H2Teesside Project

Planning Inspectorate Reference: EN070009

Land within the boroughs of Redcar and Cleveland and Stockton-on-Tees, Teesside and within the borough of Hartlepool, County Durham

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Planning Act 2008

Applicant: H2 Teesside Ltd

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1.0 INTRODUCTION

1.1 Background

1.1.1 This document has been prepared on behalf of H2Teesside Limited (the 'Applicant'). It relates to an application (the 'Application') for a Development Consent Order (a 'DCO'), that was submitted to the Secretary of State for Energy Security and Net Zero ('DESNZ') on 25 March 2024, under Section 37 of the Planning Act 2008 (the 'PA 2008') in respect of the H2Teesside Project (the 'Proposed Development').

1.1.2 The Application has been accepted for examination. The Examination commenced on 29 August 2024.

1.2 The Purpose and Structure of this Document

1.2.1 The purpose of this document is to support the Applicants' response to questions as set out in the Examining Authority's Report on the Implications for European Sites (RIES) [**PD-018**]. Table 2.1 in Section 2 of this document contains the questions listed in the RIES is reproduced in bold text in Section 2. The Applicants' response is given in plain text after each question.

2.0 RESPONSE TO RIES QUESTIONS

Table 2-1: Response to RIES questions.

REF NO.	ADDRESSED TO	PINS RIES QUESTION	APPLICANT'S RESPONSE
Q2.1.1	Natural England	Confirm if you agree with the Applicant's screening approach in respect of the Castle Eden Dene SAC. If not agreed, provide an explanation of NE's position.	The Environment Agency recommends that for large power generation developments greater than 50 MW, a radius of search of 15 km should be used when identifying relevant European designated sites which may be affected by the development. The Proposed Development is a 1.2 GWth Hydrogen Production Facility and as such, a Zone of Influence of 15 km (minimum) has been used. Castle Eden Dene SAC is considered in the context of operational stack emissions from the Proposed Development, which have the potential to affect European sites that lie relatively far from industrial developments. As Castle Eden Dene SAC is over 15 km from the Main Site and operational air quality effects will not be generated from the connection corridors, this site has been screened out of the assessment. The Applicant is confident in the screening approach that has been taken.
Q2.4.1	Natural England	Confirm if you agree with the applicant's screening conclusions in respect of the Southern North Sea SAC. If not agreed, provide an explanation of NE's position.	The Southern North Sea SAC is 101.34 km east of the Proposed Development Site. The Southern North Sea SAC is a large (3,695,054 ha), offshore site comprising entirely marine habitat (100%). Its purpose is to protect the primary habitat for harbour porpoise (*Phocoena Phocoena*), which uses a network of habitat patches in the North Sea. It is noted that the Planning Inspectorate agreed that effects upon the Southern North Sea SAC could be scoped out of the Environmental Statement as there are no impact pathways from underwater sound arising from the proposals (Appendix 1B (EN070009/APP/6.4). This is due to the large distance between the SAC and the Proposed Development and the limited effects identified on the marine environment in the EIA of the Proposed Development [APP-067]. As such, Likely Significant Effects upon harbour porpoise were also screened out.
Q2.5.1	Natural England	NE's advice in [REP4-028] was that operational emissions to air (NOx, nitrogen and acid deposition) to North Yorks Moors SAC and SPA and Northumbria Coast Ramsar site and SPA from the proposed development in combination would not be significant on the basis of information presented in the applicant's HRA report [CR1-023], which concluded that the 1% critical level was not exceeded for these pollutants. A further updated HRA report [REP5-011] has resulted in a change to the modelling, with the 1% critical level now exceeded for annual NOx, nitrogen deposition and acid deposition (North Yorks Moors SAC and SPA only). NE is requested to set out any implications for its advice on these matters as a result of [REP5-011].	The applicant understands that Natural England remains satisfied that there will be no likely significant effect on North York Moors SAC/SPA. This is because, while the 'in combination' Process Contribution for annual NOx, nitrogen deposition, and acid deposition, exceeds 1% of the critical level at North York Moors SAC/SPA, the contribution of H2Teesside to that in combination effect is imperceptible, not being visible in the modelling when reported to two decimal places.
Q2.5.2	Natural England	NE is requested to confirm if it is satisfied that the implications of installing and retaining ground-strengthening works have been adequately considered in the HRA. If concerns remain, confirm for which European sites and qualifying features, and what pathways to effect	Disturbance of birds as a result of ground strengthening works (piling) on the Main Site was assessed within the Report to Inform HRA submitted with the DCO Application [APP-040]. A revised version of the Report to Inform HRA was submitted at Deadline 6A [REP 6a-010], which considered ground strengthening works (piling) on the Main Site in-combination with other construction activities occurring concurrently (based on an indicative construction programme). The Applicant has committed to the use of rotary / Continuous Flight Auger (CFA) piling on the Main Site to minimise impulsive noise. This is

REF NO.	ADDRESSED TO	PINS RIES QUESTION	APPLICANT'S RESPONSE
			secured in the latest iteration of the Framework CEMP [REP6a-014]. Additional information on noise is provided within Annex K of the Report to Inform HRA, and noise modelling indicates that noise can be reduced to an acceptable level.
QT2.2.2b	Natural England	NE is requested to provide any evidence it holds that demonstrates the blast furnace pool as a function as a refuge for SPA birds during less favourable tidal or weather conditions. Which SPA birds use the pool and how frequently. Are these species sensitive to visual disturbance.	The Applicant provided a technical note summarising the use of the blast furnace pool at Deadline 5 [REP5-051] (Appendix 1). The technical note detailed the background to NE8, baseline data on bird counts, potential sightlines at the blast furnace pool, as well as supporting figures and photographs which demonstrate the sightlines discussed. Subsequently, an assessment of potential impacts was conducted in that Appendix which it was concluded there would be no significant effects on the SPA, SSSI or the non-breeding waterbird assemblage.
Q3.1.1	Natural England	Are you satisfied with the applicant's approach to assessment of the Ramsar sites in the absence of conservation objectives.	There are no published conservation objectives for the Teesmouth and Cleveland Coast Ramsar. The Applicant has assumed that the conservation objectives would be the same as for the Teesmouth and Cleveland Coast SPA. The Applicant considers that a robust assessment of impacts upon the Ramsar/SPA has been completed. The Applicant has considered the Conservation Objectives for the Teesmouth and Cleveland Coast SPA and concluded that the integrity of the site is maintained.
Q3.1.2	The Applicant	Confirm whether the European sites screened in for assessment are in favourable or unfavourable condition.	European designated sites do not have published condition assessment data, therefore the Applicant has not provided this. Underlying SSSIs do have condition assessment data, however the condition of the SSSI may not be directly relatable to the European designated sites. The Natural England Site Search website for the Teesmouth and Cleveland Coast SSSI reports the condition status of qualifying bird species as 'not recorded'. The Applicant has considered the Conservation Objectives for the Teesmouth and Cleveland Coast SPA and concludes that the integrity of the site is maintained.
Q3.3.1	Natural England	Can NE advise if it is content that the applicant's waterbird survey effort in [APP-208] and [AS-037] provides sufficient baseline understanding to undertake assessment. If there are any outstanding concerns, confirm what they are.	The Applicant has discussed this matter at previous meetings with Natural England. The Applicant's understanding is the underlying survey effort and third-party data used to support the assessment presented in APP-208 and AS-037 is not a source of disagreement.
QT3.1.4	Natural England	Can NE comment on information in [REP5-051]. Does it have sufficient evidence to advise that AEoI can be excluded. If not, confirm what further information is needed.	In the view of the Applicant, sufficient information has been submitted to support a conclusion of No Adverse Effect on Integrity for any European sites. This is contained within the Report to Inform HRA [REP6a-010], reflecting what was contained in REP5-051.
QT3.1.8a	Natural England	NE is requested to provide any evidence it holds that pollutant emissions and nitrogen deposition to the SSSI may have reduced relative to information on APIS.	Paragraph 12.6.16 of the Ecology ES Chapter [APP-064] shows that a net improvement in nitrogen deposition is forecast and nitrogen deposition rates are forecast to be materially lower than in earlier decades, with the habitat structure having been extensively changed due to slag deposition and movement from at least the 1940s to the early 2000s. The Scarborough Borough Council report 'Cell 1 Coatham Dunes Report' 2018 I sreporduced at Appendix 1 of this document). Much of the dunes north of the Main Site at H2T (i.e. Coatham Dunes) have developed on slag deposits from the various historic industrial activities in that area (notably Warrenby Slag Works). In these decades N deposition will have been higher than it is now due to much higher NOx emissions (and was certainly higher in 2003 than it is now according to APIS). For example, UK N deposition reduced from 465 kt N in 1990 to 278 kt N in 2017: https://essd.copernicus.org/articles/13/4677/2021/. It is the Applicant's understanding that Natural England does not dispute that nitrogen deposition has reduced and is modelled to remain below historic levels.

REF NO.	ADDRESSED TO	PINS RIES QUESTION	APPLICANT'S RESPONSE
QT3.1.8b	The Applicant	The applicant is requested to confirm if any mitigation is available to further reduce the contribution of the proposed development to nitrogen deposition at the SSSI and SPA.	Mitigation of nitrogen deposition from the Proposed Development has been embedded in the design including controlling emissions through process design and selection of appropriate stack heights to deliver effective dispersion of residual emissions. It is the Applicant's view that no mitigation is required to address atmospheric pollution impacts on Teesmouth and Cleveland Coast SPA. This is because the only sensitive features for the SPA are the tern and avocet nesting locations, and modelling has demonstrated that the project will have an imperceptible impact on pollution at those locations, or (with regard to the nearest historic location) other issues such as recreational pressure and sand dune accretion make it unfeasible that nesting could ever be restored. Regarding Teesmouth and Cleveland Coast SSSI, the Applicant's view remains that if the total nitrogen deposition rate will remain lower with H2Teesside consented (even allowing for other plans and projects) than it has been historically or when the SSSI vegetation interest generally developed, it cannot be argued that our scheme will be harming the interest of the SSSI, even by impeding restoration. That is particularly the case given the contribution of H2T is at the '1% of the upper critical load' level for being dismissed as imperceptible and is therefore not a significant contributor to overall nitrogen deposition. Moreover, other factors such as management of recreational pressure are likely having a greater effect on limiting potential for restoration of the dune vegetation than air quality. We understand that Natural England's concern is not with the emissions of H2Teesside itself, but the cumulative emissions of a range of developments around Teesside. Even if it was not agreed by Natural England that no likely significant effect can be concluded, as the contribution of the Proposed Development to a cumulative impact is so small as to be imperceptible, the Applicant considers that it would not be appropriate for any additional mitigation to be applied to address the residual effects of the Proposed Development. Notwithstanding the above project position, the Applicant generally notes (but emphasises that this does not affect the position it has stated above) that it is aware of and is contributing to wider strategic discussions regarding industrial development on Teesside working with the Environment Agency, Natural England and other parties to better understand the condition and resilience of the dune habitat when considering the reduction in industrial emissions across Teesside over many years and the potential new decarbonisation developments being progressed by various parties to align with the Track 1 status of the Teesside industrial cluster.
QT3.1.9b	The Applicant	Can the applicant submit the diagram requested by NE or confirm where it has been provided to the examination.	The Applicant submitted the requested diagram into the Examination at Deadline 6A [REP6a-019].
QT3.1.10	The Applicant	The ExA understands this matter to be resolved but would welcome confirmation from the applicant as to how the dDCO restricts disposal of treated wastewater to the selected Option 2B.	The Applicant has updated Requirement 10 of the DCO in relation to this issue, at Deadline 7.
QT3.1.16	The Applicant	Can the applicant submit a construction monitoring programme for seal based on NE's advice, on a without prejudice basis. Confirm how it would secure this in the DCO, if required.	The Applicant submitted an updated Report to Inform HRA at Deadline 6a [REP6a-010]. Annex I of the updated Report to Inform HRA, specifically addresses NE26 (seals). As detailed in Annex I, with acoustic mitigation barriers in place around the HDD3 and HDD4 sites, the cumulative M-weighted sound exposure level (SEL) in Greatham Creek is only 1 dB (101 dB) above the ambient SEL (100 dB). In addition to the acoustic barriers, this low level of change from ambient is due to the HDD works occurring behind a 2-3 m natural mound located on the banks either side of Greatham Creek. This is considered to provide a significant screening effect to seals present in Greatham Creek (4-5 m below the ridge on the 'Greatham Creek' side). This change of 1 dB is unlikely to

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			result in a perceptible change in sound to nearby seals and will not cause disturbance, such as avoidance behaviour at the mouth of Greatham Creek. Furthermore, all HDD works will be restricted to only occur between September and November, which avoids the sensitive peak pupping and moulting season for seals at Seal Sands of mid-June to end of August (INCA, 2023). The drilling activity itself will only occur for a period of 14 days and will commence at the end of September to avoid any potential overlap with the moulting period for seals in this location. As a result of the measures in place, a monitoring programme during the construction phase is not required. This is due to the negligible disturbance the HDD works are expected to have on seals, based on detailed modelling and the mitigation measures provided. Notwithstanding the Applicant's position, if the ExA were to disagree with it in its recommendation period, it would be able to secure the delivery of a seal monitoring programme by amending Requirement 15(7)(l) to refer to a Bird and Seal Mitigation and Monitoring Plan. Doing this would be consistent with the reasoning for the provision of the Bird Mitigation and Monitoring Plan set out in the Framework CEMP, which is to provide reassurance as to the efficacy of the mitigation measures considered in the assessments and to undertake related monitoring.
Q3.4.1	Natural England and the Applicant	Confirm if the ExA's understanding as set out in annex 2 of this RIES is correct and advise on the position where the ExA has indicated it is unclear.	The Applicant has replicated Annex 2 of the RIES based on the Applicant's position in respect of the Proposed Development's effects on the integrity of the European Sites and its understanding of the position of NE as at Deadline 7, based on discussions with them. This is provided at Appendix 2.
Q3.4.2	Natural England and the Applicant	Confirm at DL7 if an AEoI on all European sites from the proposed development alone or in-combination with other plans or projects can be excluded.	In the updated Report to Inform HRA submitted at D6a [REP6a-010] the Applicant has concluded that there will be no AEoI alone or in combination with other plans or projects.
Q3.4.3	The Applicant	Should it not be possible to confirm AEoI on all European sites from the proposed development alone or in-combination with other plans or projects can be excluded by DL7, submit derogations information by the same deadline (DL7) to enable it to be examined.	The Applicant is confident in the robustness and reliability of its assessment that confirms that no AEoI of any European site will be caused by the Proposed Development either alone or in-combination with other plans or projects. The examination has not been provided with any contrary evidence or analysis that would justify a different conclusion and therefore the Applicant does not intend to submit a without prejudice derogation case. The conclusion of no AEoI is clearly set out and justified with expert evidence and analysis in the updated Report to inform HRA submitted at Deadline 6A (REP6a-013) ('the RIHRA') and supplemented by the Applicant's response to Natural England ('NE')'s Deadline 6A submissions (REP6a-034) also submitted at Deadline 7. At the time of Deadline 7, the Applicant understands that NE does not yet fully agree with its conclusion, subject to further discussion on mitigation in respect of the project's impacts alone, and subject to NE coming to a view on in-combination effects The Applicant continues to work proactively with NE to seek to resolve its outstanding concerns so as to reach an agreed position on these matters by the end of Examination, including through the development of appropriate securing mechanisms. Whilst the Applicant will continue to work with NE, should this prove to be necessary, during the Recommendation and Decision period, it appreciates that the ExA will need to make a recommendation in relation to HRA issues in its Recommendation Report, taking account of the respective parties' views as they stand at the close of Examination.

REF NO.	ADDRESSED TO	PINS RIES QUESTION	APPLICANT'S RESPONSE
			In circumstances where the Applicant does not propose to submit a derogation case, the ExA will need to form a judgement as to the relative merits of the Applicant's and NE's position in respect of matters on which agreement has not yet been reached by the end of Examination. This judgment will need to be based on the expert evidence and analysis that has been provided to the ExA during the examination. If such a determination is required, the Applicant draws the ExA's attention to the High Court judgment (on a ground that was not subject to appeal in the Court of Appeal) in Together against Sizewell C Limited v Secretary of State for Energy Security and Net Zero [2023] EWHC 1526 (Admin) paragraphs 106-114 (see Appendix 3 to this document). In that judgment, Holgate J (as he then was), considered an allegation that the Secretary of State had failed to provide legally adequate reasons for disagreeing with the advice from NE (Ground 3, see paragraphs 19 and 106 to 114 of the Judgment). In dismissing Ground 3, he emphasised the following relevant principles: • the Secretary of State (and therefore the ExA) is entitled to disagree with the views expressed by NE; • where a decision-maker disagrees with the views of a body such as NE, it should give its reasons for doing so. In assessing the adequacy of those reasons, no heightened standard of reasoning applies. The relevant standard remains that set out in *South Bucks District Council v Porter (No.2) [2004] 1 WLR 257* at paragraph 36, namely that: *The reasons for a decision must be intelligible and they must be adequate. They must enable the reader to understand why the matter was decided as it was and what conclusions were reached on the "principal important controversial issues", disclosing how any issue of law or fact was resolved. Reasons can be briefly stated, the degree of particularity required depending entirely on the nature of the issues falling for decision. The reasoning must not give rise to a substantial doubt as to whether the decision-maker erred in law, for example by misunderstanding some relevant policy or some other important matter or by failing to reach a rational decision on relevant grounds. But such adverse inference will not readily be drawn. The reasons need refer only to the main issues in the dispute, not to every material consideration. They should enable disappointed developers to assess their prospects of obtaining some alternative development permission, or, as the case may be, their unsuccessful opponents to understand how the policy or approach underlying the grant of permission may impact upon future such applications. Decision letters must be read in a straightforward manner, recognising that they are addressed to parties well aware of the issues involved and the arguments advanced. A reasons challenge will only succeed if the party aggrieved can satisfy the court that he has genuinely been substantially prejudiced by the failure to provide an adequately reasoned decision* • the level of reasoning which the law expects of a decision-maker disagreeing with the view of an expert body may depend upon whether that view is an unreasoned statement or assertion, or a conclusion which is supported by an explanation and/or evidence. It may also depend upon the nature of the subject-matter. Some advice may not call for reasoning and/or supporting evidence, other advice may do. To the extent that agreement has not been reached by the close of the Examination, the Applicant invites the ExA to accept its conclusion which is informed by a robust expert assessment and evidence, that the Proposed Development will not give rise to an AEoI, and to have regard to the following matters in light of the above factors: • the Applicant has responded to every request and clarification that NE has asked for in the Examination process and has further developed robust methodologies requested by NE even where the Applicant considers

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			that the methodologies go beyond a reasonable level of precaution and lead to the reporting of results that are unrealistically adverse; • the Applicant has undertaken comprehensive baseline data collection and robust modelling both in its application, and in response to NE's queries; • the Applicant has submitted extensive expert evidence both in its written and oral representations to the Examination. The expertise of the relevant experts who have undertaken the assessments is apparent from the CVs of those experts are enclosed with this submission; • while NE has expressed disagreement with certain conclusions reached by the Applicant's experts, it has not submitted any technical evidence to substantiate its position, particularly with regards to in-combination effects (save to ask for additional developments to be considered). The bare assertion of disagreement does not constitute substantive evidence that results in any 'reasonable' 'scientific' doubt as to the Applicant's conclusions.]; and • NE has declined the ExA's invitations to attend hearings relating to ecological matters so as to allow its views to be tested and clarified. By contrast, the Applicant's expert witnesses have attended hearings to address matters raised by the ExA and to allow their evidence to be tested through questioning.= The Applicant does not consider that NE has submitted any clear, technical explanation as to why it is unable to support the conclusion that the Proposed Development will not give rise to AEoI in-combination with other plans or projects. By contrast, the Applicant has provided cogent, compelling and robust evidence to demonstrate that there will be no AEoI. Given the position summarised above, in order to assist the ExA in considering each party's position, at Deadline 8, the Applicant will submit a document, setting out those matters that are agreed and not agreed with NE (including in respect of the need and securing of mitigation) and setting out its final position on each of the numbered reference points from Natural England's Relevant Representation. This will also be reflected in the final SoCG with NE.

APPENDIX 1: APPENDIX 2: SCARBOROUGH BOROUGH COUNCIL (2018). CELL 1 COATHAM DUNES REPORT

Cell 1 Coatham Dunes Report 2018

A great place to live, work & play

March 2018

Scarborough Borough Council

Cell 1 Regional Coastal Monitoring Programme
Coatham Dunes Report 2018

Contents Amendment Record

This report has been issued and amended as follows:

Issue	Revision	Description	Date	Authorised
1	0	First issue	23/03/2018	[redacted]
1	1	Minor typographic edits	26/03/2018	[redacted]

Contents

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[1] Scarborough Borough Council is acting as client on behalf of all Local Authorities within 'Coastal Cell 1'.

Preamble

The Cell 1 Regional Coastal Monitoring Programme covers approximately 300km of the northeast coastline, from the Scottish Border (just south of St. Abb's Head) to Flamborough Head in East Yorkshire. This coastline is often referred to as 'Coastal Sediment Cell 1' in England and Wales (Figure 0-1). Within this frontage the coastal landforms vary considerably, comprising low-lying tidal flats with fringing salt marshes, hard rock cliffs that are mantled with glacial till to varying thicknesses, softer rock cliffs, and extensive landslide complexes.

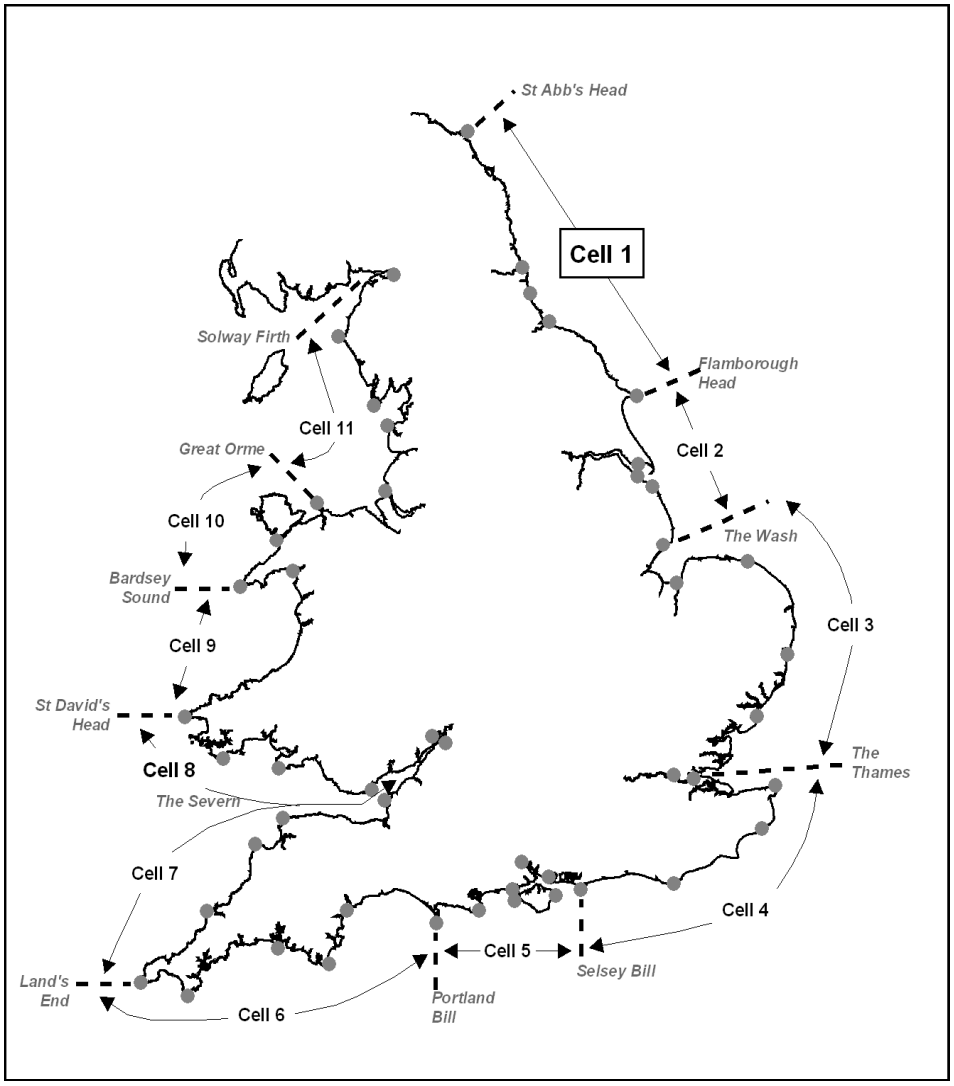

Figure 0-1 - Sediment Cells in England and Wales

The programme commenced in its present guise in September 2008 and is managed by Scarborough Borough Council on behalf of the North East Coastal Group. It is funded by the Environment Agency, working in partnership with the following organisations.

The main elements of the Cell 1 Regional Coastal Monitoring Programme involve:

- beach profile surveys
- topographic surveys
- cliff top recession surveys
- real-time wave data collection
- bathymetric and sea bed characterisation surveys
- aerial photography
- LiDAR survey
- walk-over inspection surveys

Royal HaskoningDHV has been appointed to provide Analytical Services in relation to the Cell 1 Regional Coastal Monitoring Programme 2016 - 2021.

Separate reports are produced for elements of the programme as and when specific components are undertaken, such as beach profile, topographic and cliff top surveys, wave data collection, bathymetric and sea bed characterisation surveys, and walk-over inspection surveys.

The present report is in addition to the above regular reports and covers a bespoke analysis of the coastal changes along the dunes at Coatham Sands in the borough of Redcar & Cleveland.

1. Introduction

The purpose of this report is to provide findings from a review of historic and contemporary maps and aerial photos to determine changes in land use and coastal erosion at the dunes along Coatham Sands, in the borough of Redcar & Cleveland.

All available aerial photos (historic and contemporary) from the Cell 1 Regional Coastal Monitoring Programme were downloaded from the North East Coastal Observatory website and viewed 'side by side' in ArcGIS to identify, describe and, where sufficient coastal change exists, quantify changes in the dunes along Coatham Sands, paying particular attention to the Majuba area towards the east of the frontage and any areas of identified change post 2013 and 2017 storm surges.

In addition, the selection of historic maps that is available from the National Library of Scotland website (which contains historic maps for the whole of the UK) was viewed on-screen for similar changes. [Note that the historic maps are not reproduced in this report due to copyright reasons].

2. Aerial Photography

1940

In the 1940 aerial imagery, the dunes adjacent to South Gare had not built out along the seaward edge of the spit in the manner that is observed in the present day, but instead occupied a bulbous shape, with a distinct ingress of sea water into a saline lagoon, with only a thin azimuth of land between the lagoon and the Bran Sands area of the River Tees estuary (Figure 1).

The Warrenby Slag Works are present in the 1940 imagery and slag deposits appear to push the shoreline seaward in locations immediately adjacent to the works, although the coastline here was still somewhat landward of its present day position in 1940 (Figure 2).

In the Majuba area, the present day caravan park had not been constructed in 1940 and whilst a seawall appeared to be present from the Redcar frontage towards the area of the present day Majuba car park, the car park itself was also not constructed at this time (Figures 3 & 4). It is notable that the dunes at this location were experiencing some vegetation loss and encroachment by the sea in the 1940s, even before the caravan park was built on this area.

Figure 1 – South Gare, 1940 (left) and 2017 (right)

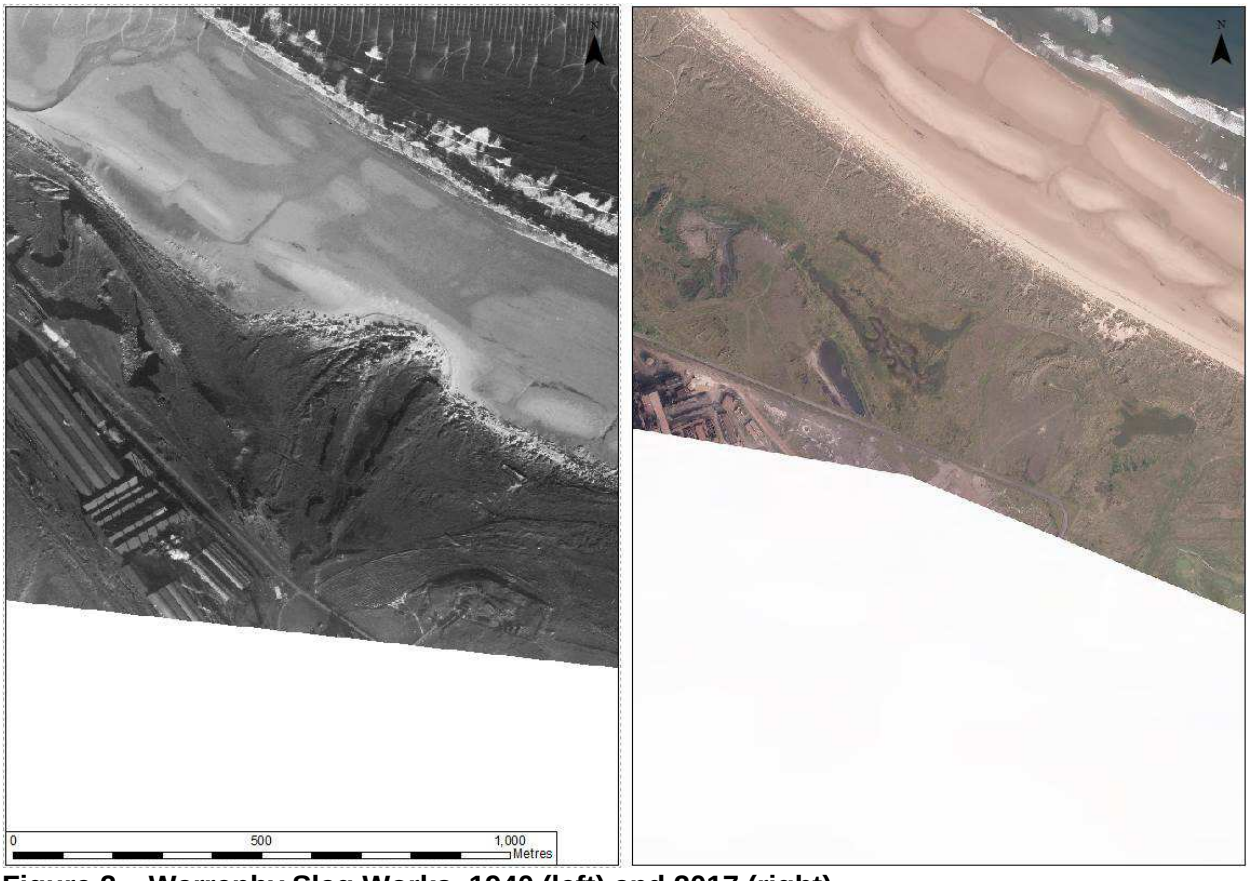

Figure 2 – Warrenby Slag Works, 1940 (left) and 2017 (right)

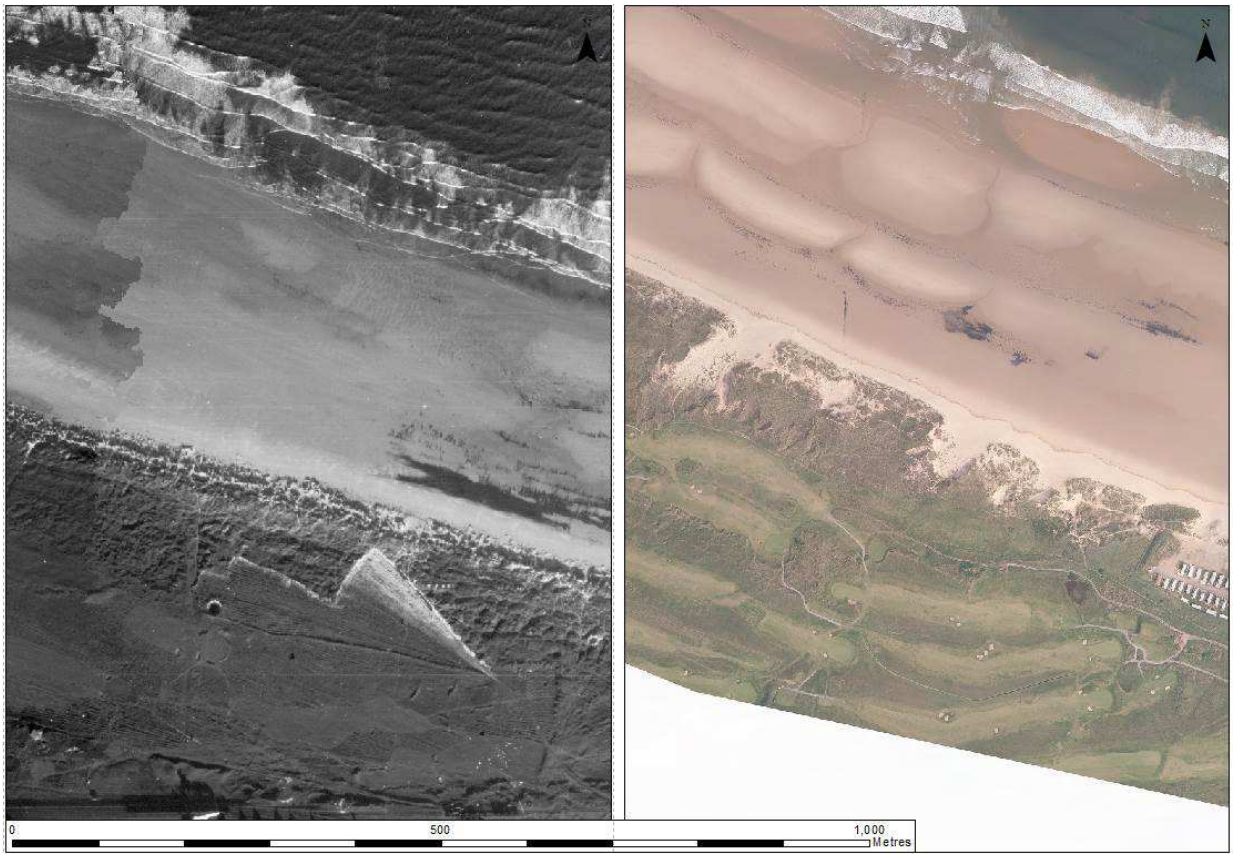

Figure 3 – Majuba Area (west), 1940 (left) and 2017 (right)

Figure 4 – Majuba Area (east), 1940 (left) and 2017 (right)

1999

By the time of the next available aerial photography from the Cell 1 Regional Coastal Monitoring Programme in 1999, the shore adjacent to the South Gare was undergoing change (Figure 5). It appears that sand or slag may have been artificially deposited to the east of the South Gare at this time, although the present day alignment had not yet been fully attained.

There had been continued progradation of the shore in the centre of the frontage, in the vicinity of the Warrenby Slag Works and the frontage by 1999 was appearing much more like a 'natural' dune system, with vegetated sand at the seaward limit, as opposed to a probable sand/slag mix present at the shore face in 1940 (Figure 6).

Both the caravan park and the car park had been constructed in the Majub area by 1999.

Figure 5 – South Gare, 1999 (left) and 2017 (right)

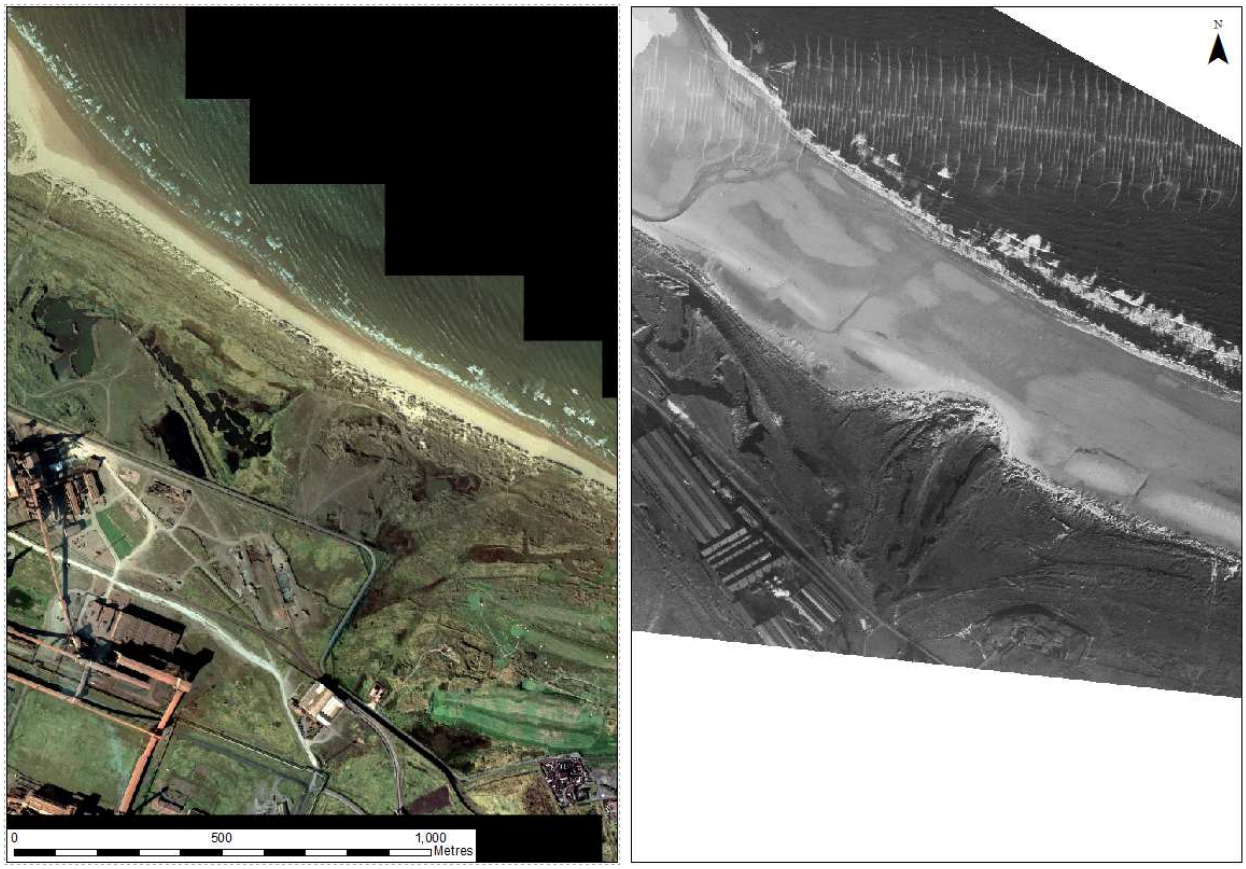

Figure 6 – Warrenby Slag Works, 1999 (left) and 1940 (right)

2009

By 2009, the shore adjacent to South Gare had continued to experience change, again likely in the form of sand/slag deposition and, due to the presence of the German Charlies in the nearshore, natural sand deposition in the now-sheltered areas. This resulted in quite a growth in the shore adjacent to the South Gare and stability in the dunes at the western end of the frontage (Figure 7).

Elsewhere along the frontage there was little change from 1999 to 2009, other than some exacerbation of areas of blow outs or bare dune vegetation to the immediate west of the caravan park in the Majuba area (Figure 8).

Figure 7 – South Gare, 2009 (left) and 1999 (right)

Figure 8 – Worsening of blow outs along eastern Coatham Sands, 2009 (left) and 1999 (right)

2010
There was little discernable change along the dunes in Coatham Sands between 2009 and 2010.

2012
The shore adjacent to South Gare appeared to contain greater quantities of material (sand/slag) and was more widely vegetated in 2012 than in 2010 (Figure 9).

At the Majuba area (Figures 10 & 11), part of the dunes adjacent to the caravan park were covered with hard-top and being used for car parking and portacabins in 2012. Presumably this was the Contractor's compund for the duration of construction of the Redcar Sea Defence Scheme. It is also noticeable that the seaward row of caravans seen in the 2010 imagery had been removed by 2012, indicating a risk from erosion or sea flooding at that time.

Figure 9 – South Gare, 2012 (left) and 2010 (right)

Figure 10 – Majuba Area (west), 2012 (left) and 2010 (right)

Figure 11 – Majuba Area (east), 2012 (left) and 2010 (right)

2015

The shore adjacent to South Gare showed some further growth between 2012 and 2015 (Figure 12), but elsewhere along the Coataham Sands frontage there was no significant difference in the shore between the 2012 and 2015 imagery, indicating that if the December 2013 storm did cause localised damage, there had been natural recovery by 2015.

Following completion of the Redcar Sea Defence Scheme, the Contractor's portacabins at the caravan park in the Majuba area had been removed by 2015, but the hard-top remained intact. The most seaward row of caravans seen in the 2015 imagery had been restored since being (temprarily) removed before the 2012 imagery (Figure 13).

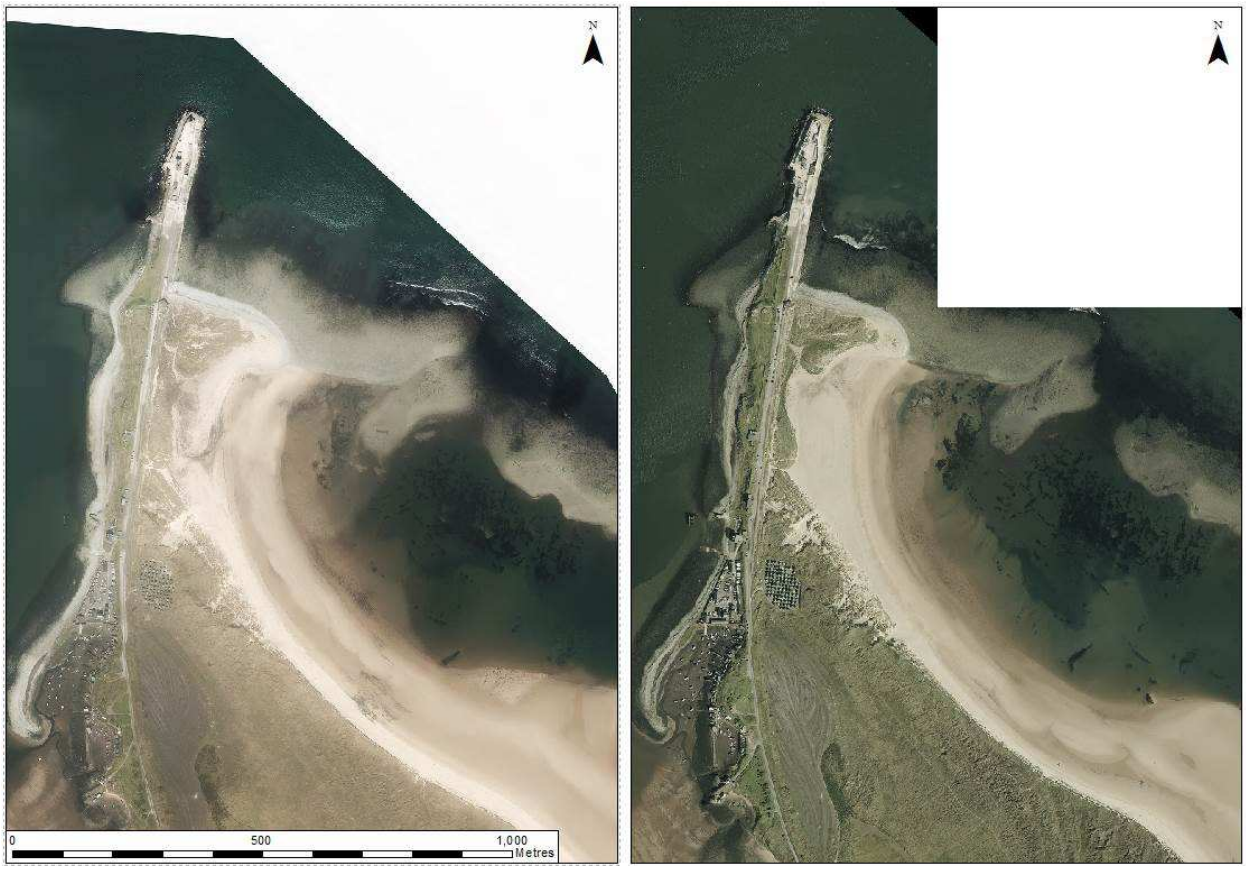

Figure 12 – South Gare, 2015 (left) and 2012 (right)

Figure 13 – Majuba Area, 2015 (left) and 2012 (right)

2017

In the immediate lee of the South Gare breakwater, the trend continued to be one of accretion in the shelter of the structure, with a notable increase in the extent of dune vegetation (Figure 14). Some areas of 'scalloped' dune evident in the 2017 aerial photography was also present in the photography that was collected in 2015 and appears not to have worsened. Arguably in some areas (e.g. Figure 15) it may have marginally recovered, although remaining heavily scalloped.

Some areas that were anecdotally described as 'breaching' or 'severely eroding' during the January 2017 storms, were clearly in such a state before the 2015 photography was collected and thus the damage to these dunes cannot be ascribed to the January 2017 storms alone (Figures 16 to 2-10).

Figure 14 – Vegetation growth on dunes in the lee of South Gare Breakwater between 2017 (left) and 2015 (right)

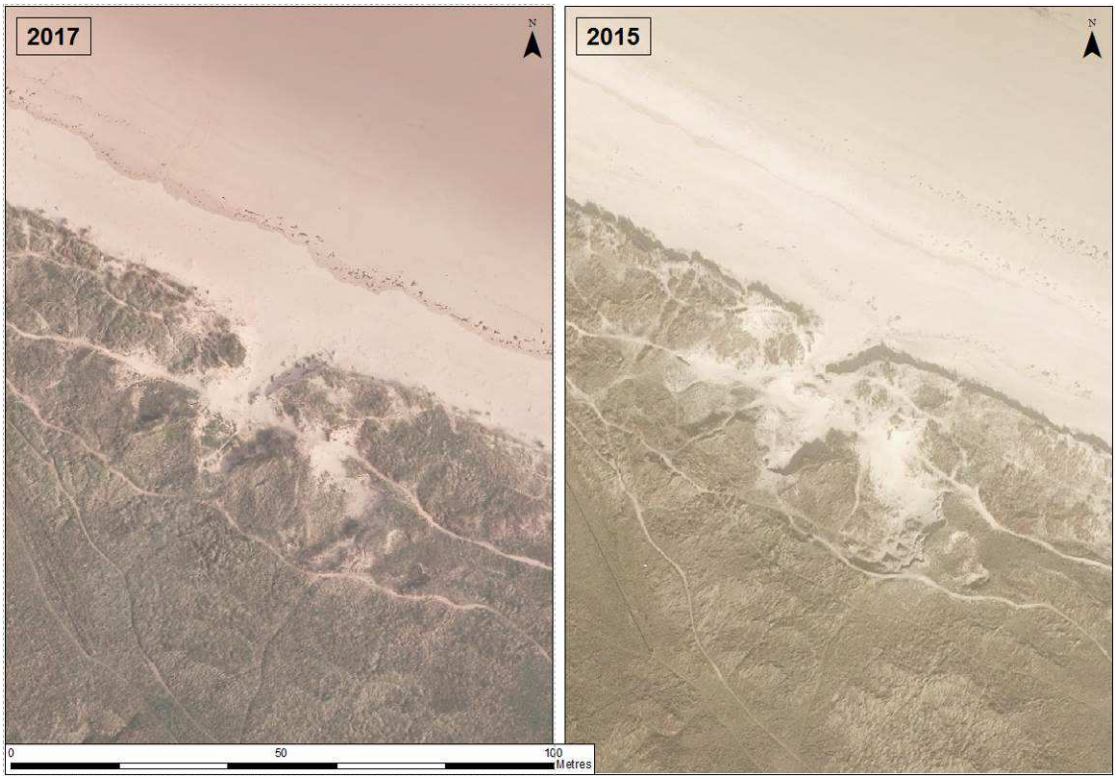

Figure 15 – 'Scalloping' of dunes along Coatham Sands in 2017 (left) and 2015 (right)

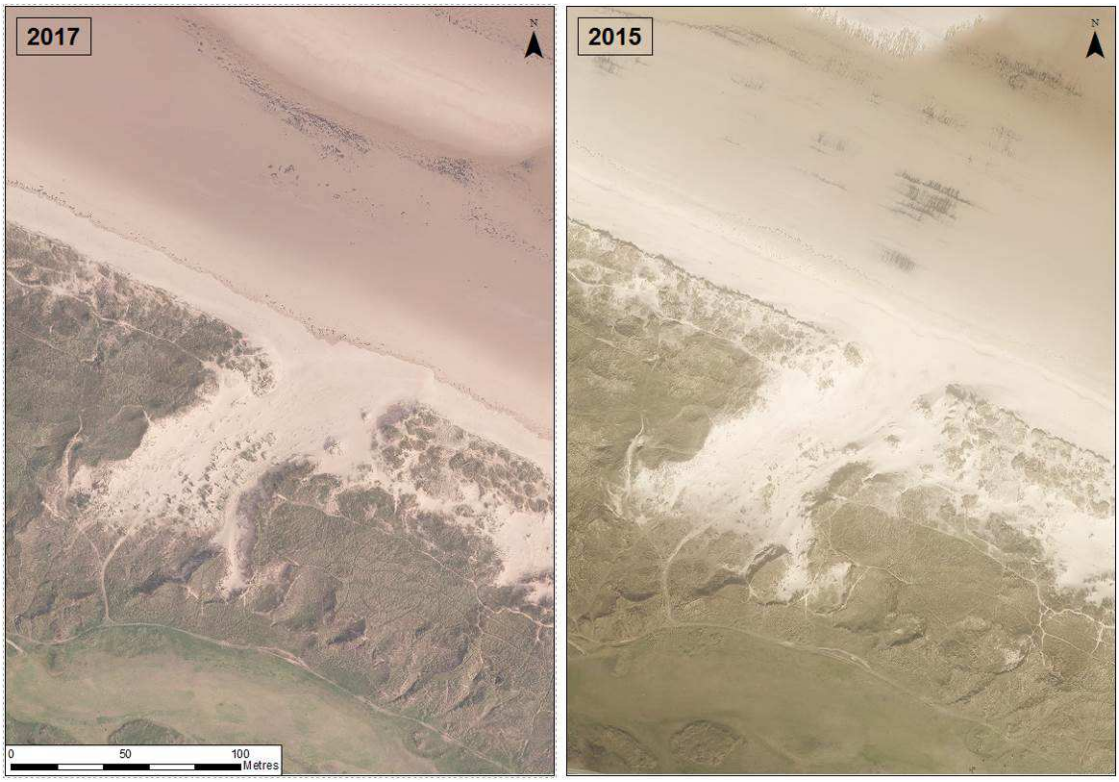

Figure 16 – Damage to dunes along Coatham Sands in 2017 (left) and 2015 (right)

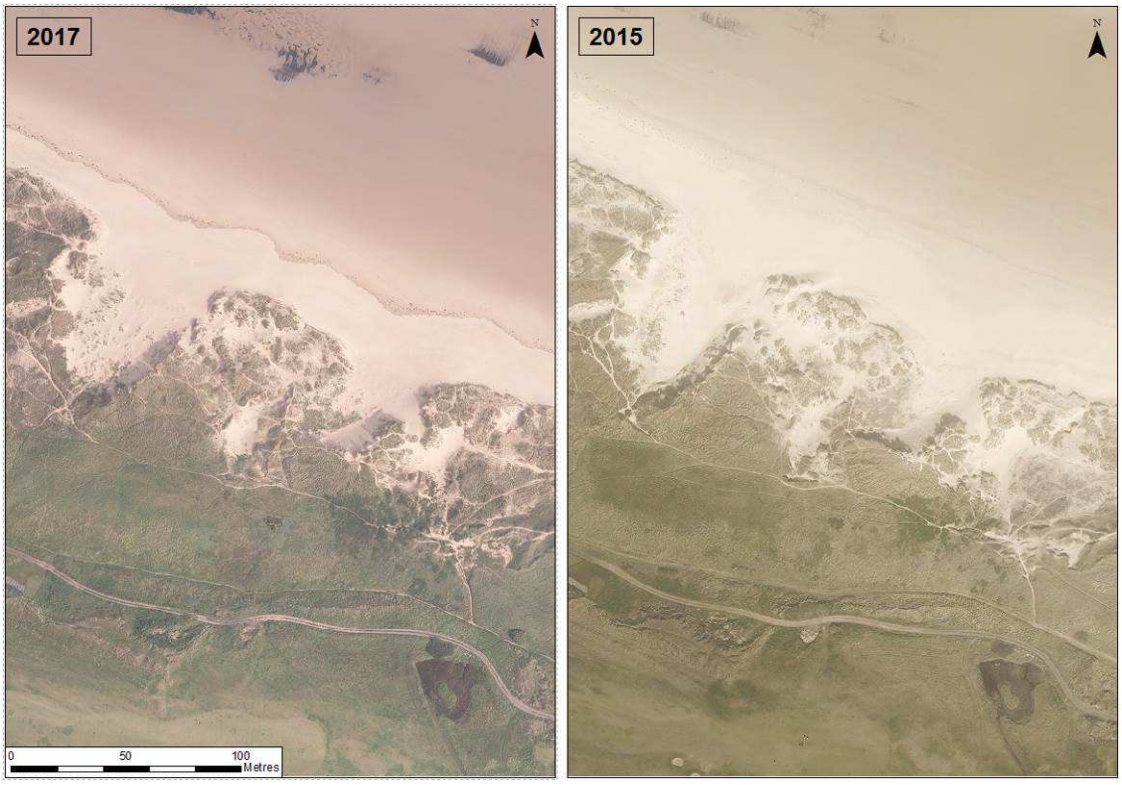

Figure 17 – Damage to dunes along Coatham Sands in 2017 (left) and 2015 (right)

Figure 18 – Dune condition fronting western section of caravan park along Majuba Area in 2017 (left) and 2015 (right)

Figure 19 – Dune condition fronting eastern section of caravan park along Majuba Area in 2017 (left) and 2015 (right)

3. Historic Maps

OS One Inch, 1885 – 1903

In the first available historic map, the morphology of the Tees estuary is very different from the present day, with extensive areas of inter-tidal mud flat and salt marsh exposed at low tide, especially across Seal Sands and Bran Sands.

South Gare appears to be a natural spit at the mouth of the Tees estuary, with rail tracks along its length. The German Charlies slag banks were not present in the nearshore zone at this time and so the sand accumulated in the lee of the spit was more parallel with the spit than in the present day (the beach immediately in the lee of the German Charlies has built out as a small embayment in the present day).

At the root of the spit the Mean High Water (MHW) mark was in a considerably more landward position than in the present day, indicating that sand dune accretion has occurred at this western end of the frontage over the long term. However, this accretion has not only occurred in the vicinity of the spit at Tees Mouth; along the whole length between the spit and what is now known as the Majuba Road car park the historic MHW line was more landward than in the present day (although the width of progradation decreases with progression to the east so that the historic MHW mark is very close to the present day in the vicinity of the caravan park).

The line of MHW is not a smooth 'bay' shape, but does have some jagged undulations towards the western section, perhaps indicating some differences in the topography or maybe even a former channel mouth.

Conversely, along Majuba Road towards Redcar (and beyond to the east), the historic MHW mark was more seaward than in the present day, indicating net recession of the shore in this area.

OS Six Inch, 1888 – 1913 & OS 25 Inch, 1892 - 1914
The improved scale of the OS six inch mapping from a similar period, shows the South Gare Breakwater clearly present and the dunes in the vicinity of the present day caravan park named as Coatham Bank. The MHW mark was considerably landward of its present day position from Tees Mouth to the present day caravan park, indicating accretion along this length, with recession evident further to the east. The point at which the dunes switch from accretion to erosion between the historic maps and the present day is exactly at the western end of the Majuba Road car park.

OS 1:25,000, 1937 – 1961 & OS One Inch 7th Series, 1955 - 1961
By the time of this map, the German Charlies had been placed and started to modify the morphology of the dunes in their lee. The jagged undulation in line of MHW was particularly pronounced just to the west of Warrenby Slag Works which by now were present (and presumably responsible for the German Charlies slag banks).

Even at this time, the MHW was landward of its present day position along most of the frontage, but the 'switch-point' between the accretion and erosion had migrated to the western end of the caravan park. This indicates that the caravan park frontage has been under some pressure since around the mid 1950s.

4. Conclusions

Analysis of historic maps from the National Library of Scotland website (which contains historic maps for the whole of the UK) and aerial photographs from the Cell 1 Regional Coastal Monitoring Programme reveals the following key findings:

- Coatham Sands has, in places along its length, been strongly influenced by historic deposition of slag from local ironworks. This means that large parts of the dunes must be a mix (in some manner) of slag deposits and natural marine-deposited and subsequently wind-blown sand.

- Accretion due to natural processes and/or progradation due to slag deposition has particularly been observed to the immediate east of South Gare, but is evident to some extent along the whole of Coatham Sands until reaching the Majuba car park. These processes were exacerbated when slag was deposited off the South Gare thereby creating the German Charlies which caused even calmer conditions conducive to natural accretion of sand at the western end.

- The most vulnerable section of Coatham Sands is undoubtedly the Majuba area. Historically, to the west of the car park the frontage experienced progradation and to the east (along the car park frontage) it experienced recession. However, the zone of transition between progradation and recession appears to have migrated westwards over time, meaning that more of the caravan park frontage and area to the immediate west has been exposed.

- However, the 'scalloped' nature of some sections of the dunes, especially towards the eastern end, has existed for some considerable time and cannot be ascribed to the effects of the December 2003 or January 2017 storms alone.

- The Majuba area, where it is understood there is an historic landfill at the core of the dunes with a covering of wind-blown sand, does appear to have lost vegetation (marginally) between 1999 and 2009 (Figure 20), perhaps due to local blow outs or storm erosion. However, the broad configuration of the dunes here has been roughly in its present condition consistently, with only minor changes, for some considerable time as shown by the similarities between the 2009 and 2017 photography (Figure 20). From previous field visits it is known that the historic waste material has become exposed on the seaward face where the covering of blown sand is absent, but this is not visible from the aerial photography.

Figure 20 - Majuba Area, 1999 (top), 2009 (middle) and 2017 (bottom)

APPENDIX 2: PINS RIES ANNEX 2 WITH APPLICANT'S UNDERSTANDING OF NE POSITION

Table A1.1: Teesmouth and Cleveland Coast SPA and Ramsar site

FEATURE	POTENTIAL IMPACT (C, O AND D UNLESS OTHERWISE STATED)	LSE?		AEoI?	
		APPLICANT'S CONCLUSION (ALONE OR IN COMBINATION)	AGREEMENT WITH ANCB?	APPLICANT'S CONCLUSION (ALONE OR IN COMBINATION)	AGREEMENT WITH ANCB?
Common tern Pied avocet Ruff Redshank Sandwich tern	HDD collapse (C)	Y	Y	N	Y
	Loss of FLL (C and D)	Y	Y	N	N – NE to confirm position after D5 and D6a updates
	Visual disturbance (C and D)	Y	Y	N	N – NE to confirm position after D5 and D6a updates
	Visual disturbance (O)	X	N	N/A	N/A
	Noise disturbance (C and D)	Y	Y	N	? – NE to confirm position after D6a updates
	Noise disturbance (O)	N	N	N/A	N/A
	Atmospheric pollution (C and D)	Y	Y	N	? – NE to confirm position

FEATURE	POTENTIAL IMPACT (C, O AND D UNLESS OTHERWISE STATED)	LSE?		AEoI?	
		APPLICANT'S CONCLUSION (ALONE OR IN COMBINATION)	AGREEMENT WITH ANCB?	APPLICANT'S CONCLUSION (ALONE OR IN COMBINATION)	AGREEMENT WITH ANCB?
	Atmospheric pollution (O)	N (alone) Y (in combination)	? – NE to confirm position after D5 updates	N (alone and in combination)	? – NE to confirm position after D5 updates
	Water quality	Y	Y	N	Y
	Coastal squeeze	X	Y	N/A	N/A
	In-combination effects	Y	Y	N	? – NE to confirm position after D5 and D6a updates
Little tern	HDD collapse (C)	Y	Y	N	Y
	Loss of FLL (C and D)	X	Y – however NE to confirm position	N/A	N/A
	Visual disturbance	X	Y – however NE to confirm position	N/A	N/A
	Noise disturbance	X	Y – however NE to confirm position	N/A	?
	Atmospheric pollution (C and D)	Y	Y	N	? NE to review information provided at Deadline 5

FEATURE	POTENTIAL IMPACT (C, O AND D UNLESS OTHERWISE STATED)	LSE?		AEoI?	
		APPLICANT'S CONCLUSION (ALONE OR IN COMBINATION)	AGREEMENT WITH ANCB?	APPLICANT'S CONCLUSION (ALONE OR IN COMBINATION)	AGREEMENT WITH ANCB?
	Atmospheric pollution (O)	Y (in combination N (alone)	N (alone)	N (in-combination) N (alone)	? NE to review information provided at Deadline 5
	Water quality	Y	Y	N	Y
	Coastal squeeze	x	Y	N/A	Y
	In-combination effects	Y (air quality only)	Y	N	? NE to review air quality information provided at Deadline 5.
Knot	HDD collapse (C)	Y	Y	N	Y
	Loss of FLL (C and D)	N	? – NE to confirm position	N/A	N/A
	Visual disturbance (C and D)	Y	Y	N	? NE to confirm position
	Visual disturbance (O)	N	?	N/A	N/A
	Noise disturbance (C and D)	Y	Y	N	? NE to confirm position

FEATURE	POTENTIAL IMPACT (C, O AND D UNLESS OTHERWISE STATED)	LSE?		AEoI?	
		APPLICANT'S CONCLUSION (ALONE OR IN COMBINATION)	AGREEMENT WITH ANCB?	APPLICANT'S CONCLUSION (ALONE OR IN COMBINATION)	AGREEMENT WITH ANCB?
	Noise disturbance (O)	N	N	N/A	N/A
	Atmospheric pollution (C and D)	Y	Y	N	? – NE to confirm position
	Atmospheric pollution (O)	N (alone) Y (in combination)	N (alone) Y (in combination)	N (alone) N (in combination)	? – NE to review information provided at D5
	Water quality	Y	Y	N	Y
	Coastal squeeze	N	Y	N/A	N/A
	In-combination effects	Y	Y	N	? - NE to review information provided at D5 and D6a
Waterbird assemblage	HDD collapse (C)	Y	Y	N	Y
	Loss of FLL (C and D)	Y	Y	N	? – NE to review annex J provided at Deadline 6a
	Visual disturbance (C and D)	Y	Y	N	? – NE to review additional modelling

FEATURE	POTENTIAL IMPACT (C, O AND D UNLESS OTHERWISE STATED)	LSE?		AEoI?	
		APPLICANT'S CONCLUSION (ALONE OR IN COMBINATION)	AGREEMENT WITH ANCB?	APPLICANT'S CONCLUSION (ALONE OR IN COMBINATION)	AGREEMENT WITH ANCB?
					provided at deadline 6a.
	Visual disturbance (O)	X	N	N/A	N/A
	Noise disturbance	Y (all assemblage)	? – NE to review Annex J	N	? – NE to review annex J provided at Deadline 6a
	Atmospheric pollution (C and D)	Y	Y	N	? – NE to review information provided at deadline 5
	Atmospheric pollution (O)	N (alone) Y (in combination)	? – NE to review information provided at Deadline 5	N (alone and in combination)	? – NE to review information provided at Deadline 5
	Water quality	Y	Y	N	Y
	Coastal squeeze	X	Y	N/A	N/A
	In-combination effects	Y	Y	N	? – NE to review information provided at Deadline 5 and deadline 6a

Table A1.2: North York Moors SAC

FEATURE	POTENTIAL IMPACT (O UNLESS OTHERWISE STATED)	LSE?		AEoI?	
		APPLICANT'S CONCLUSION (ALONE OR IN COMBINATION)	AGREEMENT WITH ANCB?	APPLICANT'S CONCLUSION (ALONE OR IN COMBINATION)	AGREEMENT WITH ANCB?
Northern Atlantic wet heaths with Erica tetralix European dry heaths Blanket Bogs	Atmospheric pollution In-combination effects	X	Y - however NE to confirm position	N/A	N/A

Table A1.3: North Yorks Moors SPA

FEATURE	POTENTIAL IMPACT (O UNLESS OTHERWISE STATED)	LSE?		AEoI?	
		APPLICANT'S CONCLUSION (ALONE OR IN COMBINATION)	AGREEMENT WITH ANCB?	APPLICANT'S CONCLUSION (ALONE OR IN COMBINATION)	AGREEMENT WITH ANCB?
Merlin Golden plover	Atmospheric pollution In-combination effects	X	Y – however NE to confirm position	N/A	N/A

Table A1.4: Durham Coast SAC

FEATURE	POTENTIAL IMPACT (O UNLESS OTHERWISE STATED)	LSE?		AEoI?	
		APPLICANT'S CONCLUSION (ALONE OR IN COMBINATION)	AGREEMENT WITH ANCB?	APPLICANT'S CONCLUSION (ALONE OR IN COMBINATION)	AGREEMENT WITH ANCB?
Vegetated sea cliffs of the Atlantic and Baltic coasts	Atmospheric pollution In-combination effects	X	Y	N/A	N/A

Table A1.5: Northumbria Coast SPA and Ramsar site

FEATURE	POTENTIAL IMPACT (C, O AND D UNLESS OTHERWISE STATED)	LSE?		AEoI?	
		APPLICANT'S CONCLUSION (ALONE OR IN COMBINATION)	AGREEMENT WITH ANCB?	APPLICANT'S CONCLUSION (ALONE OR IN COMBINATION)	AGREEMENT WITH ANCB?
Purple sandpiper Ruddy turnstone Little tern	Atmospheric pollution In-combination Effects	X	Y – however NE to confirm position	N/A	N/A

Table A1.6: Berwickshire and North Northumberland Coast SAC

FEATURE	POTENTIAL IMPACT (C AND D UNLESS OTHERWISE STATED)	LSE?		AEoI?	
		APPLICANT'S CONCLUSION (ALONE OR IN COMBINATION)	AGREEMENT WITH ANCB?	APPLICANT'S CONCLUSION (ALONE OR IN COMBINATION)	AGREEMENT WITH ANCB?
Mudflats and sand flats not covered by seawater at low tide Large shallow inlets and bays Reefs Submerged or partially submerged sea caves	Disturbance in functionally linked habitat In-combination effects	N/A	Y	N/A	N/A
Grey seal	Disturbance in functionally linked habitat In-combination effects	Y	Y	N	Y

Table A1.7: Humber Estuary SAC

FEATURE	POTENTIAL IMPACT (C AND D UNLESS OTHERWISE STATED)	LSE?		AEoI?	
		APPLICANT'S CONCLUSION (ALONE OR IN COMBINATION)	AGREEMENT WITH ANCB?	APPLICANT'S CONCLUSION (ALONE OR IN COMBINATION)	AGREEMENT WITH ANCB?
Estuaries Mudflats and sandflats not covered by seawater at low tide Sandbanks which are slightly covered by sea water all the time Coastal lagoons Salicornia and other annuals colonizing mud and sand Atlantic salt meadows Embryonic shifting dunes Shifting dunes along the shoreline with Ammophila arenaria (white dunes)	Disturbance in functionally linked habitat In-combination effects	N/A	Y	N/A	N/A

FEATURE	POTENTIAL IMPACT (C AND D UNLESS OTHERWISE STATED)	LSE?		AEoI?	
		APPLICANT'S CONCLUSION (ALONE OR IN COMBINATION)	AGREEMENT WITH ANCB?	APPLICANT'S CONCLUSION (ALONE OR IN COMBINATION)	AGREEMENT WITH ANCB?
Fixed coastal dunes with herbaceous vegetation (grey dune) Dunes with Hippopha rhamnoides					
River lamprey	Disturbance in functionally linked habitat In-combination effects	X	Y	N/A	N/A
Sea lamprey	Disturbance in functionally linked habitat	Y	Y	N	Y
	In-combination effects	X	Y	N/A	N/A
Grey seal	Disturbance in functionally linked habitat	Y	Y	N	Y
	In-combination effects	X	Y	N/A	N/A

Table A1.8: Southern North Sea SAC

FEATURE	POTENTIAL IMPACT (C AND D UNLESS OTHERWISE STATED)	LSE?		AEoI?	
		APPLICANT'S CONCLUSION (ALONE OR IN COMBINATION)	AGREEMENT WITH ANCB?	APPLICANT'S CONCLUSION (ALONE OR IN COMBINATION)	AGREEMENT WITH ANCB?
Harbour porpoise	Disturbance in functionally linked habitat In-combination effects	X	Y – although NE to confirm position	N/A	N/A

Table A1.9: The Wash and North Norfolk Coast SAC

FEATURE	POTENTIAL IMPACT (C AND D UNLESS OTHERWISE STATED)	LSE?		AEoI?	
		APPLICANT'S CONCLUSION (ALONE OR IN COMBINATION)	AGREEMENT WITH ANCB?	APPLICANT'S CONCLUSION (ALONE OR IN COMBINATION)	AGREEMENT WITH ANCB?
Sandbanks which are slightly covered by sea water all the time Mudflats and sandflats not covered by seawater at low tide	Disturbance in functionally linked habitat In-combination effects	N/A	Y	N/A	N/A

FEATURE	POTENTIAL IMPACT (C AND D UNLESS OTHERWISE STATED)	LSE?		AEoI?	
		APPLICANT'S CONCLUSION (ALONE OR IN COMBINATION)	AGREEMENT WITH ANCB?	APPLICANT'S CONCLUSION (ALONE OR IN COMBINATION)	AGREEMENT WITH ANCB?
Large shallow inlets and bays Reefs Salicornia and other annuals colonizing mud and sand Atlantic salt meadows Mediterranean and thermo- Atlantic halophilous scrubs Coastal lagoons					
Harbour seal	Disturbance in functionally linked habitat In-combination effects	Y	Y	N	Y
Otter	Disturbance in functionally linked habitat In-combination effects	N	Y	N/A	N/A

Table A1.10: River Tweed SAC

FEATURE	POTENTIAL IMPACT (C AND D UNLESS OTHERWISE STATED)	LSE?		AEoI?	
		APPLICANT'S CONCLUSION (ALONE OR IN COMBINATION)	AGREEMENT WITH ANCB?	APPLICANT'S CONCLUSION (ALONE OR IN COMBINATION)	AGREEMENT WITH ANCB?
Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation	Disturbance in functionally linked habitat In-combination effects	N/A	Y	N/A	N/A
Atlantic salmon Sea lamprey	Disturbance in functionally linked habitat In-combination effects	Y	Y	N	Y
Otter Brook lamprey River lamprey	Disturbance in functionally linked habitat In-Combination effects	N	Y	N/A	N/A

Table A1.11: Tweed Estuary SAC

FEATURE	POTENTIAL IMPACT (C AND D UNLESS OTHERWISE STATED)	LSE?		AEoI?	
		APPLICANT'S CONCLUSION (ALONE OR IN COMBINATION)	AGREEMENT WITH ANCB?	APPLICANT'S CONCLUSION (ALONE OR IN COMBINATION)	AGREEMENT WITH ANCB?
Estuaries Mudflats and sandflats not covered by seawater at low tide	Disturbance in functionally linked habitat In-combination Effects	N/A	Y	N/A	N/A
Sea lamprey	Disturbance in functionally linked habitat In-combination effects	Y	Y	N	Y
River lamprey	Disturbance in functionally linked habitat In-combination effects	X	Y	N/A	N/A

APPENDIX 3: SIZEWELL CASE

Cell 1 Coatham Dunes Report 2018

A great place to live, work & play

March 2018

Scarborough Borough Council

Cell 1 Regional Coastal Monitoring Programme
Coatham Dunes Report 2018

Contents Amendment Record

This report has been issued and amended as follows:

Issue	Revision	Description	Date	Authorised
1	0	First issue	23/03/2018	[redacted]
1	1	Minor typographic edits	26/03/2018	

Contents

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Preamble

The Cell 1 Regional Coastal Monitoring Programme covers approximately 300km of the northeast coastline, from the Scottish Border (just south of St. Abb's Head) to Flamborough Head in East Yorkshire. This coastline is often referred to as 'Coastal Sediment Cell 1' in England and Wales (Figure 0-1). Within this frontage the coastal landforms vary considerably, comprising low-lying tidal flats with fringing salt marshes, hard rock cliffs that are mantled with glacial till to varying thicknesses, softer rock cliffs, and extensive landslide complexes.

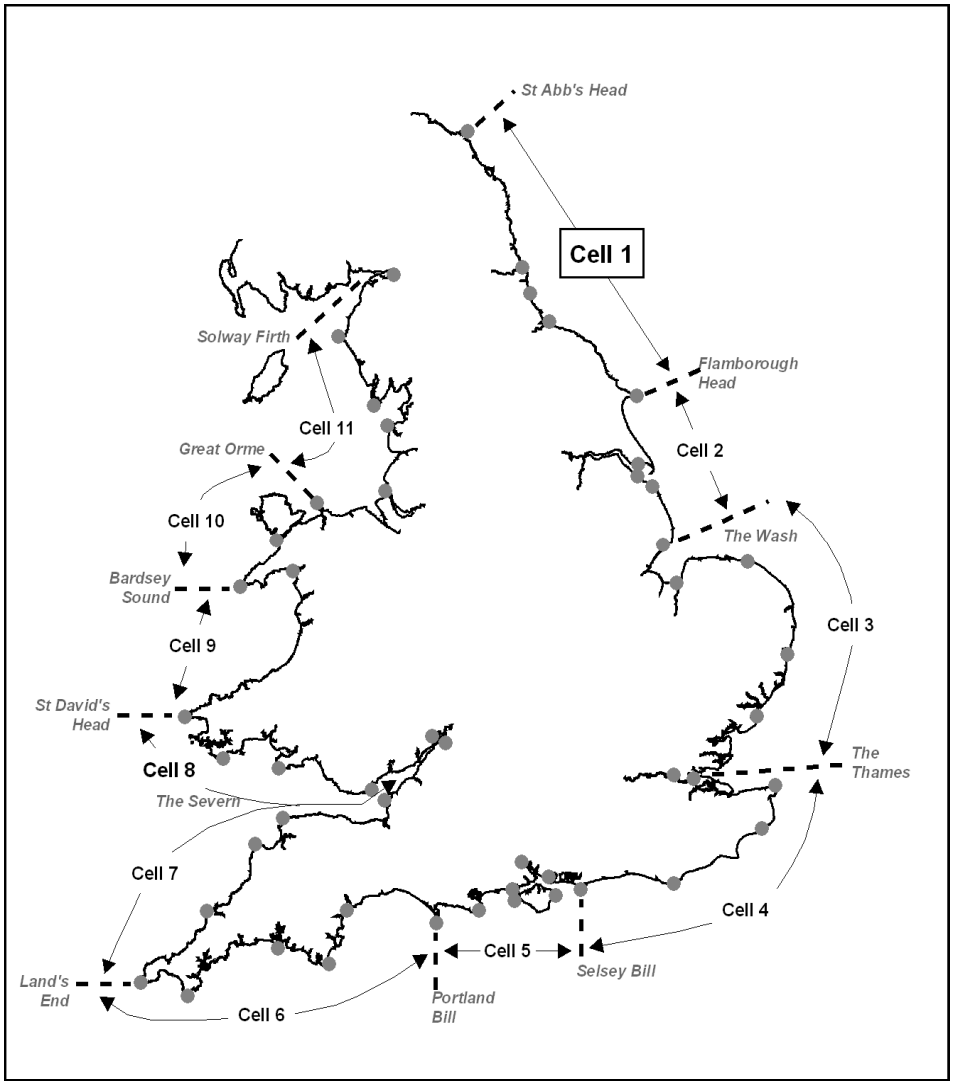

Figure 0-1 - Sediment Cells in England and Wales

The programme commenced in its present guise in September 2008 and is managed by Scarborough Borough Council on behalf of the North East Coastal Group. It is funded by the Environment Agency, working in partnership with the following organisations.

The main elements of the Cell 1 Regional Coastal Monitoring Programme involve:

- beach profile surveys
- topographic surveys
- cliff top recession surveys
- real-time wave data collection
- bathymetric and sea bed characterisation surveys
- aerial photography
- LiDAR survey
- walk-over inspection surveys

Royal HaskoningDHV has been appointed to provide Analytical Services in relation to the Cell 1 Regional Coastal Monitoring Programme 2016 - 2021.

Separate reports are produced for elements of the programme as and when specific components are undertaken, such as beach profile, topographic and cliff top surveys, wave data collection, bathymetric and sea bed characterisation surveys, and walk-over inspection surveys.

The present report is in addition to the above regular reports and covers a bespoke analysis of the coastal changes along the dunes at Coatham Sands in the borough of Redcar & Cleveland.

1. Introduction

The purpose of this report is to provide findings from a review of historic and contemporary maps and aerial photos to determine changes in land use and coastal erosion at the dunes along Coatham Sands, in the borough of Redcar & Cleveland.

All available aerial photos (historic and contemporary) from the Cell 1 Regional Coastal Monitoring Programme were downloaded from the North East Coastal Observatory website and viewed 'side by side' in ArcGIS to identify, describe and, where sufficient coastal change exists, quantify changes in the dunes along Coatham Sands, paying particular attention to the Majuba area towards the east of the frontage and any areas of identified change post 2013 and 2017 storm surges.

In addition, the selection of historic maps that is available from the National Library of Scotland website (which contains historic maps for the whole of the UK) was viewed on-screen for similar changes. [Note that the historic maps are not reproduced in this report due to copyright reasons].

2. Aerial Photography

1940

In the 1940 aerial imagery, the dunes adjacent to South Gare had not built out along the seaward edge of the spit in the manner that is observed in the present day, but instead occupied a bulbous shape, with a distinct ingress of sea water into a saline lagoon, with only a thin azimuth of land between the lagoon and the Bran Sands area of the River Tees estuary (Figure 1).

The Warrenby Slag Works are present in the 1940 imagery and slag deposits appear to push the shoreline seaward in locations immediately adjacent to the works, although the coastline here was still somewhat landward of its present day position in 1940 (Figure 2).

In the Majuba area, the present day caravan park had not been constructed in 1940 and whilst a seawall appeared to be present from the Redcar frontage towards the area of the present day Majuba car park, the car park itself was also not constructed at this time (Figures 3 & 4). It is notable that the dunes at this location were experiencing some vegetation loss and encroachment by the sea in the 1940s, even before the caravan park was built on this area.

Figure 1 – South Gare, 1940 (left) and 2017 (right)

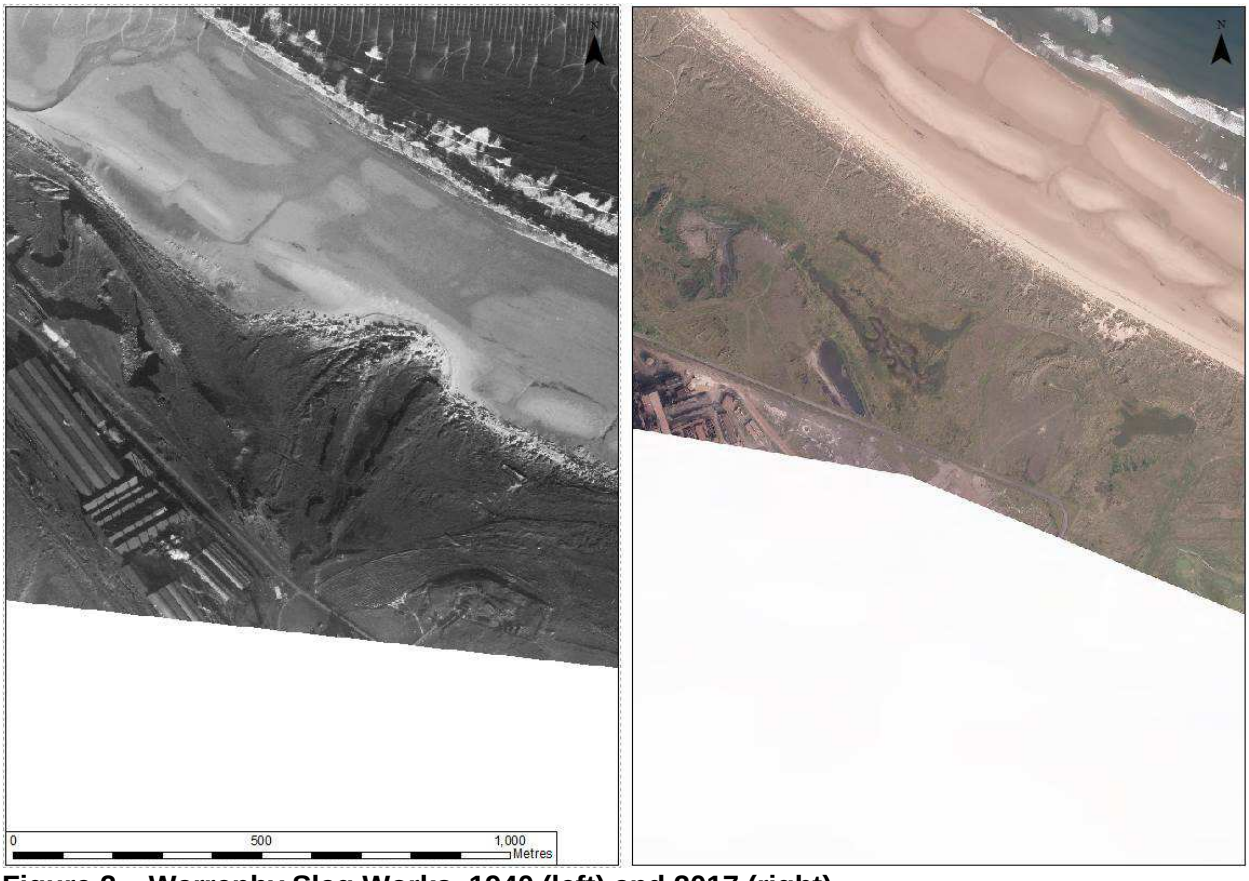

Figure 2 – Warrenby Slag Works, 1940 (left) and 2017 (right)

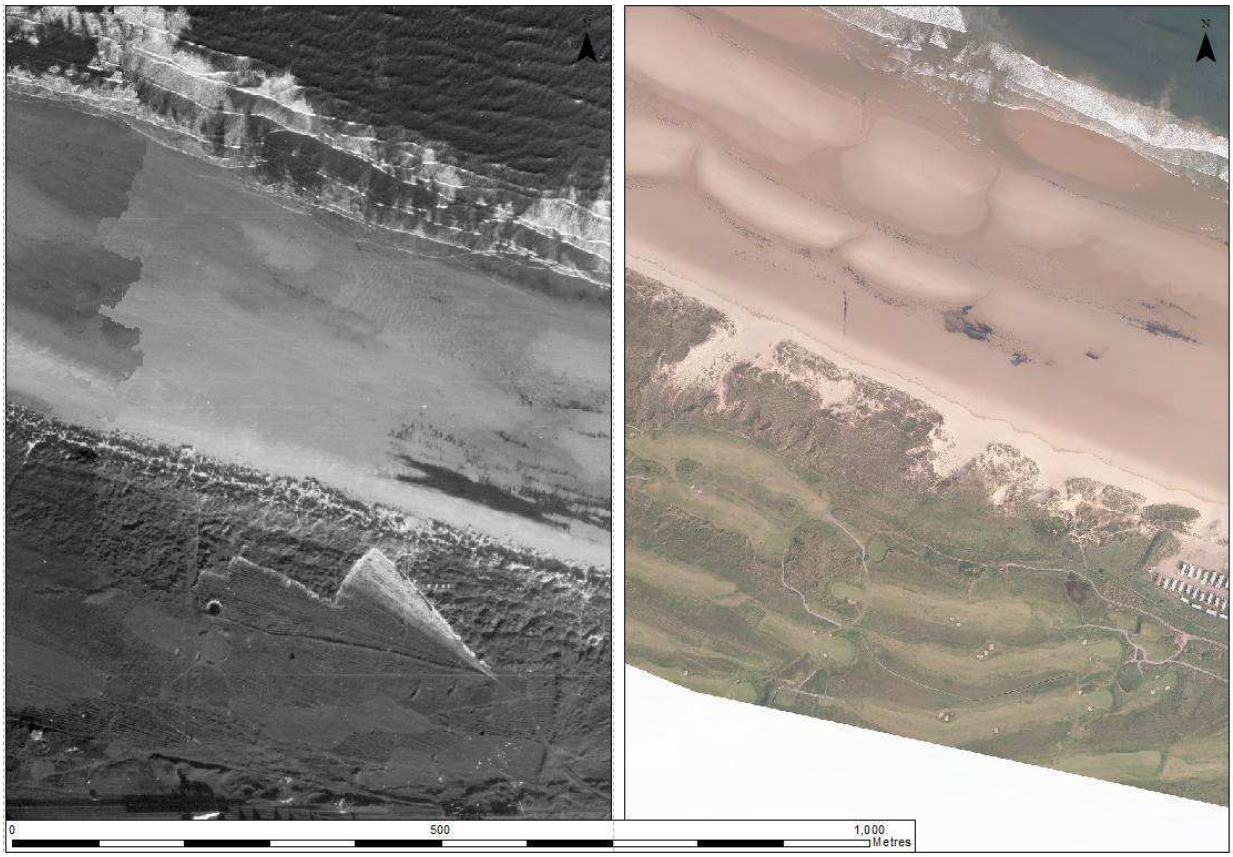

Figure 3 – Majuba Area (west), 1940 (left) and 2017 (right)

Figure 4 – Majuba Area (east), 1940 (left) and 2017 (right)

1999

By the time of the next available aerial photography from the Cell 1 Regional Coastal Monitoring Programme in 1999, the shore adjacent to the South Gare was undergoing change (Figure 5). It appears that sand or slag may have been artificially deposited to the east of the South Gare at this time, although the present day alignment had not yet been fully attained.

There had been continued progradation of the shore in the centre of the frontage, in the vicinity of the Warrenby Slag Works and the frontage by 1999 was appearing much more like a 'natural' dune system, with vegetated sand at the seaward limit, as opposed to a probable sand/slag mix present at the shore face in 1940 (Figure 6).

Both the caravan park and the car park had been constructed in the Majub area by 1999.

Figure 5 – South Gare, 1999 (left) and 2017 (right)

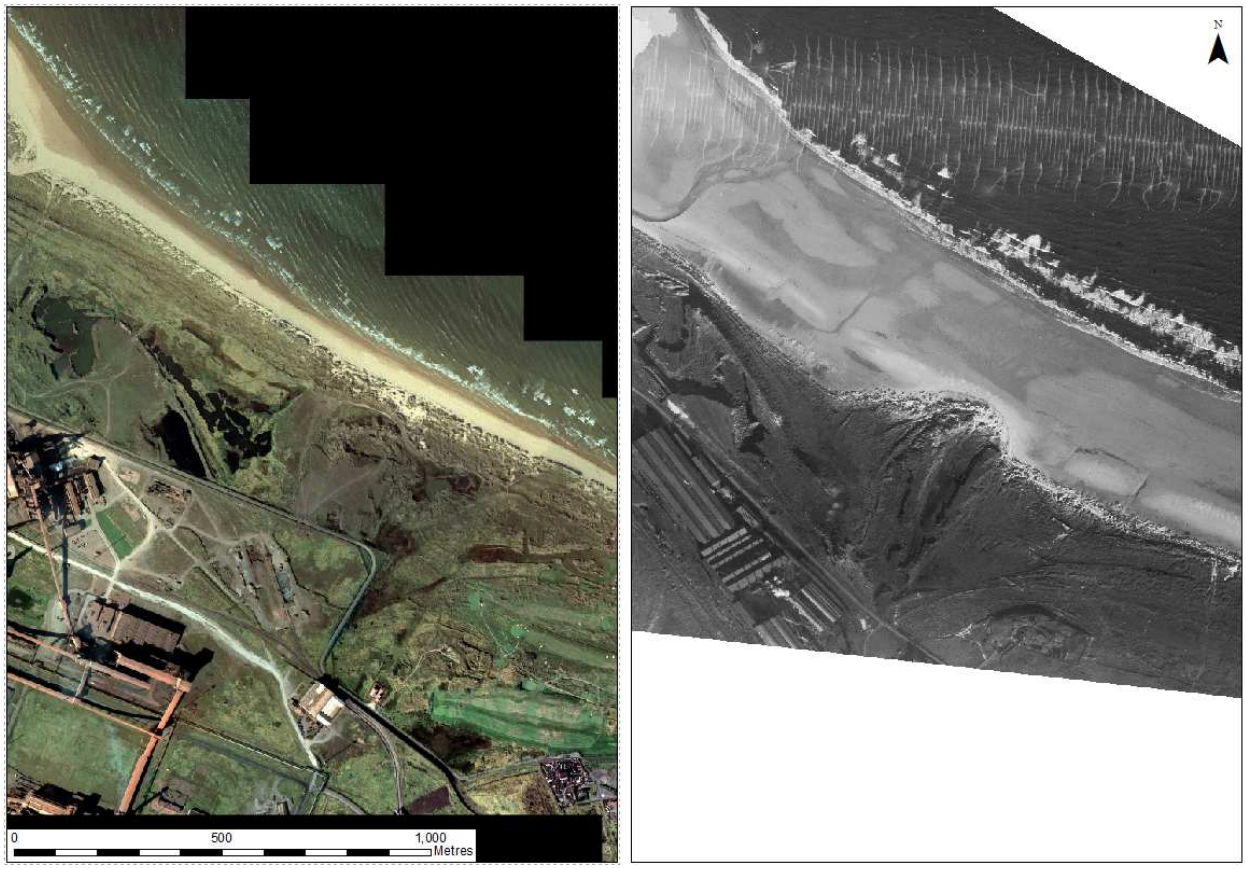

Figure 6 – Warrenby Slag Works, 1999 (left) and 1940 (right)

2009

By 2009, the shore adjacent to South Gare had continued to experience change, again likely in the form of sand/slag deposition and, due to the presence of the German Charlies in the nearshore, natural sand deposition in the now-sheltered areas. This resulted in quite a growth in the shore adjacent to the South Gare and stability in the dunes at the western end of the frontage (Figure 7).

Elsewhere along the frontage there was little change from 1999 to 2009, other than some exacerbation of areas of blow outs or bare dune vegetation to the immediate west of the caravan park in the Majuba area (Figure 8).

Figure 7 – South Gare, 2009 (left) and 1999 (right)

Figure 8 – Worsening of blow outs along eastern Coatham Sands, 2009 (left) and 1999 (right)

2010
There was little discernable change along the dunes in Coatham Sands between 2009 and 2010.

2012
The shore adjacent to South Gare appeared to contain greater quantities of material (sand/slag) and was more widely vegetated in 2012 than in 2010 (Figure 9).

At the Majuba area (Figures 10 & 11), part of the dunes adjacent to the caravan park were covered with hard-top and being used for car parking and portacabins in 2012. Presumably this was the Contractor's compund for the duration of construction of the Redcar Sea Defence Scheme. It is also noticeable that the seaward row of caravans seen in the 2010 imagery had been removed by 2012, indicating a risk from erosion or sea flooding at that time.

Figure 9 – South Gare, 2012 (left) and 2010 (right)

Figure 10 – Majuba Area (west), 2012 (left) and 2010 (right)

Figure 11 – Majuba Area (east), 2012 (left) and 2010 (right)

2015

The shore adjacent to South Gare showed some further growth between 2012 and 2015 (Figure 12), but elsewhere along the Coataham Sands frontage there was no significant difference in the shore between the 2012 and 2015 imagery, indicating that if the December 2013 storm did cause localised damage, there had been natural recovery by 2015.

Following completion of the Redcar Sea Defence Scheme, the Contractor's portacabins at the caravan park in the Majuba area had been removed by 2015, but the hard-top remained intact. The most seaward row of caravans seen in the 2015 imagery had been restored since being (temprarily) removed before the 2012 imagery (Figure 13).

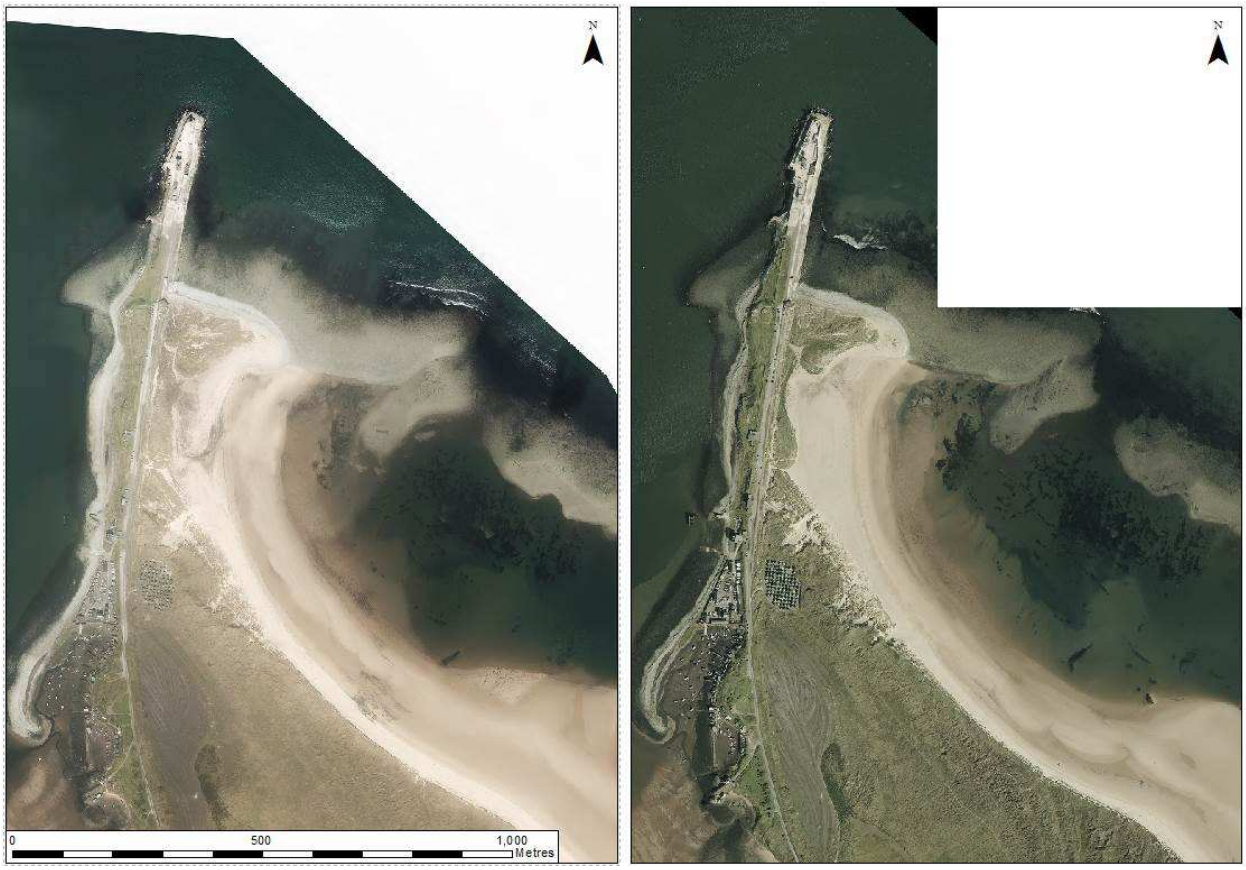

Figure 12 – South Gare, 2015 (left) and 2012 (right)

Figure 13 – Majuba Area, 2015 (left) and 2012 (right)

2017

In the immediate lee of the South Gare breakwater, the trend continued to be one of accretion in the shelter of the structure, with a notable increase in the extent of dune vegetation (Figure 14). Some areas of 'scalloped' dune evident in the 2017 aerial photography was also present in the photography that was collected in 2015 and appears not to have worsened. Arguably in some areas (e.g. Figure 15) it may have marginally recovered, although remaining heavily scalloped.

Some areas that were anecdotally described as 'breaching' or 'severely eroding' during the January 2017 storms, were clearly in such a state before the 2015 photography was collected and thus the damage to these dunes cannot be ascribed to the January 2017 storms alone (Figures 16 to 2-10).

Figure 14 – Vegetation growth on dunes in the lee of South Gare Breakwater between 2017 (left) and 2015 (right)

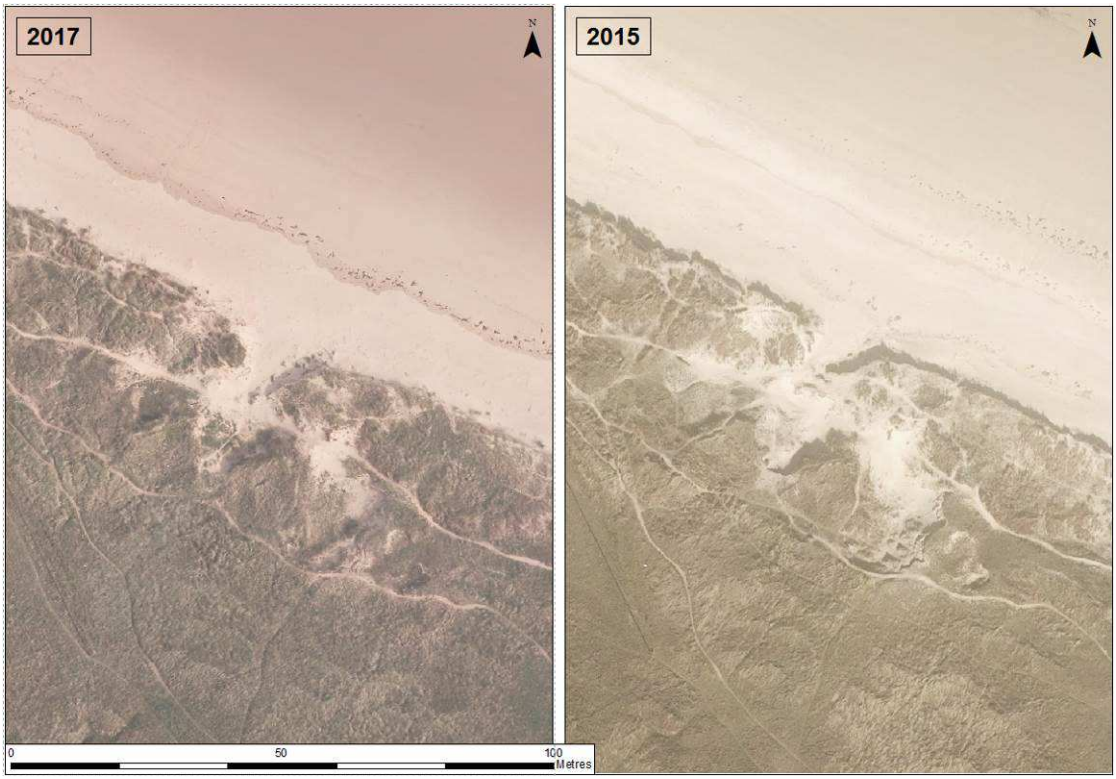

Figure 15 – 'Scalloping' of dunes along Coatham Sands in 2017 (left) and 2015 (right)

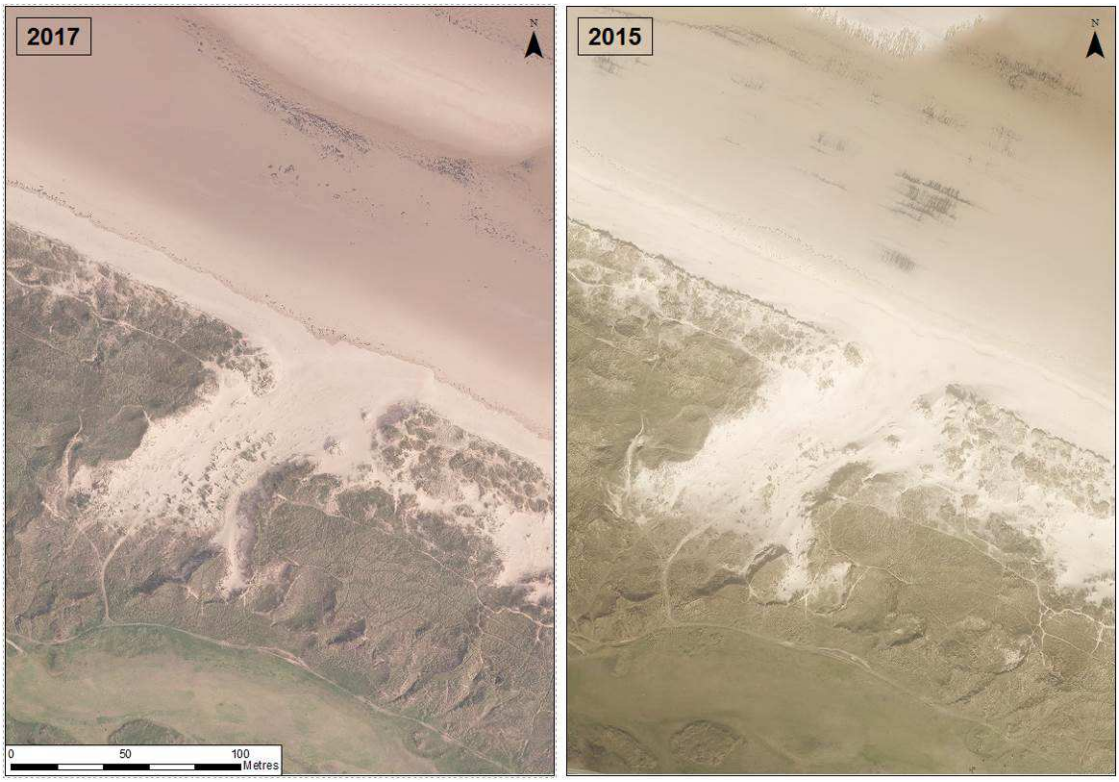

Figure 16 – Damage to dunes along Coatham Sands in 2017 (left) and 2015 (right)

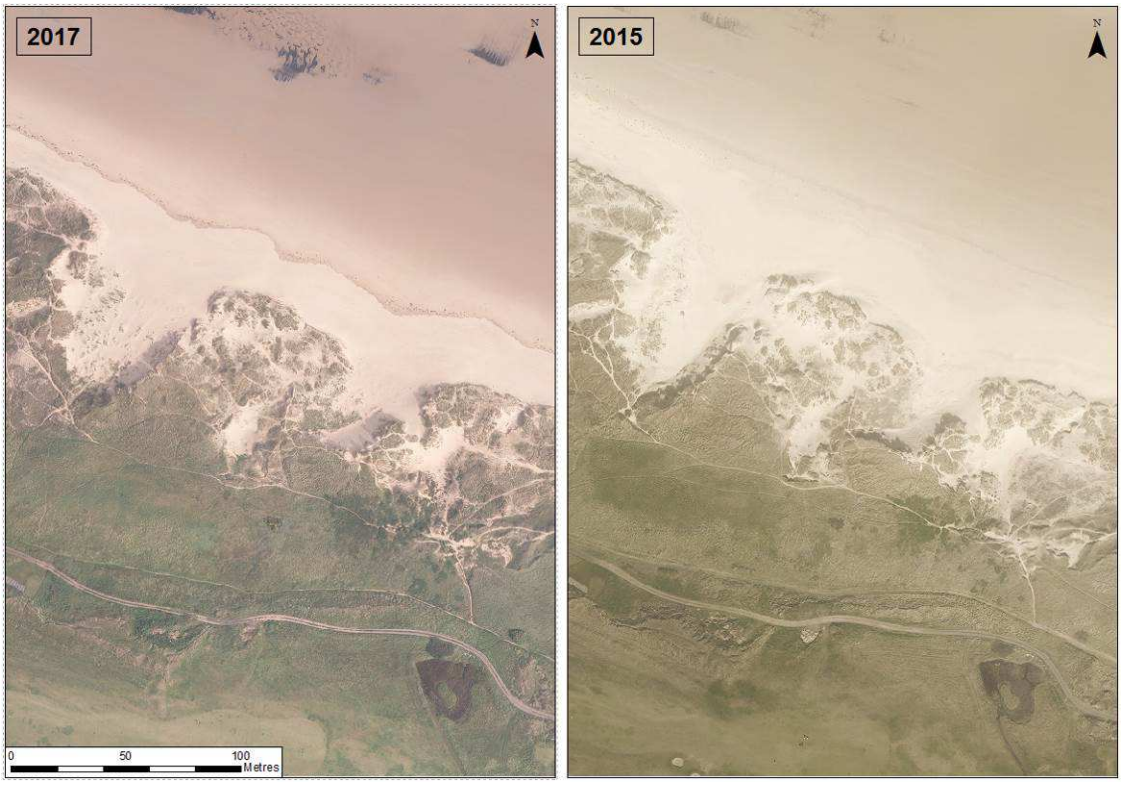

Figure 17 – Damage to dunes along Coatham Sands in 2017 (left) and 2015 (right)

Figure 18 – Dune condition fronting western section of caravan park along Majuba Area in 2017 (left) and 2015 (right)

Figure 19 – Dune condition fronting eastern section of caravan park along Majuba Area in 2017 (left) and 2015 (right)

3. Historic Maps

OS One Inch, 1885 – 1903

In the first available historic map, the morphology of the Tees estuary is very different from the present day, with extensive areas of inter-tidal mud flat and salt marsh exposed at low tide, especially across Seal Sands and Bran Sands.

South Gare appears to be a natural spit at the mouth of the Tees estuary, with rail tracks along its length. The German Charlies slag banks were not present in the nearshore zone at this time and so the sand accumulated in the lee of the spit was more parallel with the spit than in the present day (the beach immediately in the lee of the German Charlies has built out as a small embayment in the present day).

At the root of the spit the Mean High Water (MHW) mark was in a considerably more landward position than in the present day, indicating that sand dune accretion has occurred at this western end of the frontage over the long term. However, this accretion has not only occurred in the vicinity of the spit at Tees Mouth; along the whole length between the spit and what is now known as the Majuba Road car park the historic MHW line was more landward than in the present day (although the width of progradation decreases with progression to the east so that the historic MHW mark is very close to the present day in the vicinity of the caravan park).

The line of MHW is not a smooth 'bay' shape, but does have some jagged undulations towards the western section, perhaps indicating some differences in the topography or maybe even a former channel mouth.

Conversely, along Majuba Road towards Redcar (and beyond to the east), the historic MHW mark was more seaward than in the present day, indicating net recession of the shore in this area.

OS Six Inch, 1888 – 1913 & OS 25 Inch, 1892 - 1914
The improved scale of the OS six inch mapping from a similar period, shows the South Gare Breakwater clearly present and the dunes in the vicinity of the present day caravan park named as Coatham Bank. The MHW mark was considerably landward of its present day position from Tees Mouth to the present day caravan park, indicating accretion along this length, with recession evident further to the east. The point at which the dunes switch from accretion to erosion between the historic maps and the present day is exactly at the western end of the Majuba Road car park.

OS 1:25,000, 1937 – 1961 & OS One Inch 7th Series, 1955 - 1961
By the time of this map, the German Charlies had been placed and started to modify the morphology of the dunes in their lee. The jagged undulation in line of MHW was particularly pronounced just to the west of Warrenby Slag Works which by now were present (and presumably responsible for the German Charlies slag banks).

Even at this time, the MHW was landward of its present day position along most of the frontage, but the 'switch-point' between the accretion and erosion had migrated to the western end of the caravan park. This indicates that the caravan park frontage has been under some pressure since around the mid 1950s.

4. Conclusions

Analysis of historic maps from the National Library of Scotland website (which contains historic maps for the whole of the UK) and aerial photographs from the Cell 1 Regional Coastal Monitoring Programme reveals the following key findings:

- Coatham Sands has, in places along its length, been strongly influenced by historic deposition of slag from local ironworks. This means that large parts of the dunes must be a mix (in some manner) of slag deposits and natural marine-deposited and subsequently wind-blown sand.

- Accretion due to natural processes and/or progradation due to slag deposition has particularly been observed to the immediate east of South Gare, but is evident to some extent along the whole of Coatham Sands until reaching the Majuba car park. These processes were exacerbated when slag was deposited off the South Gare thereby creating the German Charlies which caused even calmer conditions conducive to natural accretion of sand at the western end.

- The most vulnerable section of Coatham Sands is undoubtedly the Majuba area. Historically, to the west of the car park the frontage experienced progradation and to the east (along the car park frontage) it experienced recession. However, the zone of transition between progradation and recession appears to have migrated westwards over time, meaning that more of the caravan park frontage and area to the immediate west has been exposed.

- However, the 'scalloped' nature of some sections of the dunes, especially towards the eastern end, has existed for some considerable time and cannot be ascribed to the effects of the December 2003 or January 2017 storms alone.

- The Majuba area, where it is understood there is an historic landfill at the core of the dunes with a covering of wind-blown sand, does appear to have lost vegetation (marginally) between 1999 and 2009 (Figure 20), perhaps due to local blow outs or storm erosion. However, the broad configuration of the dunes here has been roughly in its present condition consistently, with only minor changes, for some considerable time as shown by the similarities between the 2009 and 2017 photography (Figure 20). From previous field visits it is known that the historic waste material has become exposed on the seaward face where the covering of blown sand is absent, but this is not visible from the aerial photography.

Figure 20 - Majuba Area, 1999 (top), 2009 (middle) and 2017 (bottom)