15 HYDROLOGY AND FLOOD RISK

Introduction

15.1 This chapter presents the findings of the Environmental Impact Assessment (EIA) work undertaken in relation to the potential impacts of the proposed development on hydrology and flood risk.

15.2 This chapter considers the hydrology and flood risk impacts throughout the proposed development's construction and operation phases.

15.3 Potential impacts regarding geology and ground conditions are assessed in Chapter 13: Ground Conditions

15.4 This chapter summarises information from technical reports and publicly available data, all of which are referenced throughout the chapter.

Regulatory and Policy Framework

15.5 The main legislative drivers for assessing and managing risks to human health and the environment, including controlled waters, groundwater and land contamination are:

Welsh/UK Legislation

- Coast Protection Act 1949;
- Environment Act 1995;
- Environmental Damage and Liability (Prevention and Remediation) Regulations 2015;
- The Environmental Protection (Duty of Care) (Amendment) (Wales) Regulations 2003;
- Floods and Water Management Act 2010;
- Land Drainage Act 1991;
- Well-being of Future Generations (Wales) Act 2015;
- The Environmental Permitting (England and Wales) Regulations 2010 (as amended 2016);
- The Groundwater (Water Framework Directive) (Wales) Direction 2016; and
- The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017.

Flood and Water Management Act 2010

15.6 The Flood and Water Management Act 2010 implements the recommendations from Sir Michel Pitt's Review of the floods in 2007 and places a series of responsibilities on councils. The main aim of the Act is to improve flood risk management.

15.7 The Act designates councils as Lead Local Flood Authorities (LLFAs) with a 'lead' role in managing flood risk from surface water, groundwater and ordinary watercourses across their jurisdictional area. This involves closely working with partners involved in flood and water management, especially NRW.

Land Drainage Act 1991

15.8 Under Section 23 of the Land Drainage Act 1991 (LDA 1991) consent is required from the relevant IDB for any works likely to obstruct, or affect the flow of, a watercourse. The relevant drainage authorities in respect of the site are NRW and PCC (LLFA). Section 66 of the LDA 1991 makes provisions for the creation of byelaws considered necessary for securing the efficient working of the drainage system. Under the byelaws consent is required from the relevant drainage authority for any development within a particular distance of a drainage system.

Relevant Guidance

- CIRIA Report C532. Control of Water Pollution from Construction Sites;
- CIRIA Report C741 Environmental Good Practice on Site; and
- CIRIA Report C753 (2015) The SuDS Manual.
- Welsh Government (2018) Statutory standards for sustainable drainage systems – designing, constructing, operating and maintaining surface water drainage systems

National Planning Policy

Planning Policy Wales (Edition 10)

15.9 Section 6.6 of Planning Policy Wales (PPW) relates to 'Water and Flood Risk' and outlines the Welsh Government's objectives in terms of addressing flood risk.

15.10 PPW states that all development on land within the flood plain of a watercourse, or drained via a culvert, or on low lying land adjacent to tidal water is at some risk of flooding and whilst flood risk can be reduced using mitigation measures it can never be completely eliminated.

15.11 Paragraph 6.6.22 states climate change is likely to increase the risk of flooding as a result of sea-level rises, increased storminess and more intense rainfall. Flooding as a hazard involves the consideration of the potential consequences of flooding, as well as the likelihood of an event occurring. Planning authorities should adopt a precautionary approach of positive avoidance of development in areas of flooding from the sea or from rivers. Surface water flooding will affect choice of location and the layout and design of schemes and these factors should be considered at an early stage in formulating development proposals.

15.12 Local planning authorities should take a strategic approach to flood risk and consider the catchment as a whole. They should ensure that new development is not exposed unnecessarily to flooding and should consider flood risk in terms of the potential cumulative impact in the locality on a catchment wide basis (river catchment and coastal cell), recognising that this may require working across administrative boundaries. Development proposals should seek to reduce, and certainly not

increase, flood risk arising either from river and/or coastal flooding or from additional run-off from development in any location.

Technical Advice Note 14: Coastal Planning (March 1998)

15.13 Technical Advice Note 14 (TAN 14) paragraph 6 states that local planning authorities need to be aware of coastal issues. For planning purposes along open stretches of coast, the geographical extent of influence of physical processes affecting the coastline can be defined with some certainty by sediment cells or sub cells. In estuaries, the upstream extent of the tidal reach is an important boundary.

15.14 Paragraph 7 states that physical processes and ground conditions at the coast may be essential for creating and maintaining conservation and recreation sites and features. Interference with these processes may have consequences for the overall balance of the physical system. Whilst it is mandatory for the developer to demonstrate that the proposed site can be developed satisfactorily, having regard to those matters, local planning authorities still need to consider these potential effects when making planning decisions

Technical Advice Note 15: Development and Flood Risk (July 2004)

15.15 TAN 15 provides technical guidance which supplements the policy set out in PPW in relation to development and flooding. It advises on development and flood risk as this relates to sustainability principles and provides a framework within which risks arising from both river and coastal flooding, and from additional run-off from development in any location, can be assessed.

Local Planning Policy

Pembroke County Council - Local Development Plan: Planning Pembrokeshire's Future (up to 2021) (February 2013)

15.16 The Pembroke County Council (PCC) Local Development Plan (LDP) was adopted in February 2013. The LDP includes policies of relevance to hydrology which are set out below:

Policy GN.1-General Development Policy

"Development will be permitted where the following criteria are met:

- *It would not have a significant adverse impact on water quality."*

Policy GN.2 -Sustainable Design

"Development will be permitted where the relevant criteria are met:

- *It incorporates a resource efficient and climate responsive design through location, orientation, density, layout, land use, materials, water conservation and the use of sustainable drainage systems and waste management solutions."*

Assessment Methodology

Study Area

15.17 A 500 m buffer around the site has been selected for data collection purposes to allow for variance in final location and alignments and to identify any existing assets or infrastructure that might affect or be affected by the proposed development. A 500 m buffer is considered appropriate for data collection considering the nature of the development and the likely zone of influence on hydrological receptors. Given the landscape surrounding the development and ongoing anthropogenic activities it will be difficult to ascertain the exact source of any impacts on water quality beyond the 500 m buffer.

Baseline Methodology

Desktop Study

15.18 The hydrology and flood risk information for the study area was gathered through a detailed desktop review of publicly available sources of literature from NRW, British Geological Survey (BGS) and PCC, as summarised in Table 15.1 below.

Table 15.1 Summary of Information Sources Consulted during the Preparation of the Report

Source	Data	Information consulted/ provided
Ordnance Survey	Online OS Mapping 1: 50 000 Sheet 158: Tenby & Pembroke	Area information, rivers and other watercourses, general site environs, built environment and catchment Information
British Geological Survey	BGS (online) Geology of Britain Viewer	Site and area geology
Natural Resources Wales (NRW)	NFW data holdings, customer service and engagement team	Current flood risk, local flood defences, flood levels, supplementary geology and groundwater information
Local Planning Authority (LPA). Pembrokeshire County Council.	Pembrokeshire Local Development Plan (February 2013)	Flood Zoning. Local Development Framework
Water Utility Company	Private Water Utilities	Water and sewerage assets linking to Welsh Water
Welsh Government	Planning Policy Wales (PPW). TAN 14. TAN 15	Flood zoning for the site as used by the Natural Resource Wales (NRW)

Identification of Designated Sites

15.19 The desktop review found that the site is not located within the extents of a designated area. However, Milford Haven Estuary is located directly west and north of the site and is designated as a Site of Special Scientific Interest (SSSI) and a Special Area of Conservation (SAC).

Water Framework Directive (WFD)

15.20 The current overall WFD status for watercourses potentially affected by the site has been identified via the publicly available NRW Water Watch. This open access database provides the most up to date (2016) information for current status classifications for the coastal, transitional and river water bodies in Pembroke.

Site Specific Surveys

15.21 In order to inform the EIA, site-specific surveys were undertaken. This primarily comprised a walkover survey undertaken as part of the hydrological characterisation of the main development area and a visual inspection of local watercourses.

Consultation

15.22 A formal Scoping exercise was undertaken with PCC. PCC's Scoping Opinion is included as Appendix 4.2. In terms of hydrology and flood risk the following comments were provided:

- *"From the information provided in the Scoping Report, it would appear that the site is served or partially served by surface water drainage system. It is not clear whether these systems convey surface water directly into the Haven Waterway or whether other methods of disposal are utilised.*

- *In order to gain a better understanding of the current mechanisms for surface water disposal it would be advisable to undertake further investigations/tracing of the system. This should include any culvert/drain currently discharging into the pickling pond and graving docks both of which are intended to be infilled. Any existing watercourses, drains, ditches and outfalls which are disturbed by the proposals should be suitably intercepted and redirected to ensure that the existing local drainage network is not adversely affected.*

- *If there are any ordinary watercourses/culverted ordinary watercourses that may be affected by the development, the applicant should note that under no circumstances should any structure be built over ordinary watercourses or within 3 metres from the top of bank of any watercourse, or within 3 metres of a culverted watercourse, without the prior agreement of PCC. This will ensure that access can be maintained for future maintenance. The applicant should also be made aware that ordinary watercourses must not be filled in, culverted, or the flow impeded in any manner, without the prior written consent of PCC under section 23 Land Drainage Act 1991 as amended by the Flood & Water Management Act 2010. Consent is also required to alter a culvert in a manner that would likely to affect the flow of an ordinary watercourse, and for temporary as well as permanent works."*

15.23 NRW provided the following comments during Scoping:

- *"We agree with the scope of work to be undertaken as part of the ES, however, we would add that the applicant should consider a 75 year lifetime of the development and as such the applicant must consider the 0.1% Annual Probability of Flooding plus climate change."*

Assessment Criteria and Assignment of Significance

15.24 The baseline characterisation set out above enables the identification of the nature of potential impacts. The assessment considers the potential impacts to environmental receptors and the pathways by which the receptors may be affected. The following terms have hydrological meaning:

- Source: increase in low permeable surfacing, potential surface water contaminant sources, ground/channel disturbance;
- Pathway: the mechanism by which the source may affect a receptor i.e. run-off; and
- Receptor: identified features that may be affected, based on the sensitivity of the site.

15.25 This includes consideration of the probability of harm occurring, taking into account potential sources of flooding, including changes in surface water runoff/quality characteristics and receptors that may be affected by changes to baseline conditions.

15.26 The potential impacts likely to occur due to the proposed development have been determined by consideration of the sensitivity of the hydrological and flood risk key attributes that may be affected and the magnitude of the predicted impacts.

Receptor Sensitivity/Value

15.27 The sensitivity or value of a hydrological receptor or attribute is largely determined by its quality, rarity and scale. The determination of value or sensitivity takes into account the scale at which the attribute is important. This can be defined as being at a local level (the Site), district level (Pembrokeshire), county level (Pembrokeshire), regional level (South West Wales), national level (Wales) or international level (Europe).

15.28 For the purpose of this ES, 'flood risk' is defined as the permanent removal of, or increase in, low permeability surfacing leading to an alteration in pre-development surface water run-off rates or a derogation of floodplain storage. 'Temporary' flood risk is the temporary removal or alteration in permeable surfacing leading to a temporary increase in surface water run-off or derogation of floodplain storage (for example during construction).

15.29 The definitions set out in Table 15.2 below have been followed in the consideration of sensitivity for this project. This table takes into account guidance provided in Table 2.1 (Volume 11, Section 2) of the Design Manual for Roads and Bridges (DMRB) (Highways Agency et al., 2008).

Table 15.2 Definition of Terms relating to the Sensitivity of Hydrological Receptors

Sensitivity	Typical Descriptors
Very High	Receptor is high value or critical importance to local, regional or national economy. Receptor is highly vulnerable to impacts that may arise from the project and recoverability is long term or not possible. Surface water: WFD Current Overall Status of High. Flood risk: Land within Flood Zone 3 or Zone C2, or with more than one hundred residential properties protected from flooding by flood defence infrastructure or by natural floodplain storage.
High	Receptor is of moderate value with reasonable contribution to local, regional or national economy. Receptor is generally vulnerable to impacts that may arise from the project and recoverability is slow and/or costly. Surface water: WFD Current Overall Status of Good. Flood risk: Land within Flood Zone 3/2 or Zone C/C1 or between one and one hundred residential properties or industrial premises protected from flooding by flood defence infrastructure or by natural floodplain storage.

Medium	Receptor is of minor value with small levels of contribution to local, regional or national economy. Receptor is somewhat vulnerable to impacts that may arise from the project and has moderate to high levels of recoverability. Surface water: WFD Current Overall Status of Moderate. Flood risk: Flood plain within Flood Zone 2/1 or Zone B, or has limited constraints and a low probability of flooding of residential and industrial properties.
Low	Receptor is of low value with little contribution to local, regional or national economy. Receptor is not generally vulnerable to impacts that may arise from the project and/or has high recoverability. Surface water: WFD Current Overall Status of Poor. Flood risk: Flood plain within Flood Zone 2/1 or Zone A, or has limited constraints and a very low probability of flooding of residential and industrial properties.
Negligible	Receptor is of negligible value with no contribution to local, regional or national economy. Receptor is not vulnerable to impacts that may arise from the project and/or has high recoverability. Surface water: WFD Current Overall Status of Bad. Flood risk: Area outside flood plain (Flood Zone 1/ Zone A) or flood plain with very low probability of flooding industrial properties.

Magnitude of Impact

15.30 The magnitude of any predicted impact is dependent on its size, duration, timing (e.g. seasonality) and frequency (permanent, seasonal etc.). A qualitative appraisal of the likely magnitude of the predicted impact is provided within this assessment, taking into account the measures proposed to be adopted as part of the development to control such impacts. The magnitude of the predicted impact has been described using the criteria outlined in Table 15.3 below. This table takes into account guidance provided in Table 2.2, (Volume 11, Section 2) of DMRB (Highways Agency et al., 2008).

Table 15.3: Definition of Terms relating to the Magnitude of an Impact upon Hydrology and Flood Risk

Magnitude	Typical Descriptors
High	Total loss of ability to carry on activities. Impact is of extended temporal or physical extent and of long term duration (i.e., approximately 50 years duration).
	Significant observable degradation in water resource quality and/or increase in flood risk (i.e., approximately 50 years duration).
Medium	Loss or alteration to significant portions of key components of current activity. Impact is of moderate temporal or physical extent and of medium term duration (i.e., less than 20 years).
	Observable degradation in water resource quality and/or increase in flood risk (i.e., less than 20 years).
Low	Minor shift away from baseline, leading to a reduction in level of activity that may be undertaken. Impact is of limited temporal or physical extent and of short term duration (i.e., less than two years).
	Degradation in water resource quality and/or slight increase in flood risk (i.e., up to two years).
Negligible	Very slight change from baseline condition. Physical extent of impact is negligible and of short term duration (i.e., less than two years).
	No observable degradation in water resource quality and/or flood risk (i.e., less than 2 years).
No change	No change from baseline conditions.

Significance of Effects

15.31 The significance of predicted effects has been determined using publicly available environmental data to take into account the sensitivity of the receptor and the magnitude of each impact. Table 15.3 below is used to inform the evaluation of the significance of effects. The table is based on guidance provided within the DMRB (Highways Agency et al, 2009). The significance of the effect upon hydrology and flood risk is determined by correlating the magnitude of the impact and sensitivity of the receptor. The particular method employed for this assessment is presented in Table 15.4 and the final assessment for each effect is based upon professional judgement.

15.32 For the purpose of this assessment, any effects with a significance level of minor or less are considered to be not significant in EIA terms.

Table 15.4 Matrix used for the Assessment of the Significance of Effect.

Sensitivity	Magnitude of Impact				
	No Change	**Negligible**	**Low**	**Medium**	**High**
Negligible	No change	Negligible	Negligible or Minor	Negligible or Minor	Minor
Low	No change	Negligible or Minor	Negligible or Minor	Minor	Minor or Moderate
Medium	No change	Negligible or Minor	Minor	Moderate	Moderate or Major
High	No change	Minor	Minor or Moderate	Moderate or Major	Major or Substantial
Very high	No change	Minor	Moderate or Major	Major or Substantial	Substantial

Limitations of the Assessment

15.33 The assessment is primarily based on publicly available data obtained from NRW, PCC and commercial data supply companies, as well as additional information supplied from stakeholders during the Scoping and consultation stages.

15.34 NRW Flood Risk Maps do not take into account the impact of local flood defences and climate change on flooding, and do not provide information on flood depth, speed or volume of flow. The maps do not show flooding from other sources such as groundwater, direct runoff from fields or overflowing sewers. However, a description of these sources of flooding is provided in the Flood Consequences Assessment (FCA) that is included as Appendix 15.1, such that sufficient baseline information has been available in order to undertake the assessment.

15.35 However, the assessment is limited by a lack of:

- Flow data for watercourses and drainage channels; and
- Water quality data for specific ordinary watercourses in close proximity to the site.

15.36 Notwithstanding the above, overall a reasonably high level of certainty has been applied to the baseline and assessment presented in this chapter. Where available, catchment data regarding water quality has been used to inform the assessment, with a hydrological site walkover undertaken within the study area. The information that was available is considered sufficient to establish the baseline within the study area, therefore, there are not considered to be any data limitations that would affect the conclusions of this assessment.

15.37 Similarly, the information accessible and provided by consultees in order to complete the assessment is considered to have a high level of certainty sufficient to establish the baseline with no data limitations that would affect the conclusions of this assessment.

Baseline Environment

15.38 The baseline datasets have been collated to inform the assessment of the potential environmental effects of the proposed development. Current baseline conditions were ascertained through a desk-based assessment utilising publicly available data including OS mapping, NRW data and utility plans, site walkover and a limited drainage survey. This provided an insight into surface water features and the existing land use of the hydrological features within the immediate vicinity of the site.

Current Baseline

15.39 The site lies entirely within Pembroke Port.

15.40 A topographical survey indicates that the existing site is relatively flat, with the site sloping marginally towards the west, from 8.1 mAOD along the eastern extent of the site to the lowest point of 6.0 mAOD along the western boundary.

15.41 The closest watercourse to the site is the tidally dominated Milford Haven Waterway which lies immediately to the north and west. The Waterway has been classified by NRW as the main risk of flooding. The NRW Western Wales Flood Risk Management Plan confirms that fluvial flooding is not considered a risk for the site and therefore, this has not been assessed further in this chapter.

15.42 A culvert survey undertaken by Arcadis in January 2019 (Pembroke Dock Marine Infrastructure Gate 4 – Timber Pond/Graving Dock Infill) identifies a number of outfalls from the site into Milford Haven Waterway. The main outfall is located on the western boundary of the site and links the Waterway to the Timber Pond via a stone chamber. Flows through the culvert and the water level within the Pond are managed by a manually operated penstock. A secondary culvert then links the Timber Pond with the Graving Dock facilitating the management of water levels within the Graving Dock. Surface water runoff from low permeable areas of the site are conveyed by virtue of gravity and the existing drainage network to a number of outfalls which discharge into both the Timber Pond and Graving Dock. The Timber Pond and Graving Dock will be infilled as part of the proposed development.

15.43 Responsibility for ordinary watercourses which discharge into the Milford Haven Waterway fall under the jurisdiction of PCC as the LLFA under the Flood and Water Management Act 2010 and Land Drainage Act 1991. The LLFA is required to exercise general supervision over all matters relating to water level management within its administrative area.

15.44 Further descriptions of the key hydrological and flood risk characteristics within the study area are set out below.

Hydrological Setting

15.45 Potential sources of flooding for the site have been assessed and are set out in detail within the FCA (Appendix 15.1). They are summarised below.

Fluvial and Tidal Flooding

15.46 The NRW Flood Risk Map uses four categories to describe the risk of flooding. These categories are set out in Table 15.5 below.

Table 15.5 NRW Flood Zone Definitions

Flood Zone	Flood Zone Definition
Very Low	This land is assessed as having less than 1 in 1000 (0.1%) of flooding in any year.
Low	This land is assessed as having between 1 in 1000 (0.1%) and 1 in 100 (1%) chance of flooding in any year.
Medium	This land is assessed as having between 1 in 100 (1%) and 1 in 30 (3.3%) chance of flooding in any year.
High	This land is assessed as having a chance of flooding greater than 1 in 30 (3.3%) in any year.

15.47 NRW notes that Milford Haven Waterway is the only source of flooding within the study area, therefore the risk of flooding is determined to be tidally dominant.

15.48 The NRW Flood Risk Map indicates that the site lies in an area with low probability of flooding, assessed as land having a less than 1 in 1,000 annual probability of river or sea flooding. The area is defined as Zone A by the Welsh Government in the Development Advice Maps (DAMs) that accompany TAN 15.

15.49 As discussed in the FCA (Appendix 15.1) extreme tidal levels have been extracted from the Lle Website (http://lle.gov.wales/home) (accessed November 2018), the data has been used to generate tidal flood levels including future climate change.

15.50 The most recent climate change allowances (NRW, December 2016) outlined in Table 15.11 of this chapter indicate that an additional 1.094 m increase in ground level should be incorporated to account for future climate change up to 2116. To ensure that climate change is not 'double counted' the 1.094 m allowance for the site has been added to the modelled 1 in 200-year tidal flood level (4.78 mAOD) generating a flood level of 5.87 mAOD. Compared against the lowest approximate site level of 6.0 mAOD flooding is not anticipated to reach site based on the 1 in 200-year flood event plus climate change (see Table 15.6).

Table 15.6: NRW Extreme Tide Levels

Return Period (years)	Extreme Tide Level (mAOD)
100	4.69
200	4.78
200 plus Climate Change	5.87
1,000	4.98

Flood Defence Details

15.51 The NRW Flood Map identifies that the site is not protected by flood defences.

Groundwater Flooding

15.52 Full details of the ground conditions of the site can be found in Chapter 13: Ground Conditions. The underlying superficial deposits are Alluvium (Clay Silty, Sand and Gravel) underlain by bedrock of the Pembroke Limestone and Black Rock Subgroup and Gully Oolite formation Limestone.

15.53 There are no records of groundwater flooding within the site.

Surface Water Flood Risk

15.54 Surface water flood mapping produced by NRW indicates that the majority of the site area is at 'very low' risk with a chance of flooding each year of less than 1 in 1,000 (0.1%). Localised areas within the site are defined as being at 'low' risk between 1 in 1000 (0.1%) and 1 in 100 (1%) chance of flooding each year.

15.55 As the site is largely already surfaced by low permeable hardstanding, bar a c. 1 ha area of vegetated scrub the change in permeability as a result of the proposed development has been identified as not significant .

15.56 The main risk of flooding is associated with surface water ponding in localised areas of the site.

Flooding from Infrastructure/Sewer Failure

15.57 No potential sources of flooding from artificial drainage systems, sewers, ponds or reservoirs have been identified.

Historical Flood Events

15.58 The NRW Western Wales Flood Risk Management Plan (2015) indicates that in 2014 a combination of high tides, strong wind and large waves resulted in the worst tidal flood event in 15 years. However, the site was not affected by the flooding.

Surface Water Resources

Surface Water and Drainage Strategy

15.59 The nearest watercourse to the site is Milford Haven Waterway which is located north and west of the site. A large square Timber Pond is located in the south-western corner of the dock (in the Gate 4 area). As described in paragraph 1.43 above, surface water runoff from a large proportion of the site is directed by virtue of gravity and a drainage network towards the Timber Pond discharging into the Pond by a number of outfalls. A secondary drainage network has been identified draining the northern area of the site, via which surface water flows are directed to the Graving Dock, from where flows are discharged by an outfall. Both the Timber Pond and Graving Dock will be infilled as part of the proposed development, causing disruption to the culvert and the outfalls. A detailed assessment of infilling of the Timber Pond and the Graving Dock is presented in Pembroke Dock Marine Infrastructure, Gate 4 - Timber Pond/Graving Dock Infill Report (Arcadis, January 2019) which is included as Appendix 2.2 of this ES.

Surface Water Abstraction

15.60 The Envirocheck Report (2018) confirms that there are no surface water abstractions within the study area.

Groundwater Water Abstraction

15.61 The Envirocheck Report (2018) confirms that there is no groundwater abstraction within the study area.

Discharge Consents

15.62 The Envirocheck Report (2018) confirms that there are two active discharge consents within the study area (see Table 15.7).

Table 15.7: Surface Water Discharge Consents within the Study Area

Name of Holder	Licence Number	Grid Reference	Distance from Site	Permitted Annual Yield (m3/year)
Dwr Cymru Cyfyngedig	Bp0209401	196770 203730	396	79,555,000
Dwr Cymru Cyfyngedig	Bp0116201	196880 203780	497	79,555,000

Pollution Incidents to Controlled Waters

15.63 The Envirocheck Report (2018) also provides records for four pollution incidents to controlled waters within the study area (see Table 15.8).

Table 15.8: Pollution Incidents within the Study Area

Location	Distance from Site (m)	Grid Reference	Pollutant Description	Incident Reference	Date
Summerfield Stores, Diamond Street, Pembroke Dock	333	196700 203700	Chemicals - Other Inorganic	32743	June 1997
Summerfield Stores, Diamond Street, Pembroke Dock	333	196700 203695	Chemicals - Other Inorganic	32743	June 1997
Hobbs Point Walkway, Laugharne Holiday Park	481	196700 204195	Crude Sewage	29313	August 1996
Hobbs Point Walkway, Laugharne Holiday Park	484	196705 204195	Oils - Other Oil	29313	August 1996

Substantiated Pollution Incidents

15.64 The Envirocheck Report (2018) states that no Category 2 (Significant Incident) substantiated pollution incident has occurred within the study area.

Surface Water Quality

15.65 No water quality data is available for the site or the surrounding area within the catchment data explorer or the Envirocheck Report (2018).

Sensitive Receptors

15.66 The sensitive receptors listed in Table 15.9 below have the potential to be affected by effects arising from the proposed development. The assessment in this chapter has considered the potential effects upon these sensitive receptors.

Table 15.9: Potentially Affected Sensitive Receptors

Receptor	Importance/Sensitivity/Vulnerability to Change
Milford Haven Waterway	High
Groundwater Resources	High

Climate Change

15.67 The Met Office UK Carbon Projections ('UKCP09') datasetprovides probabilistic projections of change in climatic parameters over time for 25 km grid squares across the UK. Projected changes

during low, medium and high future global greenhouse gas emissions scenarios have been reviewed for the period from 2020 up to 2069, encompassing the construction and operational phases of the proposed development.

15.68 CP09 is presently being updated to CP18, expected to be published in November 2018 (Met Office, 2018). CP09 remains the most up-to-date available data and remains an appropriate tool for adaptation planning (Met Office, 2017).

15.69 PPW sets out how the planning system should help minimise vulnerability and provide resilience to the impacts of climate change. This includes demonstrating how flood risk will be managed now and over a development's lifetime, taking climate change into account. Guidance requires that FCAs take into account, where appropriate, increases in rainfall intensity, peak river flows and sea level rise.

15.70 The range of allowances (see Table 15.10) is based on percentiles. The 50th percentile is the point at which half of the possible scenarios for peak rainfall intensity fall below it and half fall above it. The central estimate is based on the 50th percentile and the upper estimate is based on the 90th percentile.

15.71 Table 15.10 below identifies the range of increase per time period for peak rainfall intensity. Assessment should assess both the central and upper estimates to understand the range of impact.

Table 15.10: Change to Extreme Rainfall Intensity compared to a 1961-90 Baseline

West Wales	Total potential change anticipated for '2020s' 2015- 39)	Total potential anticipated for (2040- 2069)	change '2050s'	Total potential change anticipated for the '2080s' (2070-2115)
Upper Estimate	25%	40%		75%
Central Estimate	15%	25%		30%

15.72 Table 15.11 outlines the anticipated annual sea level rise associated with climate change per defined time period. NRW expect sea level rise to increase the rate of coastal erosion.

Table 15.11: Sea Level Rise

Wales	2009 to 2025	2026 to 2055	2056 to 2085	2086 to 2115	Cumulative rise 1990 to 2115 / metres (m)
Annual Change (mm/yr)	3.5 (59.5 mm)	8.0 (240 mm)	11.5 (345 mm)	14.5 (449.5 mm)	1.094 m

15.73 NRW climate change guidance has been derived from national scale research. There may be cases where local evidence supports the use of other local climate change allowances. With specific reference to changes to extreme rainfall LIT 5707 notes that UKCP09 provides useful information on change to rainfall across the UK.

15.74 RPS has added 40% to all attenuation/runoff calculations for the proposed development to account for climate change.

Assessment of Construction Effects

15.75 The identified potential environmental impacts arising from the construction of the proposed development are listed below.

- Impact of construction on temporary flood risk;
- The impact of construction on water resources; and
- The impact of construction on the on-site drainage network.

15.76 A description of the significance of impacts upon hydrology and flood risk receptors caused by each identified impact is given below.

Impact of Construction on Temporary Flood Risk

15.77 The site is at 'low' risk of tidal flooding from the Milford Haven Waterway due to its existing topography which ranges from c.6.0 mAOD to c.8.1 mAOD.

15.78 The site is currently surfaced with low permeability hardstanding. Due to this, low permeability is unlikely to increase throughout the duration of the construction period and flood risk to the surrounding area is unlikely to alter.

Sensitivity of Receptor

15.79 The land adjoining the site consists of commercial and industrial port-related uses. The staff working at these premises are considered to be sensitive receptors. These receptors are considered to be of medium recoverability and high value. The sensitivity of the receptor is therefore, considered to be high.

Magnitude of Impact

15.80 As construction is not anticipated to have a significant change the amount of existing impermeable areas on the site the run-off rates/characteristics will remain the same. Accordingly, impacts on flood risk during construction are not predicted to affect the adjoining receptors. The magnitude is, therefore considered to be low.

15.81 Furthermore, construction methodologies will ensure that off-site surface water flows during construction are not increased. Design mitigation measures will be implemented to manage surface water flows during the construction phase. This includes a suitable drainage network which will be constructed to discharge any surface water falling on the site.

15.82 Any impact is predicted to be of local spatial extent, short term duration, intermittent and high reversibility. The magnitude is therefore, considered to be low.

Significance of Effect

15.83 The overall significance of effect on flood risk without the incorporation of any management measures is assessed as minor which is deemed not significant.

15.84 The overall significance of the effect on flood risk taking into account the mitigation measures set out in Tables 15.12 and 15.13 is assessed as minor beneficial, following the use of construction drainage techniques .

The Impact of Construction on Water Resources

15.85 During construction, there is a potential risk of accumulation of standing water on site and accidental discharges of untreated run-off to watercourses whilst the development and the operational surface water drainage system are being constructed. The Milford Haven Waterway is the nearest watercourse and is a Site of Special Scientific Interest (SSSI) and a Special Area of Conservation (SAC).

15.86 The sensitivity of watercourses is dependent on the nature of the specific watercourse. There are a number of potential pollutants which could arise during construction, and hence which may affect the water quality of receiving watercourses. These are outlined below:

- Fine particulate materials (e.g. silts and clays);
- Cement;
- Oil and chemicals (from plant machinery and processes); and
- Other wastes such as wood, plastics, sewage and rubble.

15.87 These pollutants may be present as a result of normal site activities, incorrect storage of oils and chemicals and/or accidental spillage. The significance of the incident would be dependent on the nature of the pollutant, on the mitigation measures adopted and their timing and effectiveness, and on the sensitivity of the receiving watercourse.

Sensitivity of Receptor

15.88 In this case the receptor is the Milford Haven Waterway which is in light of its ecological designations is considered to be highly vulnerable and high value. The sensitivity of the receptor is, therefore, considered to be high.

Magnitude of Impact

15.89 Activities associated with machinery during construction could lead to an increase in turbid run-off and spillages/leaks of fuel, oil etc. that could affect nearby watercourses. Based on the distance to Milford Haven Waterway from the site the magnitude of impact has been assessed as high.

15.90 The construction process would include measures to intercept run-off and ensure that discharges from the site are controlled in quality and volume. In addition, water quality monitoring could be carried out throughout the construction phase to ensure no discharge of pollutants or increase in suspended sediment occurs. The impact is predicted to be of local spatial extent, short term duration, intermittent and high reversibility. The magnitude is therefore, considered to be low adverse.

Significance of Effect

15.91 The level of effect in relation to run-off from construction sites and spillages without the incorporation of management measures could be moderate or major adverse, which would be significant in EIA terms.

15.92 However, the significance of effects in relation to run-off from construction sites and spillages, including the integration of the construction mitigation measures adopted in Table 15.12 would be minor adverse, which is not significant in EIA terms.

The Impact of Construction on the On-site Drainage Network

Sensitivity of Receptor

15.93 During construction activities and the infilling of the Timber Pond and Graving Dock a disruption to the existing drainage regime is likely. A blockage on a drainage flow path/pipe run has the potential to lead to backing up of the system and surcharging of the drainage infrastructure. The potential effect to on-site drains is considered to be of moderate vulnerability, moderate to high recoverability and minor value. The sensitivity of the receptor is, therefore, considered to be medium.

Magnitude of Impact

15.94 The construction of the proposed development has the potential to remove or disrupt the on-site drainage network, in turn increasing the flood risk to the site and the surrounding receptors. The potential impact without the incorporation of construction mitigation methods would be of local spatial extent, short term duration and intermittent occurrence. It is predicted that the impact would affect the receptor directly. The magnitude, however, is considered to be low.

15.95 Construction mitigation measures would limit the disruption to the on-site drainage network and/or include temporary construction drainage, if necessary. In this case the impact is predicted to have a negligible impact on surrounding receptors, be of short term duration, intermittent and reversible. The magnitude is therefore, considered to be no change.

Significance of Effect

15.96 The significance of effect on the on-site drainage networks without any construction mitigation measures is assessed as minor and deemed not significant.

15.97 The significance of effect on the on-site drainage networks when the construction mitigation measures adopted in Table 15.12 are incorporated is considered to be no change, which is not significant.

Assessment of Operational Effects

15.98 The potential environmental effects arising from the operation and maintenance of the proposed development are listed below:

- Impact of operation on flood risk;

- The impact of operation on water resources; and
- The impact of operation on the on-site drainage network.

15.99 A description of the significance of impacts upon hydrology and flood risk receptors caused by each identified impact is given below.

Impact of Operation on Flood Risk

15.100 As confirmed previously, due to the existing topography of the site ranging from c.6.00 mAOD to c.8.1 mAOD, it is located within Flood Zone A and, therefore, it is at low risk of tidal flooding.

15.101 No increase in permanent area of low permeability surfaces is anticipated. In the absence of an appropriate drainage scheme uncontrolled surface water flows can generate a flood risk as a consequence of site operational and maintenance works.

Sensitivity of Receptor

15.102 The land adjoining the site consists of commercial and industrial port-related uses. The staff working at these premises are considered to be sensitive receptors. These receptors are considered to be of medium recoverability and high value. The sensitivity of the receptor is, therefore, considered to be high.

Magnitude of Impact

15.103 Uncontrolled surface water flows generated during site operation and maintenance could lead to an increase in flood risk. The impact is predicted to be of local spatial extent affecting the site and local receptors, short to medium term duration and intermittent occurrence.

15.104 However, the proposed development would incorporate appropriate drainage solutions as part of the detailed design, with any temporary disruption to on-site drainage being restored having regard to the mitigation measures set out in Table 15.13. As such, any potential increase in surface water run-off (flooding) would be appropriately managed.

15.105 The proposed development will retain the existing surface water drainage regime, whereby surface water flows are conveyed by an internal drainage network and discharged directly into Milford Haven Waterway. Currently there are a number of outflows into the Timber Pond in the south west of the site. The proposed development involves the infilling of this Pond, as a consequence a flow diversion will be installed directing flows to the Waterway via either the existing outfall or a new outfall. A detailed drainage design is anticipated to be required by an appropriately worded planning condition.

15.106 The site has been subject to an FCA (Appendix 15.1) and in completing this document it has been confirmed with NRW and the LLFA that because the proposed development will retain the existing drainage regime principles of directing flows into the tidally dominant Milford Haven Waterway via land in MHPA's ownership, there is no requirement to reduce existing run-off rates.

15.107 Therefore, the impact of the proposed development, subject to the mitigation measures set out in Table 15.13 is predicted to be of local spatial extent, short term duration, intermittent and highly reversible. With the operational measures proposed, it is predicted that the impact will not affect

surrounding local receptors directly. The impact of the proposed development is therefore considered to be negligible.

Significance of Effect

15.108 The significance of effect of the proposed development on flood risk is therefore minor and not significant.

The Impact of Operation on Water Resources

15.109 During the operation of the proposed development, there are likely to be a number of potential pollutants present which may give rise to water quality effects on the surrounding surface watercourses if allowed to infiltrate them. These include:

- Fine particulate materials (e.g. silts and clays);
- Hydrocarbons;
- Oils and chemicals (from plant machinery and processes); and
- Process waste water.

Sensitivity of Receptor

15.110 In this case the receptor is the Milford Haven Waterway the sensitivity of which is considered to be high.

Magnitude of Impact

15.111 Pollution arising from accidental spillages on site such as road traffic accidents could result in a range of impacts on watercourses from negligible to high. Activities associated with machinery during the operation could lead to an increase in turbid run-off and spillages/leaks of fuel, oil etc. that could affect nearby watercourses. Based on the distance to the Milford Haven Waterway the magnitude of impact has been assessed as high.

15.112 The provision of operational mitigation measures, including on-site drainage networks, as outlined in Table 15.13 would reduce the potential impact to low.

Significance of Effect

15.113 The provision of permanent operational measures as outlined in Table 15.13 would reduce the range of potential effects, should they occur, to minor adverse, which is not significant.

The Impact of Operation on the On-site Drainage Network

15.114 During operation there is a potential for disruption to the existing drainage regime. A blockage or silting up on a drainage flow path/pipe run has the potential to lead to backing up of the system and surcharging of the drainage infrastructure. The effect to on-site drains are considered to be of moderate vulnerability, moderate to high recoverability and minor value. The sensitivity of the receptor is, therefore, considered to be medium.

Magnitude of Impact

15.115 The operation of the proposed development has the potential to block on-site drainage, in turn increasing the flood risk to the site and the surrounding receptors. The potential impact without the incorporation of operation mitigation methods would be of local spatial extent, short term duration and intermittent occurrence. It is predicted that the impact would affect the receptor directly. The magnitude, however, is considered to be low.

15.116 Operation mitigation and on-site management measures would limit the disruption to the on-site drainage. In this case the impact is predicted to have a negligible impact on surrounding receptors, be of short term duration, intermittent and reversible. The magnitude is therefore, considered to be no change.

Significance of Effect

15.117 The significance of effect on the on-site drainage networks without any operation mitigation measures is assessed as minor and deemed not significant.

15.118 The significance of effect on the on-site drainage networks when the operation mitigation measures adopted in Table 15.13 are incorporated is considered to be no change, which is not significant.

Decommissioning Effects

15.119 Decommissioning impacts are those which would occur as a result of the decommissioning of the proposed development. The decommissioning impacts assessed within this chapter are as follows:

- Impact of decommissioning on flood risk; and
- Impact of decommissioning on water resources; and
- The impact of decommissioning on the on-site drainage network

15.120 The decommissioning of the strategic improvement of Pembroke Dock components will be reduced through the incorporation of management measures outlined in Table 1.12 and Table 1.13.

15.121 The decommissioning impacts have been determined to be similar and no worse than construction impacts in relation to hydrology and flood risk, and therefore are at worse minor adverse and unlikely to be significant, subject to implementation of the standard construction practice mitigation measures set out in Table 15.12.

Mitigation

15.122 Potential impacts to the water environment will be avoided where practicable through a number of standard construction mitigation measures as outlined in Table 15.12 and Table 15.13.

15.123 As part of the development process and in line with industry standard guidelines, a number of mitigation measures will be incorporated, where practicable, to reduce the potential for impacts on water resources, hydrology and flood risk. These mitigation measures are considered to be standard industry practice for this type of development and would include, but are not limited to, the production of and adherence to, a Surface Water Management Strategy and a Flood Management Plan, the anticipated content of which is summarised below.

15.124 Temporary drainage mitigation techniques including run-off interceptor channels could be installed during construction of the formal drainage to ensure that discharges from the site are controlled in quality and volume. This may include the use of settling tanks and/or ponds to remove sediment, temporary interceptors and hydraulic brakes.

15.125 Construction material and/or spoil within construction compounds will be positioned away from drainage systems or surface watercourses and no hazardous substances would be stored within close proximity of the drainage network.

15.126 Section 6 of the FCA (Appendix 15.1) describes the principles of the Outline Surface Water Drainage Strategy for the site. The detailed drainage strategy is anticipated to be the subject of a planning condition and will be prepared by the contractor before being agreed with NRW and the LLFA. The strategy will incorporate the use of appropriate SuDS techniques, interceptors and separators as required, treating surface water run-off generated from the site, prior to discharging into the local surface water network at an agreed rate.

15.127 Any area at risk of spillage, such as vehicle maintenance areas and hazardous substance stores (including fuel, oils and chemicals) will be bunded and carefully sited to minimise the risk of hazardous substances entering the drainage system or the Milford Haven Waterway. Additionally, the bunded areas will have impermeable bases to limit the potential for migration of contaminants into groundwater following any potential leakage/spillage event.

15.128 Table 15.12 below presents a list of general industry guideline and best practice measures to be incorporated into the decommissioning and construction phases of the proposed development. These measures will be included within a Construction Environmental Management Plan (CEMP).

Table 15.12 Decommissioning and Construction Mitigation Measures

Mitigation Measure	Justification
Construction	
Surface Water Management Strategy This would ensure that any increase in surface water run-off would be handled on-site and a run-off rate to the surrounding water environment (Milford Haven Waterway) is maintained at an agreed rate. It would highlight potential contaminants and suspended sediment that could originate from the site which may affect the receiving watercourse and set out appropriate monitoring to be carried out during the construction phase and continue throughout the lifetime of the development, as necessary.	To address NRW and LLFA surface water run-off requirements.
Flood Management Plan Measures to mitigate against water pollution would apply and would include procedures as set out below.	To address NRW and LLFA surface water run-off requirements.

15.129 Table 15.3 below presents a list of measures to be incorporated into the operational phase of the proposed development.

Table 15.13 Operational Mitigation Measures

Mitigation Measures	Justification
Operation	
Surface Water Drainage Strategy The strategy will incorporate the use of appropriate SuDS techniques, interceptors and separators as	To reduce the risk of surface water flooding and manage flows from increased areas of low permeable surfacing.

required, treating surface water run-off generated from the site, prior to discharging into the local surface water network at an agreed rate.	
Drainage Maintenance Plan This plan would be applicable throughout the lifetime of the proposed development covering drainage within the site and any connections to the surface water, or foul sewer and trade waste networks.	To reduce the risk of surface water pollution and to maintain the drainage network in order that flood risk does not increase temporarily.
Flood Management Plan This plan would be applicable throughout the lifetime of the proposed development and should include flood-warning measures.	To reduce the risk of surface water pollution and to maintain the drainage network in order that flood risk does not increase temporarily
Emergency Spillage Management Plan This plan would be applicable throughout the lifetime of the proposed development and should include emergency measures in the event that spillages should occur.	To reduce the risk of surface water pollution and to maintain the drainage network in order that flood risk does not increase temporarily
Water Quality Monitoring Strategy Ongoing water quality monitoring should be undertaken throughout the lifetime of the proposed development.	To reduce the risk of surface water pollution and to maintain the drainage network in order that flood risk does not increase temporarily

Residual Effects

15.130 Residual effects are those that are predicted to remain after implementation of the measures outlined in Table 15.12 and Table 15.13. The residual effects have been set out in the main assessment sections of this chapter. No significant effects have been identified.

Cumulative Assessment

15.131 This section considers inter-project cumulative effects of the proposed development on hydrology and flood risk in conjunction with other projects/developments with the potential to contribute to such effects.

15.132 In this regard the potential cumulative developments included in the Scoping Opinion (**Appendix 4.2**) have been considered and a review of these developments within a 500 m search area from the site has been undertaken. This has identified two potentially cumulative developments:

- Martello Quays; and
- Marine Energy Test Area (META).

15.133 A 500 m search area is considered appropriate considering the nature of the proposed development and likely zone of influence on hydrological receptors. Given the landscape surrounding the site, current and ongoing activities, as well natural baseline fluctuations it will be difficult to ascertain the exact source of any impacts on flood risk and/or water quality beyond 500 m.

15.134 In accordance with PPW and TAN 15, any new development is required to attenuate surface water run-off, where practicable, to the greenfield run-off rate and provide appropriate management techniques to treat potentially contaminated run-off prior to discharge into the local drainage network.

15.135 Any works undertaken within 16 m of a watercourse and/or flood defences require consent from either NRW, the LLFA or the IDB, depending on whether the waterbody is designated a Main River

or Ordinary Watercourse. For the consent to be issued the developer is required to demonstrate that the risk of flooding during the lifetime of the development could be mitigated to a level acceptable to NRW, the LLFA and/or the IDB. Having regard to these requirements, the cumulative impacts in respect of hydrology and flood risk are predicted to be not significant.

15.136 Therefore, it has been determined that no significant cumulative effects on hydrology and flood risk receptors are likely.

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