Carlyon Bay Environmental Statement (2011)

Chapter D

Water Resources

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Contents

D1.0 Introduction

D1.1 This Chapter comprises a number of separate but inter-related assessments identified for the water resources elements of the proposed development at Carlyon Bay. It includes consideration of beach morphology change and potential change in amenity area, potential issues associated with the realignment of Sandy River, flood risk (both coastal and fluvial), drainage for the proposed new development and potential changes to water quality.

D1.2 The assessment presented in this Chapter considers the scope of the water environment as defined in the Scoping Report (July 2010) (see Chapter B of this ES for further information) which is as follows:-

1 Beach and Sandy River morphology and amenity area;

2 Flood risk, including coastal, fluvial, pluvial and groundwater or overland flow flooding; and

3 Water quality.

D1.3 This Chapter draws on information contained within the Flood Risk Assessment ('FRA') of the proposed scheme, which is provided at Appendix D1.

D1.4 Reference is primarily made in this chapter to the 'natural baseline' when considering the effects of the proposed scheme. However, reference is also given to the extant scheme as a baseline comparison.

Structure

D1.5 The remaining sections of this Chapter are structured as follows:-

1 Section 2: Policy context;

2 Section 3: Assessment methodology – an overview of the methods and tools used to undertake the assessment;

3 Section 4: Baseline conditions – consideration is given to both to the natural baseline and also to the extant scheme;

4 Section 5: Potential effects – consideration of the effect of the proposals on the water environment as defined above. Both effects during construction and after completion are considered;

5 Section 6: Mitigation measures – where necessary measures that may be put in to in place to reduce and where possible remove impacts;

6 Section 7: Residual effects – identification of any effects on the water resources that remain after mitigation measures are in place;

7 Section 8: Summary and Conclusions;

8 Section 9: Abbreviations; and

9 Section 10: References.

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D2.0 Policy Context

Planning Policy Statement ('PPS') 25: Development and Flood Risk (2010)

D2.1 The sea defences have been designed to meet the requirements of PPS25: Development and Flood Risk. This has included the requirements set out within PPS25 to consider the effects of climate change and uncertainty.

Bathing Water Directive

D2.2 The proposed works have been assessed with regard to the Bathing Water Directive[1] ('BWD') (2006/7/EC) to ascertain whether there would be any adverse impact or change to the classification of designated Bathing Waters. The BWD sets out a number of microbiological and physico-chemical standards that Bathing Waters must either comply with ('Mandatory' standards) or endeavour to meet ('Guideline' standards). Classification assessment, by the Environment Agency, is against faecal indicator organism standards only.

Water Framework Directive

D2.3 The site has been considered in light of the Water Framework Directive ('WFD') (2000/60/EC), which is designed to enhance the status and prevent further deterioration of aquatic ecosystems; to reduce incidence of water pollution; and to mitigate the effects of flooding and drought. Under the WFD, assessment is made of the ecological potential and the chemical status of each waterbed. The site is located within the St. Austell WFD Waterbody.

Shoreline Management Plan ('SMP2')

D2.4 The SMP2 for this area of coast is in draft form and not yet formally released. CEG as a stakeholder has been consulted on the proposed wording. The adopted wording for Carlyon Bay is understood to be as follows:-

[1] Council of the European Communities 1976 Directive 76/160/EC (OJ No. L 31 5.2.1976) (concerning the quality of bathing water) as transposed into English and Welsh law through The Bathing Waters (Classification) Regulations (SI 1991 No. 1597) as amended by The Bathing Waters (Classification) (England) Regulations 2003 (SI 2003 No. 1238). Classification of bathing waters remains through the 1976 BWD until the end of the 2014 bathing season. Reporting of classification from 24 March 2015 onwards will be against the revised Bathing Waters Directive: Council of the European Communities 2006 Directive 2006/7/EC (OJ No. L 64 4.3.2006) (concerning the management of bathing water quality and repealing Directive 76/160/EEC) as transposed into English and Welsh law through the Bathing Water Regulations 2008 (SI 2008 No. 1097).

"Lying to the west of Par Docks, the Carlyon Bay frontage principally comprises three areas with beaches – Polgaver, Shorthorn and Crinnis. All three areas are man made, having been formed from material from the inland china clay workings, which was carried to Carlyon Bay by Sandy River since its diversion in about 1842. This 1.3 km frontage is relatively sheltered from the dominant westerly Atlantic swell and storm systems however it is still subject to high wave energy from the south and south-east periodically.

The mapping of erosion risks has indicated that there is unlikely to be significant horizontal movement of the high water position over the next 100 years (partly due to steepness of the current beach profile). Landward movement of MHW by up to 10m is possible due to sea level rise, but this tends to indicate that the shoreline position is relatively stable in the longer term. Flood mapping has however shown that areas of Polgaver, and to a lesser extent Shorthorn, are at risk during a 1:200 year tidal flooding event in 2105 (see inset map below).

An important consideration for the development of policy at Carlyon Bay is the extant planning permission which exists on Crinnis and Shorthorn. This dictates that the area may be subject to significant development pressures, immediately above the mean high water position. A large part of the area above MHW is effectively already brownfield at Crinnis Beach, given that it is the site of the now closed and un-maintained Cornwall Coliseum (Cornish Leisure World) and has a history of leisure development. However the extant permission would have a significantly larger footprint than the existing development, particularly when considering development above the mean high water position at Shorthorn Beach.

It is noted that Cornwall Council is in discussion with the landowner over aspirations of a revised development proposal reducing the footprint from the extant consent. Temporary defence (steel piles and rock armour) of the development site has been constructed along some 600m of Crinnis Beach. A suitable position for any permanent defensive line (which would need to be established to protect any development) would be critical to the long term overall sustainability of the foreshore. Ensuring that any structures are set far enough back from the predicted mean high water position in 2105 would be critical.

As the outcome of the final planning decision relating to the development proposals are unlikely to be known in time to inform the draft version of the SMP, at present it is difficult to either fully consider or discount the presence of development.

Whether a new development takes place or not the preferred plan and policy for Carlyon Bay is no active intervention across the three epochs. NAI represents an intention to implement a policy which will not adversely affect natural coastal processes. Because the beach form and present-day shoreline is seen as fairly sustainable under natural conditions, there would be no requirement or justification for implementing a managed realignment policy. Hold the line is also deemed unsuitable for the frontage (and would have no justification), as there are currently no assets at risk.

Given that it is anticipated that unlike the extant permission scheme, a condition of the planning permission for a revised scheme would be that the site owners and managers remain responsible for any defences for the life of the development, the no active intervention policy therefore also reflects the position of the coast protection and flood defence authorities, in that they would not become default maintainers of the defences at Carlyon Bay in the future. Importantly this avoids any future risk or obligation to be placed on the public purse."

D2.5 A Shoreline Management Plan is a non-statutory document that provides a broad assessment of the long term risks associated with coastal processes and offers guidance to coastal engineers and managers to identify and recommend strategic and sustainable coastal defence policy options for particular lengths of coasts to reduce these risks. It is noted that this extract from the SMP2 is written in the context of funding from the public purse and, as CEG is proposing to fund and maintain the seawall itselves, the policy is not directly relevant to the proposed scheme.

Cornwall SFRA

D2.6 A Level One Strategic Flood Risk Assessment ('SFRA') for Cornwall was produced during 2009 to provide an overview of flood risk in Cornwall and identify the places where flood risk is an issue. More detailed Level 2 assessments for those places at risk of flooding and where there are pressures for new development will be completed in due course. Carlyon Bay is located within the general coastal zone where a more detailed Level 2 assessment will be carried out.

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D3.0 Assessment Methodology & Significant Criteria

Assessment Methodology

Beach morphology and amenity area

D3.1 The assessment of the development considers the effect, if any, of the proposed development on coastal processes. This assessment is informed by beach modelling undertaken using HR Wallingford's calibrated numerical models that were developed as part of the design work in 2004 with a planning application submitted in 2005 ('the 2005 design') and updated for the current proposals. The beach modelling also provides technical input to the Flood Risk Assessment (FRA) Carlyon Bay.

D3.2 The assessment includes the following elements to determine beach behaviour:-

1 Baseline mapping studies;

2 Beach plan and cross shore modelling using computer based techniques (as for the 2005 design);

3 2D and 3D physical model testing to determine the performance of the beach with the proposed development in place; and

4 Consideration of climate change and uncertainty in accordance with PPS25 requirements.

D3.3 The potential change in open beach amenity area is examined as part of the assessment of morphology to assess whether there will be any net loss or gain of beach amenity area only due to the development proposals. Amenity impacts and enhancements are considered further in Chapter F (Socio-Economics).

Sandy River morphology

D3.4 The assessment of the currently proposed scheme considers the potential impact, if any, of the proposed development on the river (e.g. change in plan location, flows, etc). The assessment is informed by the FRA undertaken and through consultation with the EA.

D3.5 The assessment undertaken in the FRA considers compliance with the requirements of PPS 25 and addresses the following elements:-

1 Existing river catchment flows, and the flow capacity of the existing tunnels through the cliff;

2 Climate change predictions and a sensitivity test of climate change impacts on the river in terms of physical changes, flows and flooding;

3 Proposed river channel arrangements and their adequacy for the predicted flow conditions; and

4 Interaction between the river flows, sea levels and wave action, including conveyance of water overtopping the sea defences to the sea.

Flood risk

D3.6 The FRA considers the impact of development on flood risk to the site, surface water and drainage in accordance with PPS25. A copy of the FRA is provided as a technical appendix to this ES.

Coastal Flood Risk

D3.7 The assessment of protection is in accordance with PPS25 addresses the following elements:-

1 Beach morphology as described above;

2 Consideration of climate change in accordance with PPS25 requirements;

3 2D and 3D physical model testing to determine the performance of the sea defence configuration to provide the required level of overtopping protection as set out in HR Wallingford (2009). Carlyon Bay sea defences, Design Brief, Technical Note DKR4334/TN06;

4 Interaction between the sea defences and the river outfall, using joint (tri) probabilities of waves, water levels and river flows.

Fluvial Flood Risk

D3.8 The assessment of protection, in accordance with PPS25, addresses the Sandy River hydraulic design, based primarily on the FRA modelling carried out in association with the design work undertaken in 2005. This was agreed by the EA with adjustments as required to comply with PPS25 and current climate change predictions.

Pluvial Flood Risk

D3.9 Surface water drainage by means of a combination of infiltration and by discharge to Sandy River close to its outfall.

Groundwater or overland flow flooding

D3.10 The assessment of groundwater and groundwater flow conditions, based primarily on the FRA modelling submitted for the 2005 design and which was agreed by the EA, to demonstrate that groundwater flooding will not give cause for concern.

D3.11 The topography is such that overland flooding will not be a concern and this is demonstrated in the assessment.

Foul Drainage

D3.12 Foul drainage (that will be by means of gravity mains laid to pumping stations, ultimately discharging into an adoptable pumping station at the base of the cliff, with a rising main to the newly requisitioned sewer in Beach Road).

Water Quality

D3.13 The proposed development at Crinnis is adjacent to Crinnis Leisure Centre Bathing Water and the development at Shorthorn is adjacent to the Crinnis Golf Links Bathing Water. In their response to the request for an EIA 'Scoping Opinion' (see Chapter B of this ES), the Environment Agency, the competent authority for Bathing Waters in England and Wales, identified the need for consideration of environmental impacts, principally from construction, on the BWD parameters transparency and oils. As such an assessment was undertaken for both construction and operational activities that may potentially provide sources and pathways of sediments and oils into the Bathing Waters.

Significance Criteria

Beach and river morphology and amenity area

D3.14 PPS25 states that the minimum requirements for flood risk assessments consider the effects of a range of flooding events including coastal processes (beach morphology). These impacts are considered in this Chapter. The change to beach morphology includes:-

1 Change (accretion or erosion) in beach plan shape; and

2 Change (accretion or erosion) in beach cross section.

D3.15 The change in river morphology may include:-

1 Change (movement) in plan shape location;

2 Change in water level;

3 Change in flows and hence biodiversity (see Chapter E); and

4 Change in river conveyance characteristics.

D3.16 Change to beach and river morphology provides a mechanism for potential impact. Hence, the potential environmental impacts resulting from any physical changes in morphology are evaluated in Chapters E, F, H, I, J, K and L where appropriate.

D3.17 The change in area of the open beach is evaluated and from this the impact on the amenity can be assessed (see Chapter F).

Flood Risk

D3.18 PPS25 sets out that in the 1:200 year event, including allowance for climate change and uncertainty, the volume of water reaching the tertiary line from

overtopping of the sea defences must be within acceptable limits, as set down in Table 4.8 and Figure 4.1 of the Flood Risk Assessment. This addresses risk to property and people including safe access and egress.

D3.19 The Sandy River, downstream of the cliffs, should be able to convey the 1:100 flows, including allowance for climate change, and voluntarily including the event of increased adit capacity to alleviate upstream flooding (MLM (2010)).

D3.20 The surface water drainage system should be sufficient to collect and convey all pluvial water up to and including the 1:30 year event so that there is no flooding on site.

D3.21 The surface water drainage system should prevent any significant surface water flooding in a 1:100 year event including allowance for climate change and any flooding that does occur should be routed away from habitable areas, such as plant rooms etc to prevent them becoming flooded.

Water Quality

D3.22 The Environment Agency uses microbiological standards to assess the classification of Bathing Water – namely the faecal indicators total coliforms, faecal coliforms and faecal streptococci. Schedule 3 of the BWD Regulations (SI 1991 No. 1597) transposes Mandatory standards from the Annex of the BWD for the parameters transparency and oils – only these have been identified by the Agency as relevant to this assessment.

D3.23 The Regulations standards for transparency require 95% of [20] secchi disc records[2] taken fortnightly (1 May – 30 September) immediately before and during the bathing season, each year, to be greater than 1 metre depth. The Regulations standards for oils require, for 95% of [20] records taken fortnightly (1 May – 30 September) each year to report from visual and olfactory inspection there is *"no film visible on the surface of the water and no odour"*.

Consultation

D3.24 The proposals for the sea defences have been developed in consultation with the Environment Agency. A series of documents have been distributed to the Environment Agency during the consultation process during the production of the Flood Risk Assessment and these include:-

1 HR Wallingford (2009). Carlyon Bay sea defences – Design Brief – Technical Note DKR4334_TN06;

2 HR Wallingford (2010a) Beach evolution and wave overtopping studies, EX6198, October 2010; and

3 HR Wallingford (2010b), 3-D modelling Technical Notes (included in FRA).

[2] The Secchi disc is a circular disk used to measure water transparency in oceans.

D3.25 Following the issue of the EIA Scoping Opinion from Cornwall Council, the scope of the Environment Agency's requirements or water quality assessment was clarified[3]. The Agency advised that the scope be limited to potential impacts on Bathing Waters, and specifically potential impacts on transparency and oils – supporting parameters in Schedule 3 of the Regulations (SI 1991 No. 1597). The Agency confirmed that their scope requirements did not include BWD microbiological parameters (e.g. from increased flows to the sewer network and wastewater treatment works; coastal circulation patterns).

D3.26 Consultation responses were received from the following organisations and where appropriate these comments have been addressed in this Chapter. Comments have also been addressed in the consultation response document submitted:-

1 Cornwall Council
2 Cornwall Council – Highways Offices
3 Cornwall Council – Pollution Control
4 Cornwall Council – Conservation Officer
5 Cornwall Council – Historic Environment Advisor (Archaeology)
6 Cornwall Council – Natural Environment Team
7 Cornwall Council – Landscape and Urban Design
8 Cornwall Wildlife Trust
9 Carlyon Parish Council
10 St Blaise Parish Council
11 Natural England
12 Environment Agency
13 Highways Agency
14 Cornwall RIGS Group
15 Carlyon Bay Watch Ltd

[3] Emma Whereat (Environment Agency Planning Liaison Officer) telecom with Trevor Wade (Cascade Consulting, MLM partner organisation) 2 September 2010.

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D4.0 Baseline Conditions

Beach Morphology and amenity area

Natural Baseline

D4.1 The sites known as Crinnis, Shorthorn and Polgaver are a relatively recent phenomenon within Carlyon Bay. In its original state, the bay is understood to have been rocky with little or no beach material. Changes to this state began during the middle part of the 19th century. At this time the Sandy River discharged into St Austell Bay at Par, carrying a substantial sediment burden of eroded sand and waste materials arising from the china clay industry within the catchment. However, following construction of Par Harbour in 1829, an adit was engineered to divert the Sandy River away from Par to prevent siltation of the harbour, to discharge into Carlyon Bay at what is now known as Shorthorn Beach.

D4.2 The area surrounding Carlyon Bay has also been associated with metalliferous mining. Records indicate that, following the diversion of Sandy River into Carlyon Bay, some tin streaming and china clay recovery activities were conducted at the base of the cliff.

D4.3 Since the mid 19th century the efflux of sediment carried by the Sandy River discharging at the Shorthorn adit has resulted in the accumulation of a substantial quantity of beach material at Carlyon Bay. This caused the high water mark to move some 200m seaward, creating the three beaches that occupy the present site. Records indicate that the maximum extent of seaward migration was reached in 1933. Since then the deposition of new material via the Sandy River has diminished and the beach appears to have reached equilibrium.

D4.4 The above illustrates that the beach at Carlyon Bay has evolved over the past 150 years or so. Under the present (semi natural) regime, the beach morphology is subject to significant and continuous change with periodic rotations in the beach orientation. Thus the beach is a natural dynamic system with regular changes.

D4.5 Storm conditions reportedly lead to extensive flooding and erosion of the beach area above the high water level, particularly on Crinnis and Shorthorn Beaches.

D4.6 At present local residents and tourists make recreational use of the beach.

D4.7 A review of survey information in relation to the temporary sea wall currently at the site was presented in HR Wallingford Report, Beach Evolution and Wave Overtopping Studies, EX6198, October 2010. This showed that the beach volume has not been affected by the presence of this temporary seawall design. There were some localised changes around the partly constructed temporary river apron but these impacts have been negated following the removal of the partly constructed temporary river apron in July 2010.

Extant Scheme Baseline

D4.8 The extant seawall alignment is for much of its length, situated close to, or within, the intertidal zone especially at the western end of the site. This alignment would mean that there would be greater interaction between the seawall and beach, resulting in a change in transportation rates, in turn impacting on the current natural variation in beach alignments.

Sandy River morphology

Baseline

D4.9 The Sandy River's catchment is situated between St Austell and the port of Par. It comprises three adjoining catchment areas; the Tregrehan Stream, Penny's Lane and Sandy River itself. The river rises on the Carclaze Downs and flows south to Sandy Bottom before turning east and flowing parallel to the coastline to discharge into Carlyon Bay via two outfall tunnels at Shorthorn Beach.

D4.10 The course of the Sandy River has been extensively modified over the last 300 years. The Sandy River originally discharged into the Par Estuary at the site of the present Par Docks. The china clay industry used the river to dispose of china clay waste 'stent' and to avoid siltation of the docks; the river was diverted through the cliffs into the sea at Spit Tunnel and at a later date, through the original Crinnis Tunnel. By 1980, the river was discharging through both these tunnels, but was no longer used for china clay transport.

D4.11 At this time the tunnels had inadequate capacity to accommodate excess flood flows, which then continued to discharge to Par Docks via the access roads. As a result, the land upstream of the Crinnis Adit flooded about once a year, the excess spilling down the valley towards spit tunnel. The culvert on Sandy River at Cypress Avenue was also undersized and caused flooding of the fields upstream.

D4.12 The 1500mm dia circular concrete culvert at Crinnis Beach was constructed during the 1980s to alleviate the flooding described above. The river route to the Spit tunnel was terminated and all the flow was directed down the new twin culvert arrangement.

D4.13 The deposition of the china clay waste transported along the river has largely formed the beaches that exist at Crinnis, Shorthorn and Polgaver today.

D4.14 In recent years the river has been temporarily channelised through the site using steel sheet pile walls, culverts and rock filled gabion baskets before discharging onto the beach seaward of the development area. Seaward of this point the river is unconstrained and varies in plan location from time to time as it interacts with the coastal processes in operation.

D4.15 The area upstream of the outfall tunnels is understood to flood at times of high river flow, indicating that the tunnels act as significant constrictions on flow. The catchment assessment carried out as part of the FRA for the 2005 design

confirmed that the potential 1:100 year plus climate change catchment flow is substantially greater than the flow capacity of the existing tunnels.

Flood Risk

Coastal flood risk

Natural Baseline

D4.16 The seaward part of the site is designated as Zone 3a High Probability, in accordance with PPS25. Much of the development (to the rear of the seaward edge) is sited within Zone 2 Medium Probability, with a small area in Zone 1 Low Probability.

Extant Scheme baseline

D4.17 The seawall as approved by the extant permission would reduce the flood risk to the development. As set out in the Public Inquiry into the previous sea defence proposals, the extant seawall will provide adequate protection to the extant development, albeit to a lesser extent than that required by PPS25.

Fluvial flood risk

Natural Baseline

D4.18 From historical survey data the route of Sandy River between the bottom of the adits and the sea has varied considerably and in some periods travelled a considerable distance eastwards along Shorthorn before discharging into the sea or infiltrating into the beach material.

Extant Scheme Baseline

D4.19 The extant scheme included the channelization of the Sandy River through the development. The river would pass though a stilling basin before passing between two training walls down the beach before discharging at mean high water. The extant scheme would reduce flood risk to the development through channelization of river flow.

Pluvial flood risk

Natural Baseline

D4.20 Pluvial flows infiltrate directly into the porous sand beach material and have uninterrupted flowpaths to the sea.

Extant Scheme Baseline

D4.21 The extant scheme included the covering of the site with a mixture of permeable and impermeable areas. Where areas remained permeable these would continue to infiltrate into the underlying material. The impermeable

areas would be drained using a combination of SUDS and positive drainage systems discharging to the Sandy River and the sea.

Groundwater or overland flow flooding

Natural Baseline

D4.22 The material of the existing ground at the site consists predominantly of a porous sand material. The site investigations show that the groundwater level rises and falls with the tide with the observed level of the groundwater being similar to the sea level at that particular time. There is no information that suggests that groundwater flooding has been an issue in the past.

D4.23 Overland flooding will not be a concern as there are no significant areas upstream of the site that would contribute water towards the site. Any runoff entering the site would infiltrate through the naturally permeable ground.

Extant Scheme Baseline

D4.24 The risk of flooding from groundwater during extreme conditions within the development was mitigated by the setting finished floor levels above the predicted maximum groundwater and tide level after accounting for climate change in 100 years. The extant scheme did not found the seawall onto the bedrock due to the potential for interrupting the natural flowpath between the beach and the sea.

Water Quality

D4.25 The site lies within the St Austell WFD Coastal Waterbody. The ecological potential of this waterbody has been designated moderate whilst the status objective is for good ecological potential by 2027. Chemical status is currently good whilst dissolved oxygen, copper and other relevant chemical elements, have all been deemed as high (i.e. satisfactory).

D4.26 Two designated Bathing Waters are located immediately adjacent to the proposed development site. Crinnis Leisure Centre Bathing Water is adjacent to the Crinnis area of works whilst Crinnis Golf Links Bathing Water is adjacent to the Shorthorn area of works. Table D4.1 shows the classification of the Bathing Waters in the last 10 years – using microbiological standards for faecal indicators alone.

Table D4.1 Classification of Bathing Water Quality in the Study Area since 2001 (Environment Agency)

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Crinnis Leisure Centre	G#3	G	I	G	G	G	G	G#3	G	G
Crinnis Golf Links	G	G	G	G	G	I	G#3	G#3	F	G

Source:
G = meets *Guideline* standards for faecal indicators under the BWD
I = meets *Mandatory* standards for faecal indicators under the BWD
F = failure to meet *Mandatory* standards for faecal indicators under the BWD
#1 monitoring for the 2010 Bathing Season ongoing at time of writing. Of 18 samples reported (on the Environment Agency website 17 September 2010) all meet Guideline standards
#2 monitoring for the 2010 Bathing Season ongoing at time of writing. Of 18 samples reported (on the Environment Agency website 17 September 2010) 17 meet Guideline and one fails to meet Mandatory standards
#3 Sampling data reported on the Environment Agency website indicates that the Mandatory standard only was met on 2 or more occasions in each of these bathing seasons – normally associated with overall classification as Mandatory standard, not Guideline Standard

D4.27 Microbiological quality at Crinnis Leisure Centre is consistently very good, with three occasions reported as Mandatory standard only (leading to overall Mandatory classification that year) in 2003; two occasions of Mandatory standard only (yet overall Guideline classification) in 2001 and 2008; and one occasion of Mandatory standard only in 2007; all other sampling occasions reported as Guideline standard.

D4.28 Microbiological quality at Crinnis Golf Links is more variable and regularly poorer. Microbiological data have been reported as failing to meet the Mandatory standards of the BWD on two occasions in 2009 and once in 2010. The Environment Agency[4] advises that more detailed investigation of sources of reduced microbiological quality at Crinnis Golf Links bathing water are scheduled.

D4.29 Mandatory failures have been slightly poorer than those from Crinnis Leisure Centre although for 5 out of the last 7 seasons the bathing water has been classed as excellent (Guideline). In 2009 the bathing water failed the BWD standards (with 2 individual fails). In 2006 the bathing water met the mandatory requirements but did not meet the guideline standards (3 samples lower than Guideline standards). These failures could be associated with the Sandy River or the SWW Sewage outfall off Polgaver, which to date has not been sampled for BWD parameters.

D4.30 Data for the parameters identified as relevant to this assessment have been provided by the Environment Agency for 19 sampling occasions in the 2010 bathing season at both of the bathing waters. On all occasions at both bathing waters the transparency was reported as greater than 1m – i.e. acceptable according to the standards in the Regulations. Additionally, on all occasions at

[4] Claudine Fontier (Environment Agency Sampling & Collection Team Leader) telecom with Trevor Wade (Cascade Consulting, MLM partner organisation) 14 September 2010.

both bathing waters oil and grease were reported as absent - i.e. acceptable according to the standards in the Regulations.

D5.0 Potential Effects

D5.1 The proposed development is described in Chapter C. With respect to water resources, the proposed development at Crinnis will comprise construction of the following:-

1 Concrete seawall with a recurve profile and crest level of +9.2m ODN;

2 Rock armour toe buried beneath the existing beach;

3 Sheet pile wall buried beneath the existing beach;

4 Concrete promenade with secondary and tertiary sea defence walls; and

5 Modification to and channelization of Sandy River through the site, with the channel terminating beyond the line of the defences and above MHW.

D5.2 The proposed development on Shorthorn beachfront, will comprise:-

1 Primary sea defence bund to +9.5mODN, formed from beach material with a sheet pile core, and located on the upper part of the beach, landward of the zone of normal wave and tidal action (approximately 60m landward of the present day MHW line);

2 Secondary defence sheet pile wall, backed by beach material;

3 Drainage channel located between primary and secondary defences, lined with scour protection; and

4 Flood water drainage areas in the hinterland behind the sea defences and between elevated developed areas and access routes.

D5.3 The following sections examine the potential effects of the proposed scheme (primarily the sea defences) on beach morphology and amenity area, Sandy River morphology, flood risk and water quality.

During Construction

D5.4 There will be some localised excavation of beach material as the seawall is constructed, including the placement of the rock armour. The beach material will be reinstated after construction.

D5.5 The programme of work is envisaged to last 42 months. The first stage would include demolition of existing structures including the remaining buildings at Crinnis while other works would include cliff stabilisation as well as sea defence and building construction. Further details are provided in Chapter C.

Beach and River Morphology and Amenity Area

Beach Morphology

D5.6 Moving beach material may cause local changes to beach levels (e.g. local scour) on the existing beach. However, the work is to be undertaken above the high water mark and hence above the area of the main coastal processes.

This, combined with the temporary nature of such changes, means that the impact on beach morphology is therefore considered to be **minor adverse** without mitigation.

D5.7 As the proposed scheme encroachment is less seaward in extent than the extant scheme, the impact on beach morphology compared to the extant scheme is considered to be **moderate beneficial.**

Amenity Area

D5.8 During construction, parts of the beach will be temporarily inaccessible to the public for health and safety reasons while the construction activities take place. The impact on beach amenity area compared to the natural baseline is considered to be **minor adverse** without mitigation.

D5.9 As the proposed scheme encroachment is less further seaward in extent than the extant scheme, the impact on amenity area of the proposed scheme is considered to be **moderate beneficial** when compared to the extant scheme.

Sandy River Morphology

D5.10 The Sandy River will be diverted into its final alignment as construction of the permanent works proceeds. The diversion will be undertaken in accordance with the Environment Agency's licensing and so the impact on the river morphology compared to the natural baseline is considered **negligible**.

D5.11 There are few differences between the proposed and the extant scheme and hence the impact on Sandy River morphology of the proposed scheme is considered to be **negligible** when compared to the extant scheme.

Flood risk

D5.12 There are no existing properties on the site proposed for the sea defences and therefore the impact on flood risk during construction is considered **negligible**.

D5.13 As the defences provide a greater degree of flood protection, the proposed scheme is considered to be **moderate beneficial** when compared to the extant scheme.

Water Quality

D5.14 Site accommodation is to be included within the works in addition to the site compound, which will require sewerage to be provided. Without mitigation, the impact of additional sewerage and disposal given the proximity of Crinnis Leisure Centre Bathing Water and Crinnis Golf Links Bathing Water beaches, has been deemed **moderate adverse**.

D5.15 A number of activities are proposed during construction that without mitigation could be harmful with regard to water quality. Construction works include the accessing of the site by heavy plant, including both wheeled and tracked vehicles. As such, there is a risk of pollution due to leaks of fuel or lubricants

when the plant is in use. Any plant may also need to be washed down before returning onto the public highway, and this could result in fuel or lubricants being released in the washwater. Similarly, hazardous liquids would be stored on site and may transfer to watercourses as a result of spillages and then runoff. The impact on water quality from the introduction of hydrocarbons, or other hazardous liquid, could affect compliance with Bathing Water Regulations at the designated bathing beaches and, without mitigation, is assessed as **moderate adverse.**

D5.16 As the proposed scheme encroachment is less further seaward in extent than the extant scheme, the impact of the proposed scheme on water quality due to releases of hydrocarbons or other hazardous liquids is considered to be **minor beneficial** when compared to the extant scheme.

D5.17 A number of construction activities have the potential to lead to dust, e.g. cutting or sawing. This may in turn transfer into watercourses (via runoff or directly from the air) and could lead to a reduction in water quality through an increase in turbidity. This could affect compliance with Bathing Water Regulations at the designated bathing beaches and, without mitigation, the impact of this is assessed as **moderate adverse**.

D5.18 As the proposed scheme encroachment is less further seaward in extent than the extant scheme, the impact on amenity area of the proposed scheme is considered to be **minor beneficial** when compared to the extant scheme.

D5.19 The movement of heavy plant on the soft ground (e.g. foreshore) could also cause increased erosion. The development of wheel ruts can concentrate water flows which would tend to increase erosion locally. This, in combination with runoff, could result in increased turbidity in the local marine environment during construction as the tidal cycles mobilise the detached sediment. Increases in turbidity could affect compliance with bathing waters Regulations at the designated bathing beaches. Any impact is, however, likely to be both temporary and localised and therefore impact on water quality due to erosion is assessed as **minor adverse**.

D5.20 As the proposed scheme encroachment is less further seaward in extent than the extant scheme, the impact of the proposed scheme on water quality due to increased turbidity associated with the introduction of dust etc. is considered to be **minor beneficial** when compared to the extant scheme.

D5.21 Much of the construction will involve extensive excavation. Excavation and movement of material will increase the risks of erosion and transport by runoff (work above the tidal envelope and so wave action has been discounted), and is likely to affect the water quality due to increased turbidity. As above, any such changes could affect compliance with Bathing Water Regulations at the designated bathing beaches. However, as any impact is likely to be both temporary and localised, the impact on water quality due to erosion is assessed as **minor adverse**.

D5.22 As the proposed scheme encroachment is less further seaward in extent than the extant scheme, the impact of the proposed scheme on water quality due to increased turbidity associated with erosion is considered to be **minor beneficial** when compared to the extant scheme.

D5.23 No intertidal works are proposed and so intertidal sediments will not be directly disturbed. Turbidity impacts and the potential for mobilisation of faecal bacteria from intertidal sediments is therefore assessed as **negligible**.

D5.24 As the extant scheme, includes works within the intertidal area, the impact of the proposed scheme on water quality due to works within the intertidal area is considered to be **moderate beneficial** when compared to the extant scheme.

After Completion

Beach and Sandy River morphology and amenity area

Beach morphology

D5.25 Detailed beach studies have been undertaken (see the Flood Risk Assessment and HR Wallingford report EX6198), to assess the effect of the proposed sea defences on beach behaviour and to compare these findings with the baseline conditions.

D5.26 Analysis of beach survey data has confirmed that there is negligible long-term loss of sand from Carlyon Bay in its present state. In addition this analysis has indicated that the presence of the temporary seawall since 2004 has not caused sediment loss from Carlyon Bay. The current sea defence proposals are located further landward than the temporary seawall and will therefore have a lesser impact than the temporary defences.

D5.27 Beach planshape modelling has been undertaken using 19 years of wave data to obtain statistical information on possible variations in beach orientation and hence beach width along the frontage for the current proposals.

D5.28 The effects of long-term sea level rise were also assessed in the modelling of beach plan shape. 100 years sea level rise allowance was added to the water level used in the model for this scenario, effectively moving the water line closer to the seawall and reducing the width of the beach.

D5.29 The modelling presented in HR Wallingford (2010a) EX6198 has demonstrated that the natural variations in beach plan shape are not adversely affected by the presence of the proposed seawall. Therefore the impact on plan shape for the proposed scheme compared to the natural baseline is considered to be **negligible**.

D5.30 The proposed seawall is significantly landward of the extant seawall permission. The extant seawall position, in places, significantly interrupts the coastal processes and impacts on the plan shape. Therefore the impact on beach plan shape for the proposed development compared to the extant scheme is considered to be **moderate beneficial**.

D5.31 Response of the beach cross section profile to storms was also assessed for conditions up to and including the 1:200 year conditions with additional allowances for increased storminess and sea level rise.

D5.32 There will be short term localised changes in beach morphology during storms. Numerical modelling (HR Wallingford 2010a) has indicated that the beach profile in front of the sea defences in Crinnis may flatten and lower beach levels at the sea defence to around +3mODN for a starting beach width of 24.7m (from the concrete seawall to the +1.5mODN contour). Post storm recovery of the beach will occur as calmer wave conditions build up the beach profile once again. Physical modelling of beach behaviour (HR Wallingford (2010b)) indicated that the numerical model predictions of beach levels were conservative and the beach tended to build up during storms.

D5.33 In Crinnis, short term changes in the local profile of the beach during storms are likely to be greater for the current proposed scheme when compared with the natural baseline, therefore the impact of the proposed scheme on Crinnis beach cross sectional profile during storm conditions is considered to be **minor adverse**.

D5.34 In Shorthorn, the setback position of the defence will further minimise its potential for interaction with the active beach, except under extreme storm conditions. Therefore, due its set back, the impact of the proposed scheme on Shorthorn cross sectional beach profile during storm conditions is considered to be **negligible**.

D5.35 Compared with the extant scheme, beach levels at the structures during storms are generally higher for the current proposed scheme, as the sea defence is located further landward and intersects with the beach at a higher elevation and therefore the current proposals have a reduced effect compared with the extant scheme. The impact on cross section local profile during storm conditions compared with the extant scheme is considered to be **minor beneficial**.

Amenity

D5.36 As the seawall is generally behind the existing vegetation line, the presence of the sea defences does not reduce the overall area of available beach compared with the natural baseline case. Therefore the impact on beach area is assessed as **negligible.** Additional facilities (e.g. showers) will be provided which should improve the area in terms of amenity value and are described in Chapter C.

D5.37 The available beach under the proposed new scheme is considerably greater than for the extant scheme, particularly at the western end of the site where the extant seawall would extend into the intertidal zone, meaning that at certain times no beach would be visible above the waterline. Compared to the extant scheme, which included exposed rock, the proposed scheme is assessed to be **moderate beneficial** as it has less impact on the natural coastal processes of the area.

Sandy River Morphology

D5.38 There will be no effect on the Sandy River upstream of the adits as the adits act to limit flow to the beach. The river will be channelised through the site, with the channel terminating beyond the line of the defences. Beyond this point the fluvial flow will discharge across the beach. The physical modelling (HR Wallingford 2010b) demonstrates that for the proposed scheme, the river can discharge onto the beach without blockage. This is an improvement to the existing baseline condition in which the river becomes blocked due to interaction with coastal processes and then meanders across the site. This change is moderately beneficial to river conveyance, and hence flood risk (see Flood Risk below), although the lack of conveyance does not currently detrimentally impact on any properties. Hence, excluding biodiversity issues, the impact on Sandy River morphology due to stabilisation of the channel is **negligible**. The effect on biodiversity receptors is considered in Chapter E.

D5.39 The extant scheme included similar measures to the current proposals and so the effect of the proposed scheme on Sandy River is also considered **negligible** when compared with the extant scheme.

Flood Risk

Coastal

D5.40 Coastal flood risk has been assessed by numerical and physical modelling (2-dimensional and 3-dimensional) of the beach and sea defences to determine performance to reduce overtopping (i.e. wave splash passing over the seawall) and ensure conformance with the requirements of PPS25. The full findings of the studies are presented in the Flood Risk Assessment.

D5.41 Beach morphology is closely linked to the performance of the sea defences and numerical modelling of beach behaviour was used to determine design beach levels for use in the assessment of sea defence performance as presented in HR Wallingford Report,' Beach evolution and wave overtopping studies, EX6198' (HR Wallingford 2010a).

D5.42 Climate change was included in the design conditions for the assessment of overtopping, in accordance with PPS25. Target overtopping criteria were set to ensure that structural damage to buildings will not occur that could lead to flooding in extreme storm conditions, up to and including the 1:200 year condition in combination with sea level rise over the design life of 100 years.

D5.43 Initially 2-dimensional physical modelling was used to determine the general cross-section of the sea defences for both Crinnis and Shorthorn that would deliver the required standard of protection. This was further refined by 3-dimensional physical model testing (HR Wallingford 2010b) that consider 3-dimensional effects such as drainage of overtopping water behind the sea defences. The findings of the studies are summarised in the FRA and presented in detailed in the Appendices to the FRA.

D5.44 The presence of the sea defences reduces the flood risk to the site compared with the natural baseline. However, there are no habitable properties currently on the site and therefore the impact of the proposed scheme compared to the natural baseline is considered to be **negligible** in terms of flood risk. The assessment would change to substantial beneficial if the site was developed.

D5.45 In both Crinnis and Shorthorn, the flood risk will be reduced in comparison to the extant scheme as the defences are designed to deliver a higher standard of protection (in accordance with current guidance in PPS25). Therefore the impact of the proposed development compared to the extant scheme is considered to be **minor beneficial** in terms of flood risk.

D5.46 Overtopping of the defences will occur, particularly under extreme events, and it will be necessary to manage the overtopping. This is discussed further in Sections D6 and D7.

D5.47 Under storm events overtopping of the promenade and parts of Shorthorn will exceed levels for pedestrian access. Mitigation measures are discussed in Section D6.0 to control public access during storms.

D5.48 The interaction between the sea defences and the Sandy River outfall was assessed in the 3-D physical model. This demonstrated that under extreme wave conditions, the majority of waves that propagated up into the river channel were contained within the stilling basin that is designed to encourage wave dissipation. Therefore it is considered that wave action in the river does not lead to any significant flooding of the site. Under 100 year flow conditions, the river spilled into low lying areas of Shorthorn that are designed to accommodate flood waters. This mechanism is little different from the present situation.

Fluvial

D5.49 Detailed hydrology was undertaken in 2003 to determine the flows in the Sandy River. This work has been updated to take account of the latest climate change predictions in line with PPS25.

D5.50 The Sandy River will pass through a stilling basin, designed to reduce propagation of waves up into the channel, as tested in the 3D model. Immediately downstream of the stilling basin the river passes through the sea defences and will be channelised beyond the line of the defences, to prevent the river from running along the defence line, before discharging across the beach above mean high water. Therefore the impact on river flood protection compared to the natural baseline is considered to be **moderate beneficial**.

D5.51 The extant scheme also included for the restricted flow through the adits, to be conveyed through the development without causing flooding to the development. Therefore compared to the extant scheme the impact of the river flood protection is considered to be **negligible.**

Pluvial

D5.52 The proposals are to provide hard surfacing to the development within Crinnis with softer landscaping prevailing within Shorthorn. Pluvial water at Crinnis will be collected and routed using a positive drainage system to either soakaways to the rear of the development or via a carrier drain below the promenade to an outfall within the Sandy River channel. Due to the nature of the underlying material the infiltration rates across the development vary, therefore the soakaways will be linked to allow movement of water between the soakaways to maximise the soakage potential of the site.

D5.53 During a 1:100 year pluvial event there will be surface run-off from the habitable part of Crinnis. This water will either be shed directly to the beach, through drains in the promenade, through the primary and secondary defences, or to the rear of the development where it may cause minor flooding of non habitable areas. Any flooding will be drained away by the positive drainage network as the intensity of the pluvial event decreases.

D5.54 During pluvial events there would be a rill which runs along the landward side of the development. This rill will pick up any overflow from the soakaways and discharge it to the Sandy River via a collection pipe.

D5.55 Pluvial water at Shorthorn will be routed to the drainage channels within the development from where it will soakaway through the permeable beach material or, in extreme events, discharge to the Sandy River. Compared to the natural baseline, the impact of the proposed pluvial drainage proposal on flooding is considered to be **negligible**.

D5.56 The extant scheme included a hard surface finish over much of the development at both Crinnis and Shorthorn. The proposed development removes much of the hard landscaping at Shorthorn, allowing the existing soakage regime to be maintained were practicable. Therefore, compared to the extant scheme, the impact of the proposed pluvial drainage proposal on flooding is considered to be **minor beneficial**.

Groundwater

D5.57 The sheet piling forming part of the sea defence walls will not prevent the tide from affecting the groundwater levels within the site as the piles do not toe into the bedrock. However, the effect of the tide on groundwater levels will be less than at present as the sheet piles will reduce the movement of seawater from in front to behind the defences.

D5.58 Groundwater behind the defences, as a result of infiltration drainage etc, will not be restricted from discharging beyond the sheet piled wall.

D5.59 The risk of the development being flooded from groundwater in extreme conditions has been mitigated by setting the building floor levels above the predicted 1:200 year tide level including allowance for climate change. Compared to the natural baseline, the impact of the proposed scheme on groundwater flooding is considered to be **negligible.**

D5.60 The current proposals represent no change in impact from the extant scheme and therefore the impact is considered to be **negligible.**

Water Quality

D5.61 The developer has a Water Act 2003 Section 98 agreement with the sewerage undertaker, South West Water, to adopt the sewerage pumping station on site and connect the development to off-site facilities and to provide sufficient capacity at the Sewage Treatment Plant off-site. The additional wastewater resulting from the development will be accommodated for in both the sewerage network and at the wastewater treatment works and the impact of additional wastewater from the development on local water quality is considered **negligible**.

D5.62 There would be an increase in hardstanding as a result of the development. This would lead to an increase in runoff rates and the hydrological implications of this are considered further above. Runoff at greater speeds has the ability to carry an increased sediment load. Much of the increased hardstanding would be porous paving or roofed areas and the quality of runoff is envisaged from these is considered to be reasonable. Increased hardstanding also occurs through the development at the Upper Car Park and through an increase in roads. From these hydrocarbons (such as oil) could be carried by runoff into the drainage system or soakaways. Given the size of these areas the impact of water quality in runoff on the compliance with bathing waters Regulations at the designated bathing beaches, without mitigation, is considered to be **moderate adverse**.

D5.63 An assessment has been carried out to compare the impacts against the extant baseline and the effect is considered neutral/negligible.

D5.64 Tables D5.1 and D5.2 below provide a summary of the above assessment in terms of potential water resource impacts due to the proposed development.

Table D5.1 Summary of impact during construction (without mitigation)

Area	Section Ref	Impact	Assessment compared to natural baseline	Assessment compared to extant baseline
Beach morphology	D5.6 / D5.7	Change in beach plan shape and cross section	**Minor adverse**	Moderate beneficial
Amenity area	D5.8 / D5.9	Change in amenity area	**Minor adverse**	Moderate beneficial
Sandy River morphology	D5.10/D5.11	Change in river plan location, level nature and conveyance.	**Negligible**	Neutral/Negligible
Flood risk	D5.12/D5.13	Worsening of coastal, fluvial,	**Neutral/ negligible**	Moderate Beneficial

Area	Section Ref	Impact	Assessment compared to natural baseline	Assessment compared to extant baseline
		pluvial and groundwater flooding		
Water quality	D5.14	Additional sewerage and disposal	**Moderate adverse**	Neutral/ negligible
	D5.15/D5.16	Introduction of hydrocarbons and other hazardous liquids	**Moderate adverse**	Minor beneficial
	D5.17/D5.18	Increased turbidity as a result of dust etc	**Moderate adverse**	Minor beneficial
	D5.19/D5.20	Increased turbidity as a result of erosion etc	**Minor adverse**	Minor beneficial
	D5.21/D5.22	Increased turbidity as a result of excavation	**Minor adverse**	Minor beneficial
	D5.23/D5.24	Increased turbidity and mobilisation of faecal bacteria	**Negligible**	Moderate beneficial

Note: adverse effects are reviewed further in sections D6.0 and D7.0

Table D5.2 Summary of Impacts after completion (without mitigation)

Area	Section Ref	Impact	Assessment compared to natural baseline	Assessment compared to extant baseline
Beach morphology	D5.29 - D5.30	Change in beach plan shape	**Negligible**	Moderate beneficial
	D5.31 - D5.33	Storm response change in beach cross section : Crinnis	**Minor adverse**	Minor beneficial
	D5.34 / D5.35	Storm response change in beach cross : Shorthorn	**Negligible**	Minor beneficial
Amenity area	D5.36 / D5.37	Change in amenity area	**Negligible**	Moderate beneficial

Area	Section Ref	Impact	Assessment compared to natural baseline	Assessment compared to extant baseline
Sandy River morphology	D5.38 / D5.39	Change in river plan location, level nature and conveyance.	**Negligible**	Negligible
Flood risk	D5.44 / D5.45	Increase in coastal flood risk	**Negligible**	Negligible
	D5.50 - D5.51	Increase in fluvial flood risk	**Moderate beneficial**	Minor Beneficial
	D5.55 / D5.56	Increase in pluvial flood risk	**Negligible**	Minor beneficial
	D5.59 / D5.60	Increase in groundwater flood risk	**Negligible**	Negligible
Water quality	D5.61	Impact of additional wastewater on local water quality	**Negligible**	Neutral/ negligible
	D5.62	Impact of increased runoff on bathing water quality	**Moderate adverse**	Neutral/ negligible

Note: adverse effects are reviewed further in sections D6.0 and D7.0

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D6.0 Mitigation Measures

Introduction

D6.1 Detailed numerical and physical modelling has been undertaken to develop the design of the sea defences and to assess the impacts on the natural shoreline processes. Mitigation measures have been incorporated into the design to reduce impacts where possible as detailed in the following sections.

During Construction

D6.2 Prior to any construction works the contractor will produce a Construction Environmental Plan ('CEMP') (see Chapter C of the ES for further details). This will include construction site boundaries, the position of the site compound and accommodation, location of sensitive receptors, vehicular access routes as well as a detailed programme of works. Given that the designated Bathing Waters are sensitive receptors, the site compound should be situated to the north of the proposed development site (furthest from the Bathing Waters).

D6.3 During construction, public access will be restricted to ensure safety. However, as much public access to the beaches will be maintained as is practicable and is commensurate with the programme of works as addressed in the CEMP.

D6.4 Relevant Pollution Prevention Guidelines (PPGs) will be observed and adhered to and documented within the CEMP, to ensure that any water quality impacts are suitably mitigated.

D6.5 The following will also be undertaken to guard against pollution of watercourses and in particular designated Bathing Waters through spillage or runoff contributions:-

1 wheel washing facilities will be installed within the site compound (and away from the Bathing Waters) and washwater will be collected and discharged (potentially off site) so as to not cause pollution to watercourses;

2 any unknown liquids to be identified by sampling, analysis and description;

3 oils, fuels and chemicals to be stored on hardstanding in bunded enclosures and away from the Bathing Waters, watercourses and drains;

4 filling of hazardous materials shall occur within bunded enclosures;

5 pipe valves to remain secure and any abandoned drains to be sealed off;

6 roads and hardstanding to be kept clean to avoid any adverse runoff;

7 an emergency response plan will be produced to deal with any spillages and spillage kits will be readily available;

8 any spillages will be reported to the Environment Agency and managed in consultation.

D6.6 The CEMP should include a special management plan with regard to activities undertaken on the beach (e.g. vehicle movement) to ensure that they would not cause damage to the ecosystem and/or affect bathing water quality. The management plan should also require that plant be maintained regularly and that drip trays be used under stationary vehicles on the beach. This would help minimise the risk to the Bathing Waters associated with vehicle leakage (of fuel, lubricants, etc). Vehicles should be stored within the site compound when not in use to limit the amount of time they may be on the beach.

D6.7 The following will be undertaken to minimise dust pollution that could transfer into watercourses:-

1 concrete will be produced at least 10m from watercourses;

2 groundworks will be sealed and revegetated as soon as possible;

3 materials to be stored out of wind and all dust generating materials to be covered (when being transported on and off the site);

4 cutting and grinding on site will be minimised;

5 dust extractors will be used in association with cutters and saws;

6 dust generating surfaces and areas will be dampened to lower this risk.

D6.8 In order to mitigate impacts from vehicular movement on the softer ground, vehicular movement between beach access points and work sites should be restricted to defined routes, preferably situated away from the shoreline to prevent unnecessary ingress of vehicles into the marine environment and fenced off with temporary fencing if practicable. Protective matting should be used to spread the load of vehicles and reduce the likelihood of erosion. Work will not be below the high tide level, and so eroded materials will not be transported into the sea by the tide. Nevertheless any excavated sediment should be removed from the site as soon as possible to avoid aeolian transport of the material.

D6.9 Current best practice with regard to watercourse crossings and runoff should be followed to ensure that the risk to water quality is mitigated, as set out in HR Wallingford (2010c). Any debris or contaminated water falling into the river from bridge decks should be avoided through collection. Collected runoff should then be disposed of suitably. Prior to any work at Sandy River, discussion with the Environment Agency will be held to agree a method statement, with regard to relevant PPGs and so that a Flood Defence Consent can be granted.

D6.10 Best in class site accommodation is to be included within the works in addition to the site compound. Current plans indicate that surface drainage and wastewater from the site compound will pass through settlement tanks and oil interception facilities before discharging to the sewer. All potentially contaminated water will be disposed of in accordance with the Water Resources Act 1991 and the Water Industry Act 1991 to the satisfaction of the Environment Agency. Environment Agency Pollution prevention Guidelines (PPG) will be adhered to at all times.

D6.11 Issues of river restoration and biodiversity enhancement are discussed in Chapter E.

After Completion

Beach and Sandy River morphology and amenity area

D6.12 As set out in Section D5.0, the seawall has been set back sufficiently far landward to not significantly impact on coastal processes. No further mitigation is envisaged although the beach will continue to be monitored as set out in the Sea defence and river management manual, HR Wallingford (2010c) which forms part of the FRA at Appendix D1. The Sea defence and river management manual sets out a framework for managing and cleaning the beach to maintain the quality of the amenity facility.

Residual Flood Risk

D6.13 Overtopping of the sea defences occurs under extreme conditions. The design of the defences and the site has included mitigation measures to manage water on the site and hence manage the flood risk.

D6.14 In Crinnis, overtopping water would be contained in the promenade area and drain back seaward via drainage scuppers in the seawall, preventing flooding of residential buildings and the landward areas of the site. The modelling presented in the FRA shows that the beach is stable and that the predicted beach changes during storm conditions can be accommodated.

D6.15 In Shorthorn, the area between the Primary and Secondary wall would drain the majority of water back to Sandy River and then to the sea. Water overtopping the Secondary wall would pond in lower lying storage areas incorporated into the Shorthorn site design as indicated on drawing 612778/5/002, to collect and divert overtopping water which would then be drained into the Sandy River before returning to the sea. Buildings would be raised to be out of the zone of high overtopping, and the access road through Shorthorn and access to the buildings would be elevated such that they will not be inundated during extreme storm conditions.

D6.16 Under extreme storm conditions areas of the promenade in Crinnis and parts of Shorthorn would be unsafe for pedestrians. These areas would be closed to the public under storm conditions by the management company. A storm warning system would be set up (HR Wallingford 2010c) and would be used as a guide to close off areas of the site.

Water Quality

D6.17 Consideration on water quality impacts from runoff from roads and car parks should be made as part of the wider consideration of SUDS. Runoff from these systems should not directly enter watercourses but should be treated through systems such as filters. Any SUDS should be maintained periodically. .

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D7.0 Residual Effects

Introduction

D7.1 The management of residual effects will be critical to the safe operation of the site for site occupants and users. The Sea Defence and River Management Manual sets out the management approach to the management of the residual effects.

During Construction

Beach and Sandy River morphology and amenity area

D7.2 No significant impacts to the beach or Sandy River morphology are envisaged with the mitigation measures in place.

Flood Risk

D7.3 During construction, flooding of parts of the site from overtopping tidal water and the Sandy River could occur. The construction sequence will be such that the risk of flooding of the construction works will be minimised and that any flood water will be able to drain from the site either via infiltration through the underlying material or from collection and disposal by the positive drainage network once completed. Any flooding will have no impact outside of the site boundary.

Water quality

D7.4 No residual impacts to water quality are envisaged from the works.

After Completion

Beach and Sandy River morphology

D7.5 No residual impacts to the beach or Sandy River morphology are envisaged from the works. The beach and Sandy River will be surveyed as set out in HR Wallingford (2010c) and the framework set out in that management plan will be used to assess whether there are any residual impacts. The proposed works present some opportunities for habitat enhancement in the Sandy River water course, these proposals are discussed further in Chapter E.

Flood Risk

D7.6 The defences have been designed and tested to limit overtopping to the rates as specified in Table 4.8 of the FRA. The development will be managed and will receive flood warnings from the Environment Agency's Flood Warning Service.

D7.7 The beach promenade at Crinnis may need to be closed to the public following receipt of a flood warning from the Environment Agency. Those responsible for the management of the development will be responsible for restricting access to the promenade in times of higher risk to users.

D7.8 At Crinnis, following overtopping of the primary and secondary defences, water would discharge back to the beach via the scuppers in the wall, via the steps and ramps and also through the promenade drainage. This will allow drainage of these areas following overtopping. The sea defences have been designed to limit overtopping of the tertiary line.

D7.9 Within Crinnis, failure of any part of the drainage network at the rear of the site may lead to some localised flooding, but due to the configuration of the network this would be limited and would not affect any vulnerable areas. Any localised flooding would be routed to other parts of the drainage network to soakaways or to the outfall to the Sandy River.

D7.10 At Shorthorn, any overtopping would be collected within the drainage channels and would either infiltrate or, if the overtopping was significant, would be discharged into the Sandy River or onto the beach at the eastern end of Shorthorn.

D7.11 The Shorthorn area drains via infiltration and, in extreme events, discharges into the Sandy River. As the drainage network is predominantly open channel a blockage is unlikely and would be easily recognised if it were to occur. These checks would be part of the routine site maintenance. Due to the nature of the underlying material being significantly porous it is highly unlikely that infiltration would fail. The areas utilised to allow infiltration would be unavailable for other uses following significant rainfall or overtopping until the water has been discharged, however this period would be of relatively short duration.

D7.12 The Sandy River is not expected to cause flooding to properties as it will be designed to convey the flows from the 100 year rainfall event including allowance for climate change, even though it is not possible for these flows to reach the site as the adits limit the flow to the site. If future work increases the capacity of the adits then the Sandy River will still be sufficiently sized to convey these flows through the development.

Water quality

D7.13 No residual impacts to water quality are envisaged from the works.

D8.0 Summary & Conclusions

Beach and Sandy River morphology and amenity area

D8.1 An assessment has been made of beach morphology using baseline mapping, computer based numerical modelling and 2D and 3D physical model testing to determine the performance of the beach with the development constructed. This showed that the seawall has been set back sufficiently far landward to not significantly impact on coastal processes.

D8.2 Numerical modelling showed short term localised changes in the beach morphology during storm events. Post storm events, the beach recovered as calmer wave conditions serve to rebuild the beach.

D8.3 As the seawall is generally behind the existing vegetation line, the presence of the sea defences does not reduce the overall area of available beach compared with the natural baseline case.

Flood Risk

D8.4 The sea defences have been designed to exceed the requirements of Planning Policy Statement (PPS) 25 'Development and Flood Risk' including allowance for climate change in accordance with Table B2 of that document.

D8.5 The seaward part of the site lies within Zone 3a High probability of flooding in accordance with PPS25. Most of the remainder of the site lies in Zone 2 Medium Probability of flooding, with a small area in Zone 1 Low Risk of flooding.

Coastal

D8.6 At Crinnis the volume of water overtopping the tertiary line is limited to acceptable levels.

D8.7 At Shorthorn the setting back of the defences minimises the potential for interaction with the beach morphology except in extreme events.

D8.8 At Shorthorn the buildings and access road have been raised above the 1:200 tidal level including allowance for climate change and the effect of waves. Therefore a safe, dry access in accordance with PPS25 is available.

D8.9 The proposals for the sea defences were developed in consultation with the Environment Agency.

D8.10 The promenade at Crinnis and areas of Shorthorn will be closed to the public as necessary in the case of an extreme tidal event being forecast.

Fluvial

D8.11 The impact of the Sandy River on the development has been assessed as part of the modelling work undertaken to determine beach morphology.

D8.12 The existing river alignment is not natural as the river has had its course engineered upstream of the adits to route it away from its original discharge location at Par Harbour to Shorthorn. Downstream of the adits the river has been channelled across the part of the site before discharging across the beach. The river has no heritage value and there will be no detrimental effect.

D8.13 The hydrology work undertaken in 2003 has been updated to take account of the latest climate change predictions in line with PPS25. The capacity of the channel downstream of the adits will be sufficient to accommodate the unrestricted flows from the 100 year rainfall event including allowance for climate change.

D8.14 The work to the river downstream of the adits has no effect on the river upstream as the adits limit the volume of water discharging to Shorthorn.

D8.15 The alignment of the Sandy River through the development has been modelled and the stilling basin designed so that waves do not propagate up the river channel to unacceptable levels.

D8.16 The channel extends past the defence line so that the river does not change course adjacent to the defences and hence prevents erosion at the toe of the wall. This channel terminates above MHW.

Pluvial

D8.17 An assessment has been made of the surface water drainage requirements for the development for rainfall events up to and including the 100 year event including allowance for climate change. This work is detailed in the Flood Risk Assessment.

D8.18 The surface water drainage will not flood the site in the 30 year rainfall event and any flooding arising from a 100 year event including allowance for climate change will not cause any flooding of vulnerable areas due to the layout of the development.

D8.19 An assessment has been made of wave overtopping during a 1:200 year event including allowance for climate change. At Crinnis overtopping at the tertiary line is limited to acceptable values. At Shorthorn the drainage channels within the development site have been designed to convey any overtopping waters to the Sandy River. The access road and buildings at Shorthorn have been raised such that they will not be inundated during storm events.

Groundwater

D8.20 The risk of flooding from groundwater is negligible. The risk of internal flooding has been mitigated by setting ground floor levels above the predicted 200 year tidal level including allowance for climate change and wave effect.

Foul water

D8.21 The east part of the development on Crinnis would drain by gravity to a private pumping station which would pump the flows into the gravity system serving the west part of the Crinnis development. Foul flows for the west of the Crinnis development would drain by gravity to an adoptable pumping station. Foul drainage on Shorthorn would gravitate to a private pumping station which would pump the flows to the east Crinnis foul system, upstream of the private pumping station.

D8.22 The adoptable pumping station on Crinnis would pump all of the foul flows from Crinnis and Shorthorn to a newly requisitioned sewer in Beach Road.

Comparison with Extant Scheme

D8.23 The revised proposals at Shorthorn will see the sea wall move considerably landward compared to the extant scheme, providing less impact on coastal natural coastal processes and greater amenity area.

D8.24 The beach levels following a storm event will generally be higher than for the extant scheme due to the revised alignment of the defences.

D8.25 There will be increased capacity within the channelised Sandy River through the development to take account of the latest climate change predictions.

D8.26 The revised proposals meet the requirements of PPS25 in full in relation to flooding where as the extant scheme does not.

Summary

D8.27 The proposed scheme meets the full requirements of PPS25 including allowance for climate change in relation to flood risk. It allows for the future upgrading of the Sandy River adits to increase their capacity to the 100 year fluvial flow in the Sandy River including allowance for climate change.

D8.28 The extant scheme provided a lesser level of protection against flood risk and no allowance for the upgrading of the Sandy River adits.

D8.29 There are no significant adverse effect and, when compared to the extant scheme, there are moderate benefits.

Water Quality

D8.30 An assessment was undertaken of construction and operational activities potentially associated with sources and pathways of sediments and oils to the EU designated bathing waters of Crinnis Leisure Centre and Crinnis Golf Links which lie adjacent to the Crinnis and Shorthorn sites respectively. The scope of work was confirmed by the Environment Agency to be limited to potential impacts on the BWD parameters, transparency and oils; it should be noted that these parameters are not used by the Environment Agency for classification of bathing water quality.

D8.31 Prior to mitigation, potential moderate adverse impacts on water quality from the proposed works could be associated with heavy plant (oils and dust), particularly on the foreshore during construction; and site runoff (oils and sediments) during operation. Prior to mitigation, potential minor adverse impacts on water quality from the proposed works could be associated with heavy plant (erosion and excavation), particularly on the foreshore during construction.

D8.32 Mitigation measures have been identified which will reduce the significance of each of the potential impacts on both of the designated bathing waters to negligible.

D9.0

Definitions & Abbreviations

Definitions

1 Primary Defence – most seaward defence formed by a reinforced concrete recurve wall with buried rock armour in Crinnis and by buried rock armour in Shorthorn.

2 Secondary Defence – reinforced concrete upstand wall with bull nose in Crinnis set back approximately 10m from Primary Defence. Ha-ha wall at Shorthorn set back approximately 10m from the Primary Defence.

3 Tertiary Line – in Crinnis the line at least 4m from the secondary wall on which buildings can be constructed.

Abbreviations

4	FRA	Flood Risk Assessment
5	MHW	Mean High Water
6	PPS25	Planning Policy Statement 25
7	ODN	Ordnance Datum Newlyn
8	3-D	3-dimensional
9	2-D	2-dimensional

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References

1 Flood Risk Assessment reference JJH/612778/JRC, January 2011

2 HR Wallingford (2006) Carlyon Bay Public Inquiry 'Historical review of beach evolution in Carlyon and St Austell Bays, Technical Note DKR 3776/TN06'

3 HR Wallingford (2009). Carlyon Bay sea defences – Design Brief – Technical Note DKR4334_TN06

4 HR Wallingford, (2010a) Beach evolution and wave overtopping studies, EX6198, October 2010

5 HR Wallingford (2010b) 3-D modelling Technical Notes (included in FRA above)

6 HR Wallingford (2010c) Sea defence and river management manual.