in the 'cliff instability' area between the labelled cliff slumps (Figure 0-10). The crack shown in Figure 0-11 is to the east of the eastern cliff slump in the 'cliff instability' section. The visible cracks showed small vertical displacement (mm scale) and indicate shallow translational failure.

3.4.2 Cliff Instability

Figure 0-8 highlights the section of cliff instability. This section has two land slips and one area which has not yet failed, however Figure 0-10 shows a crack appearing at surface. The middle section which has not yet failed appears to have different vegetation compared to the two areas of failure. This may be indicative of different composition and water contents of the soil due to different ground conditions and natural and artificial drainage.

3.4.3 Soil Creep

Whilst there was a variable vegetation cover across site, it was possible to discern from the irregular profiles of the soil surface vegetation evidence of soil creep (the progressive mass movement of the soil cover) down slope.

3.5 Drainage

Artificial drainage pipes have been installed throughout the cliff although there is no formal record. At the top of the cliff, there are drains with exposed geotextile at the top of a failed section of cliff (Figure 0-20). There was also geotextile exposed on the footpath along the second row of beach huts near the crack shown in Figure 0-10. This may indicate the presence of drainage in the area or may be from the founding of some beach huts.

In the areas of failure, there were several exposed plastic pipes for drainage and water supply. The previous failure (Figure 0-18) had areas of darker soils underneath the cemented block/overhang which indicated a 'wet' layer which could have resulted from natural preferential drainage through the soil layers. This was also notable in the clay layer at this location, as the Client commented on site that the clay at the toe of the cliff in this location remained wet even after periods of good weather.

3.6 Erosion on the beach / Toe erosion

In addition to the progressive changes in beach level recorded by the provided topographic difference model (see Appendix A) which have resulted in beach lowering along the site frontage, the results of storm erosion of the head of the beach were evident during the site visit and had resulted in a number of failures of the toe of the escarpment caused by the loss of restraint / undercutting to the toe of the slope.

4 Preliminary Geotechnical Assessment

As previously noted, the escarpment slope at the site is around 15m high with an irregular slope profile to accommodate the terracing for the existing beach huts but the overall slope batter, crest to toe is around 1v:2h (approx. 26.6^0). As the published geological mapping indicates the escarpment is predominantly formed by the undifferentiated Headon Beds and Osbourne Beds strata, comprising clay, silt and sand (i.e. not rock), dating from the Mid Eocene Epoch, this slope angle is too steep to ensure long term stability, particularly as this strata weathers on the face of the escarpment, although areas of the slope may exhibit a state of transient 'meta-stability' in the short term. Consequently, we would expect the slope to be inherently unstable and thus would expect to see a range of slope instability issues, as is evident at the site, ranging in scale from soil creep to actual slope failures.

Whilst all of this instability would be expected just from the batter of the slope, given the nature of the strata that forms it, a number of additional factors evident at the site, compound the natural instability. These include:

- The cutting of sub-vertical facets to form the terraces for the beach huts, thus further steepening the slope.
- Water seepage from the slope, be they natural from the permeability contrasts of the material forming the slope (i.e. sand is more permeable than silts, which are more permeable than clays), or from other sources.
- Erosion and undercutting of the toe of the slope by progressive, natural, beach lowering and storm damage.

Whilst all of these additional factors will exacerbate the inherent instability of the escarpment, the erosion and undercutting of the toe of the escarpment by progressive beach lowering and storm erosion will have the most immediate impacts on the stability of the slope. Such loss of support to the toe of the slope is perhaps the most destabilising occurrence to affect any slope, but this is particularly so where the slope is inherently unstable in any event. Failures of the toe of the slope, caused by such a loss of toe support, are also themselves, progressive, as the failure of the toe then removes support to the slope above, causing further failure, and this cycle repeats as the failures climb the slope.

5 Advised Future Management Measures

The inherent instability of the escarpment slope means that any attempts to stabilise the slope would involve substantial large scale engineering works, involving significant costs, which are unlikely to be justified. In addition, the current and future shoreline management strategy identifies this area as **managed realignment**, which in large part may reflect the inherent instability of the escarpment. We would also comment that because of the scale and nature of the instability it should be borne in mind that small scale ad hoc works associated with the beach huts, such as cutting or widening terraces, or installing water supplies or drainage, may risk further destabilisation of the escarpment.

In view of the above, we would comment on the future usage and management of the remaining beach huts as follows:

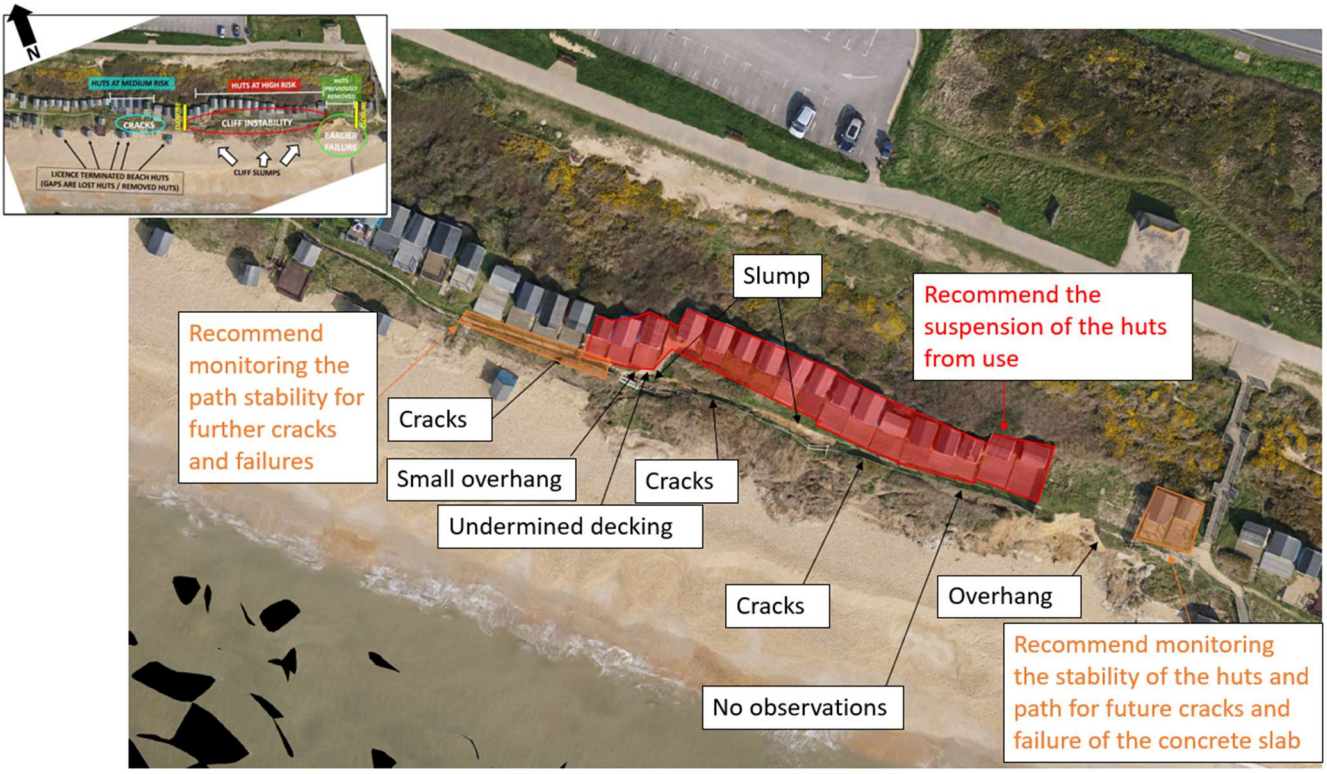


Figure 5-1 Satellite image from UAV topographic survey provided by NFDC. Mark-up shows beach huts at risk, existing failures and advised actions

The areas shaded red are where there is immediate risk to these beach huts themselves or the access routes to them and thus, we would advise the suspension of the use of these huts.

The areas highlighted in amber are where the proximity to existing failures or developing tension cracks would suggest it is likely that these huts are at risk in the short to medium term and are particularly at risk in the event of further loss of support to the toe of the escarpment by ongoing beach lowering or storm erosion. On-going monitoring of the slope condition in these areas is recommended.

The remaining unshaded huts on the upper terrace, toward the western end of the site, are located away from current indicators of instability. However, because of the inherent instability of the escarpment as a whole, we would recommend on-going monitoring of the slope condition in these areas, particularly in the event of further loss of support to the toe of the escarpment by ongoing beach lowering or storm erosion.

We understand that NFDC already undertake regular monitoring of the site area, and we would advise continuing with this regime to identify and monitor any future evidence of slope movement. Should NFDC feel it necessary, in the light of future monitoring, please feel free to get in contact with JBA Consulting for further advise.

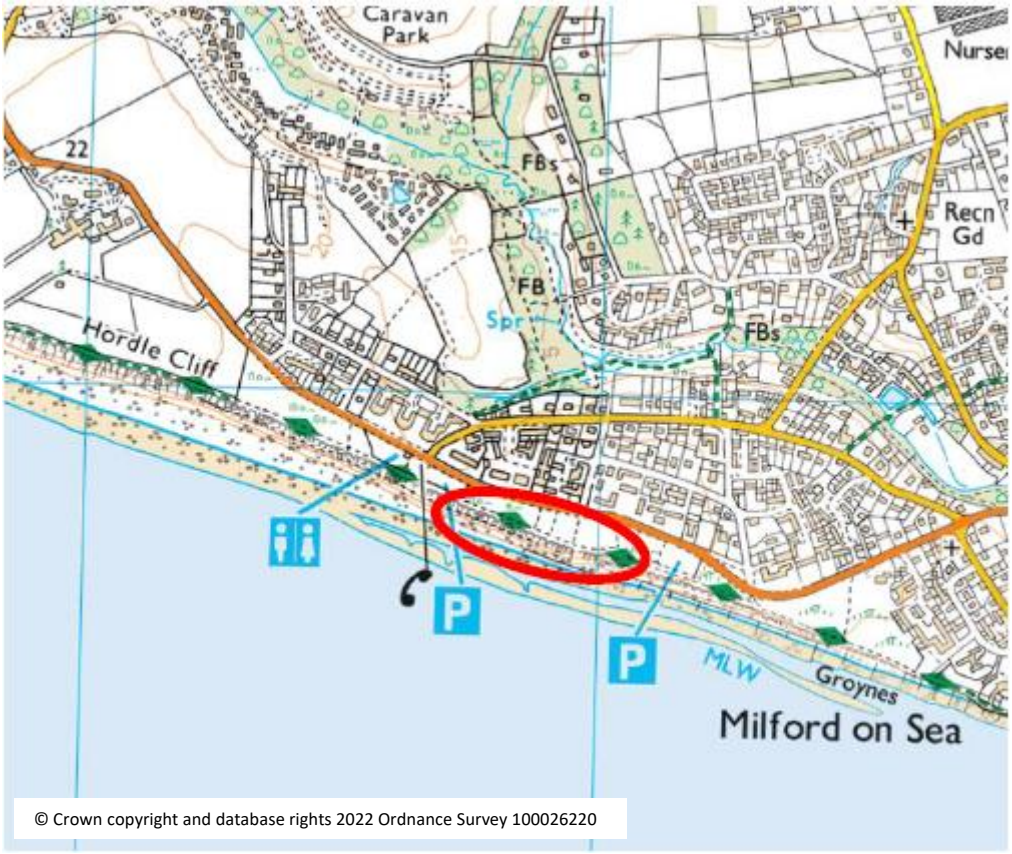
Appendix A – Client Brief

HORDLE CLIFF ASSESSMENT – BACKGROUND & OUTLINE BRIEF

Issue

Two recent storms, Eunice, on 18th February 2022 & Franklin, on 20th February 2022, caused considerable impact to the coastline at Hordle Cliff, Hampshire, just west of Milford-on-Sea, resulting in significant beach erosion and instability to the lower cliff terrace along a ~250m section.

Damage caused by the storms to a number of beach huts combined with the threat of further possible impacts means that NFDC now needs to look at making informed decisions regarding future management of the site.



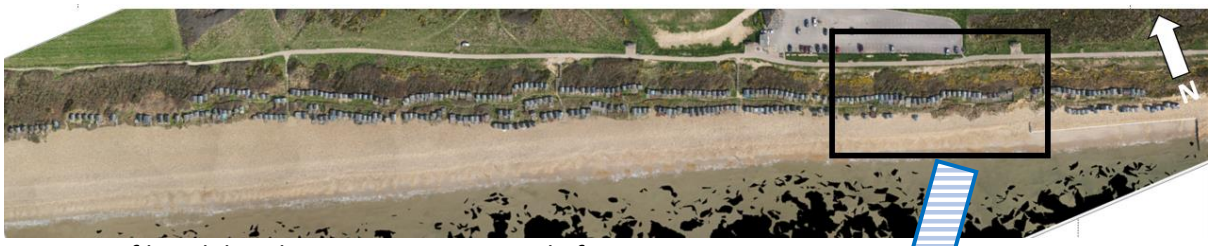
Location of site at Hordle Cliff, west of Milford-on-Sea

Storm Eunice was particularly severe. The highest recorded waves coincided with a storm surge at the height of a spring high tide. As a result, the already reduced beach suffered significant erosion with the beach at the toe of the cliff lowering approximately 1.5m.

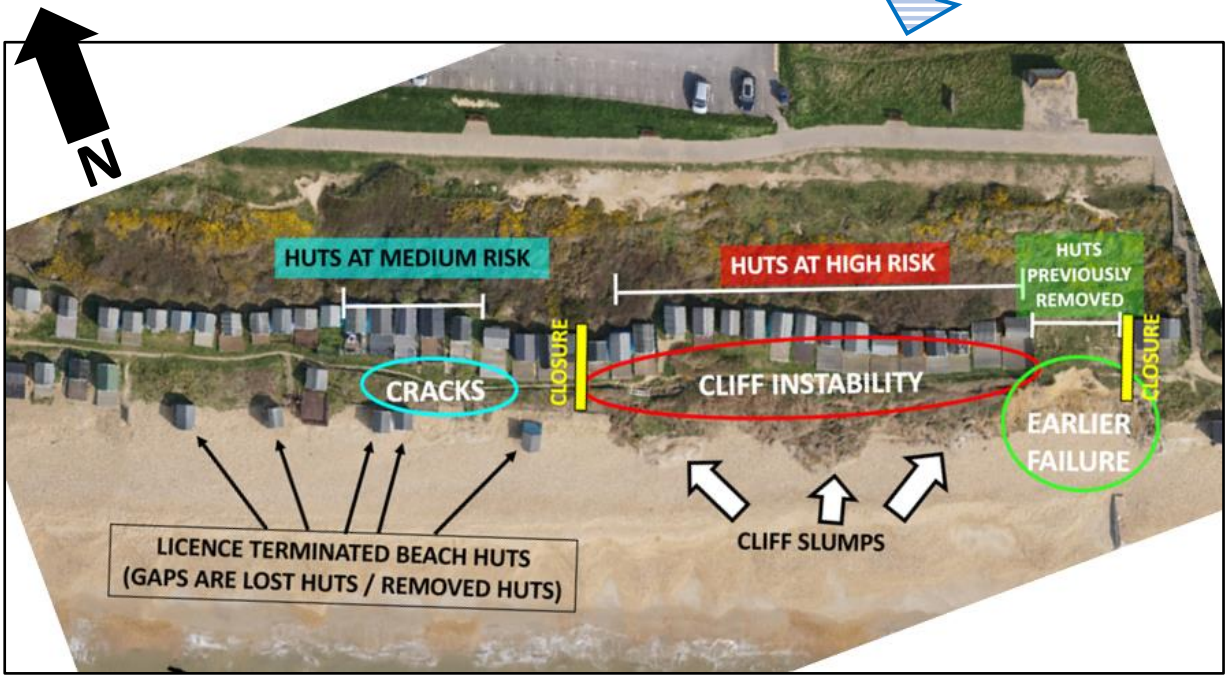
The majority of the cliff is public open space within NFDC ownership. Sited on the cliff are around 300no. privately owned beach huts, with owners paying NFDC an annual licence to site their hut. There are two rows of huts, one along the upper beach terrace and one along the lower cliff terrace. Access to the beach huts is provided with a number of timber access steps from the cliff top to a footpath along the base of the cliff with additional steps to beach level.

General arrangement of beach huts (2 rows: one on the beach and one on the lower cliff)

The main structural damage was caused to beach huts to the eastern end of the section where 5no. beach huts were lost completely and around another 25no. damaged (some severely) by wave impact. Once beach levels were lowered, ground instability and movement then quickly ensued in the lower cliff terrace with cliff failures occurring. This instability is now impacting the viability of a number of beach huts located along the cliff and the access to them. Areas have had to be closed off due to safety concerns and the council now needs to look at making some decisions in terms of managing the site.



Location of beach hut damage, to eastern end of site



Cliff instability and huts at risk at the eastern end of the site

Location of beach hut damage following Storms Eunice & Franklin, to eastern end of site

Work Requirement:

In order to inform NFDC in terms of its future management of the site, the council wishes to instruct a suitable consultant to undertake an independent geotechnical assessment (report) of the current cliff instability issue, with a view to identifying:

- Likely development of ground movement
- Timeframe of development and further movement
- Impact on beach huts and the associated beach hut plots
- What are the risks

To consider actions:

- Termination of hut licences – now or in the future?
- Safety – cliff terrace and at beach level
- Should beach huts be removed now? Is there an compromise / interim solution to extend the life of the beach huts?
- Likelihood of opening access to the eastern end huts
- Future recommendations

Appendix B – Client Provided Aerial Photographs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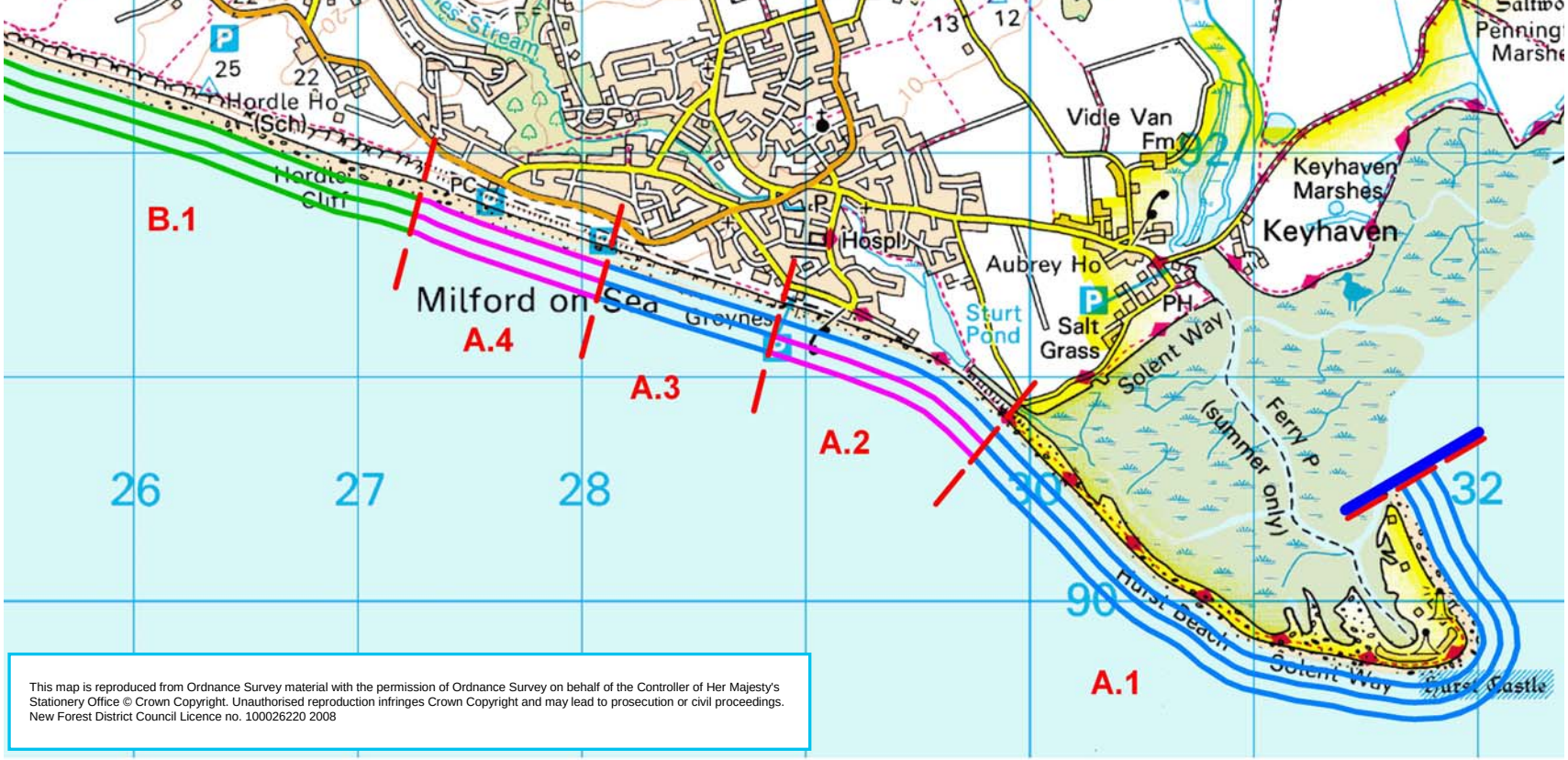
Appendix C – Extract of the current Shoreline Management Strategy



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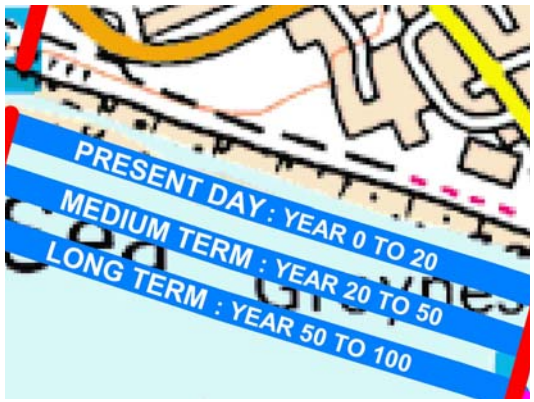

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	Managed realignment
	No active intervention

POLICY UNIT	POLICY UNIT REFERENCE
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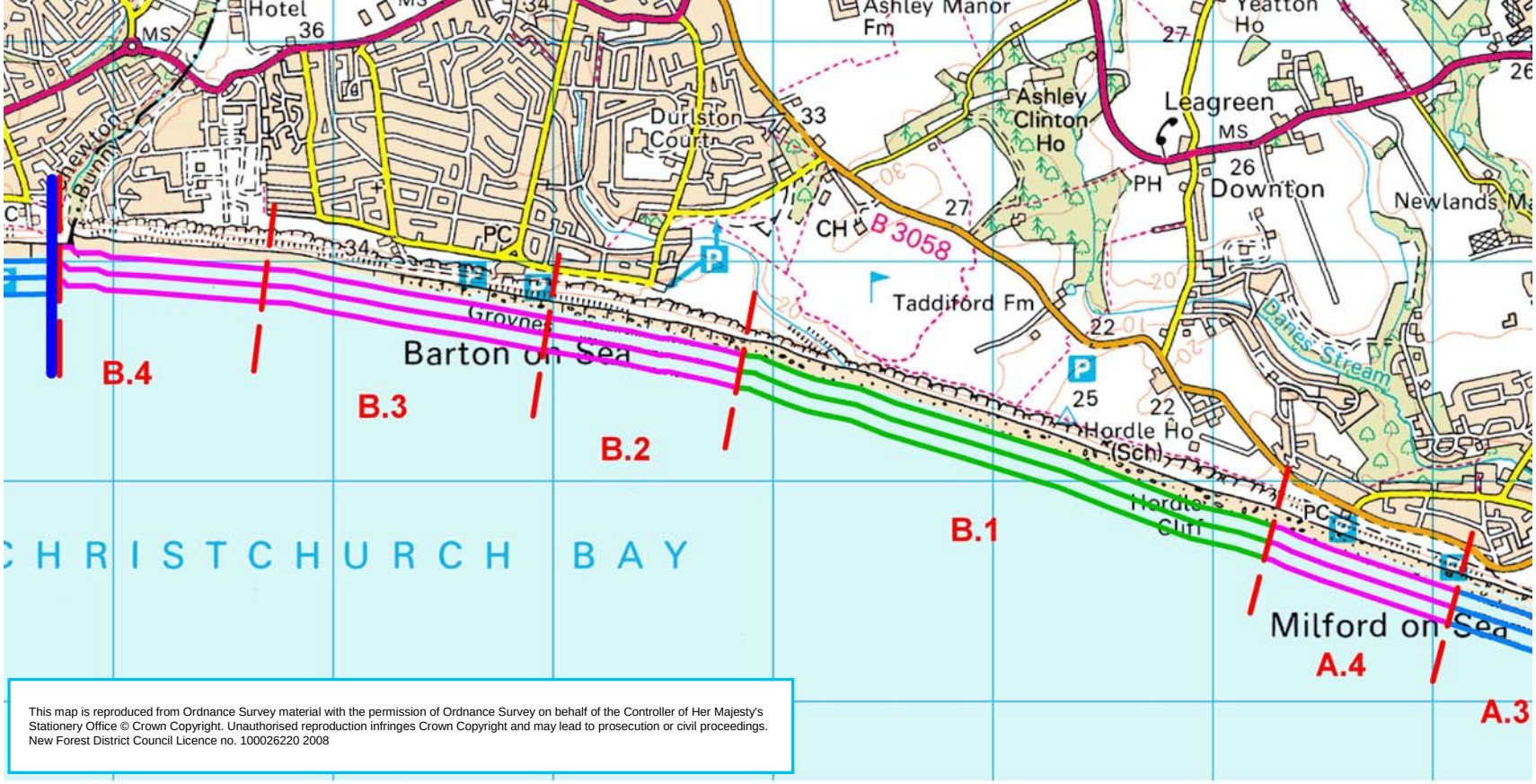

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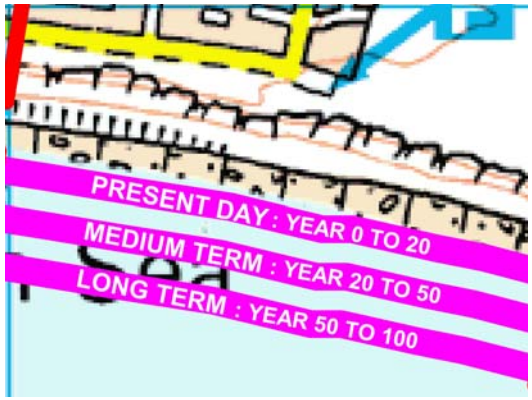

LINE COLOUR	POLICY
	Hold the existing line
	Managed realignment
	No active intervention

POLICY UNIT	POLICY UNIT REFERENCE
B.2	(CBY.B.2)

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Appendix D – Site Visit Photographs

Figure 0-1 Example of a beach hut alignment. Photo taken on 07/06/2022. Approx. Ordnance Survey grid reference SZ 27777 91758.

Figure 0-2 Example of beach hut alignment. Photo taken on 07/06/2022. Approx. Ordnance Survey grid reference SZ 27692 91771.

Figure 0-3 Example of ground raised and retained for beach hut and decking placement. Photo taken on 07/06/2022. Approx. Ordnance Survey grid reference SZ 27702 91768.

Figure 0-4 Example of how beach hut bays have removed toe of the slope and added in ad-hoc retaining structures. This beach hut has been removed due to damage from the February 2022 storms. Photo taken on 07/06/2022. Approx. Ordnance Survey grid reference SZ 27687 91768.

Figure 0-5 Example of failed slope retention at the beach huts along the beach. Photo taken on 07/06/2022. Approx. Ordnance Survey grid reference SZ 27649 91790.

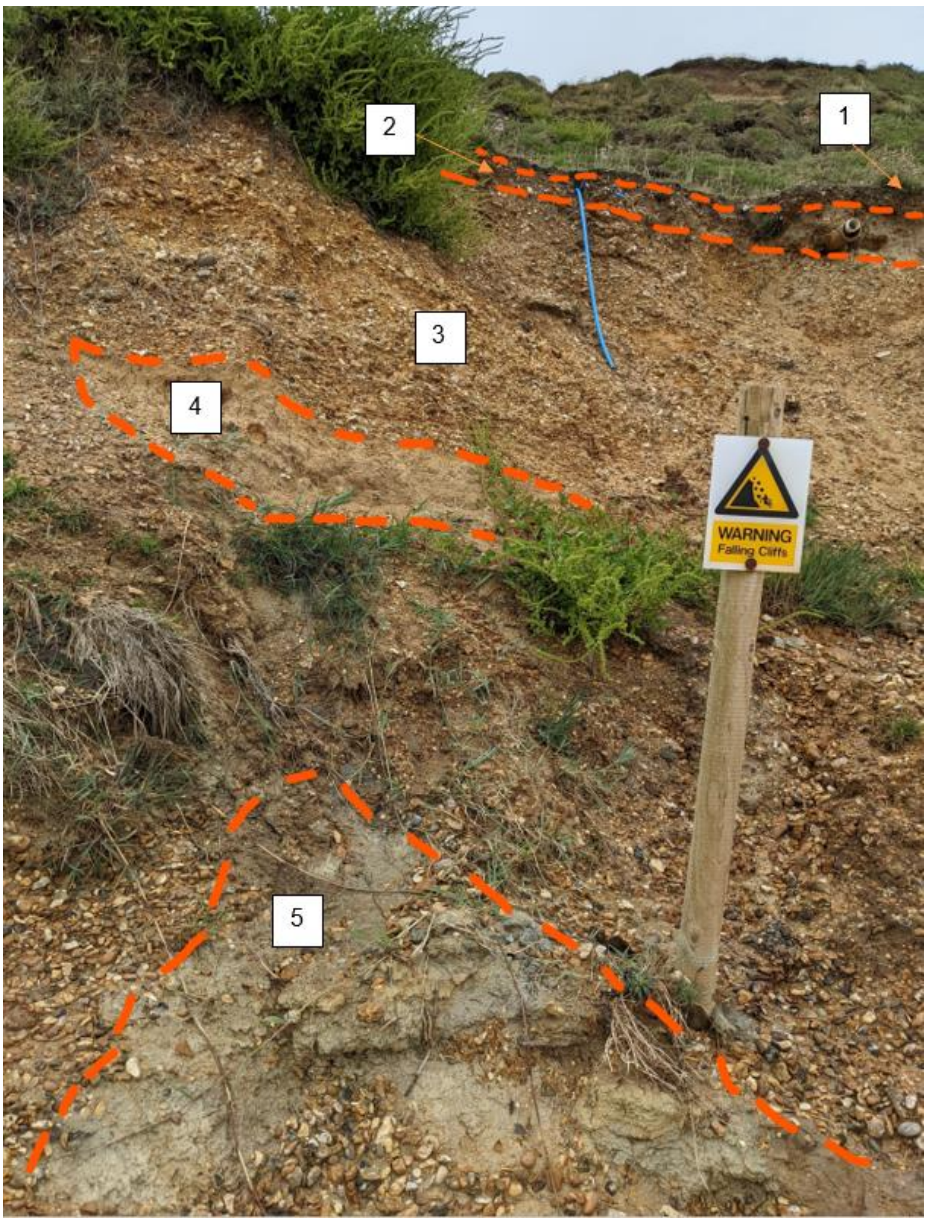

Figure 0-6 Photograph showing strata observed on site. Date taken 07/06/2022. Approx. Ordnance Survey grid reference SZ 27757 91744. (Refer to section 3.2).

Figure 0-7 Photograph showing the slope gradient behind the beach huts on the beach. Date taken 07/06/2022. The photograph was taken behind the beach huts to the east of the area specified in the brief. Approx. Ordnance Survey grid reference SZ 27784 91733.

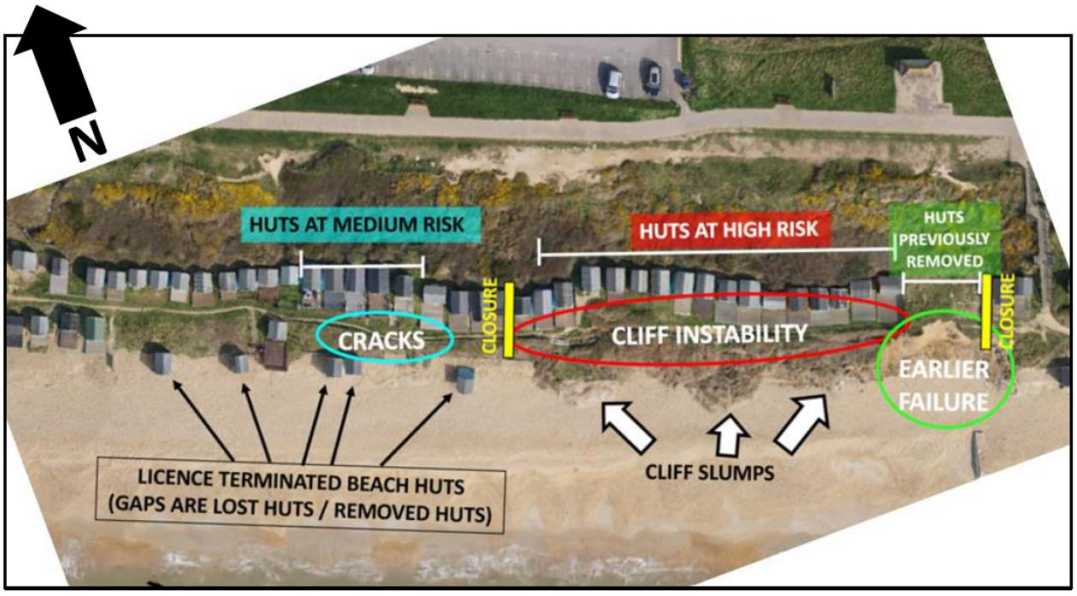

Figure 0-8 Cliff instability and huts at risk at the eastern end of the site (Ref. Geotechnical Assessment_Brief JBA.pdf)

Figure 0-9 Photo of crack, taken 07/06/2022. Approx. Ordnance Survey grid reference SZ 27704 91768.

Figure 0-10 Photo of crack, taken 07/06/2022. Approx. Ordnance Survey grid reference SZ 27720 91763.

Figure 0-11 Photo of crack, taken 07/06/2022. Approx. Ordnance Survey grid reference SZ 27755 91751.

Figure 0-12 Photo of western cliff slump. Photo taken 07/06/2022. Approx. Ordnance Survey grid reference SZ 27709 91766.

Figure 0-13 Photo of crack at the top of the western cliff slump. Photo taken 07/06/2022. Approx. Ordnance Survey grid reference SZ 27711 91767.

Figure 0-14 Photo of the overhang and undermining of the beach hut decking at the western cliff slump. Photo taken 07/06/2022. Approx. Ordnance Survey grid reference SZ 27708 91760.

Figure 0-15 Photo of the slumped material at the western cliff slump. Photo taken 07/06/2022. Approx. Ordnance Survey grid reference SZ 27708 91760.

Figure 0-16 Photo of second cliff slump. Photo taken 07/06/2022. Approx. Ordnance Survey grid reference SZ 27732 91757.

Figure 0-17 Photo of earlier failure. Photo taken 07/06/2022. Approx. Ordnance Survey grid reference SZ 27753 91752.

Figure 0-18 Photo of earlier failure showing pipe, cemented overhang and water line. Photo taken 07/06/2022. Approx. Ordnance Survey grid reference SZ 27757 91743.

Figure 0-19 Photo of other failure higher up the slope. Photo taken 07/06/2022. Approx. Ordnance Survey grid reference SZ 27642 91794.

Figure 0-20 Photo of drainage at the top of the cliff, taken 07/06/2022. Approx. Ordnance Survey grid reference SZ 27649 91814.

Figure 0-21 Photo of failure at the top of the cliff, adjacent to the drainage channel, taken 07/06/2022. Approx. Ordnance Survey grid reference SZ 27649 91814.

Figure 0-22 Photo of unsupported toe of the slope in the middle cliff slump area. Photo taken 07/06/2022. Approx. Ordnance Survey grid reference SZ 27730 91751.