

Flood Consequence Assessment – The Mole, Barry Docks

P01

April 2021

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Revision History

Revision Ref/Date	Amendments	Issued to
April 2021	-	Nick Card

Contract

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Purpose

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Abbreviations

ABP	Associated British Ports
AEP	Annual Exceedance Probability
FRAW	Flood Risk Assessment Wales
JBA	JBA Consulting
NRW	Natural Resources Wales
PPW	Planning Policy Wales
TAN-15	Technical Advice Note 15

1 Introduction

1.1 Terms of Reference

JBA Consulting were commissioned by Associated British Ports (ABP) to undertake a Flood Consequence Assessment (FCA) to support a planning application for proposed engineering works at the Mole, Barry Docks.

1.2 FCA Requirements

This FCA follows Welsh Government guidance on development and flood risk set out in Technical Advice Note 15: Development and Flood Risk (TAN-15). Where appropriate the following aspects of flood risk will be addressed in all planning applications over its expected lifetime in flood risk areas:

- The likely mechanisms of flooding
- The likely source of flooding
- The depths of flooding through the site
- The speed of inundation of the site
- The rate of rise of flood water through the site
- Velocities of floodwater across the site
- Overland flow routes
- The effect of access and egress and infrastructure, for example public sewer outfalls, combined sewer outflows, surface water sewers and effluent discharge pipes from wastewater treatment works
- The impacts of the development in terms of flood risk on neighbouring properties and elsewhere on the floodplain

2 Site Description

2.1 Site location

The 3.1ha Brownfield site is located in Barry in the Vale of Glamorgan (NGR ST115673), as shown in Figure 2-1. The site is located in an industrial area of Barry, within the docks, and currently houses the Barry Community Water Activity Centre. A residential development, and Neptune Road forms the western boundary of the site, with all other boundaries surrounded by Barry Dock.

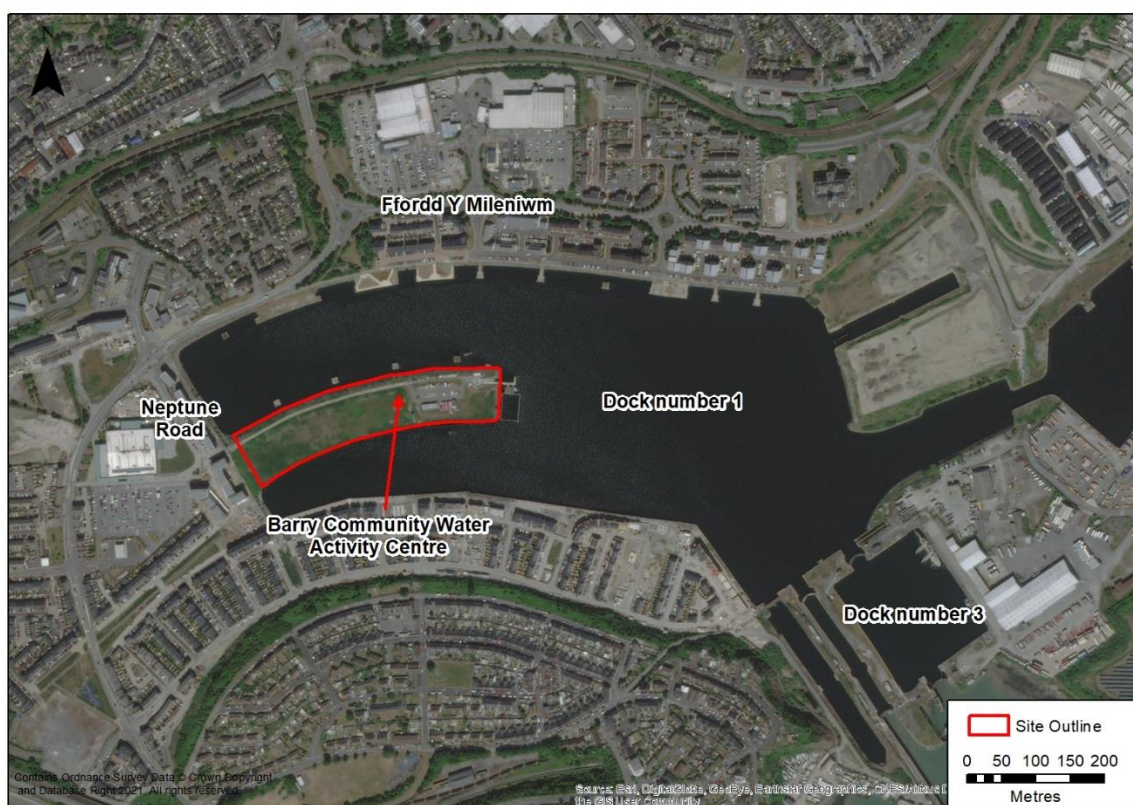


Figure 2-1 Site location

2.2 Site topography

The site has a generally flat topography as shown in Figure 2-2. There is a slight slope from 8.9mAOD in the west of the site to 8.6mAOD in the east. From north to south the site is generally level, except for an existing access road along the northern boundary of the site which is approximately 0.9m lower than the surrounding ground level. An area of raised ground adjacent to the access road has an approximate level of 9.2mAOD. A slipway in the eastern part of the site is represented by a lower ground level of 7.5mAOD.

Peak Surveying Services have produced a detailed topographic survey of the site which can be found in Appendix A. Figure 2-2 gives a broad overview of levels on site using NRW 1m LiDAR.

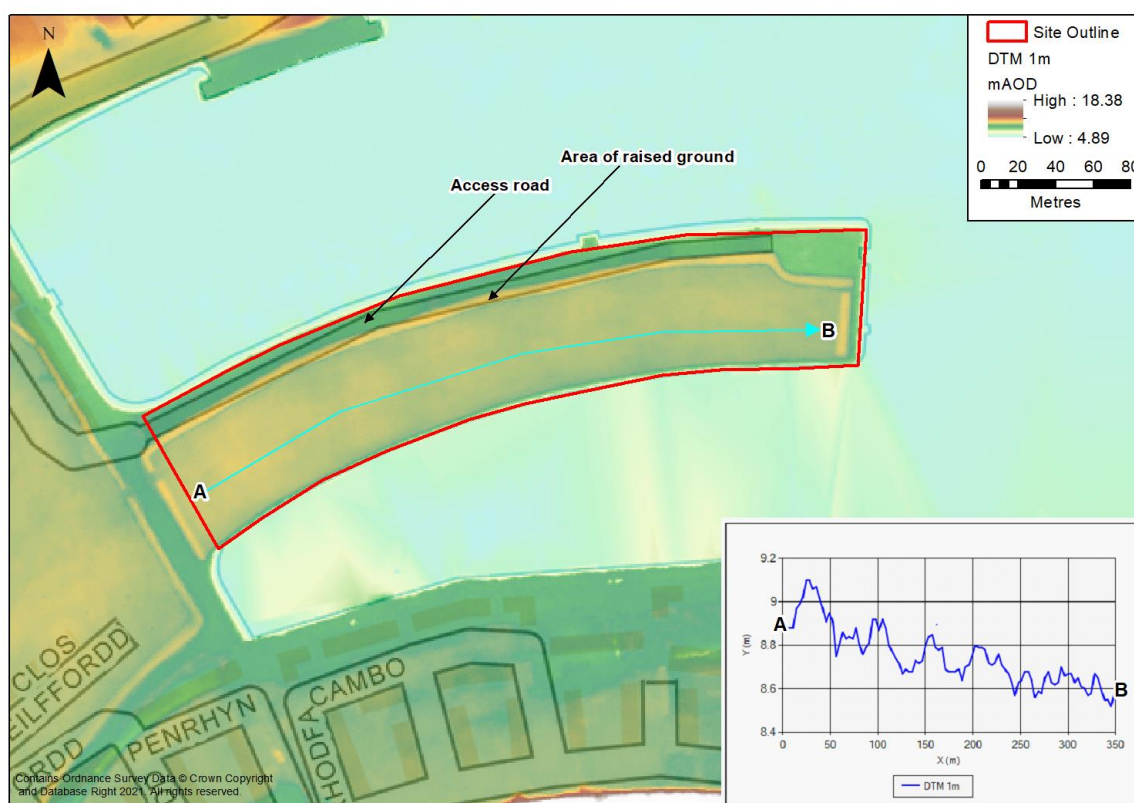


Figure 2-2 Site topography using Natural Resources Wales 1m LiDAR

2.3 Soils and Geology

The soils on site were assessed on the Cranfield Soilscales Viewer¹ and were shown to be freely draining slightly acid but base-rich soils. However, due to the industrial nature and setting of the site it is very likely that the soils on site are heavily compacted and constitute of made ground to significant depths. This means that the site is effectively impermeable.

The geology of the site was assessed using the BGS Geology of Britain Viewer². The bedrock geology was shown to be Blue Anchor Formation comprised of mudstone and other sedimentary bedrock. Superficial deposits at the site are comprised of clay, silt and sand.

2.4 Proposed development

Future proposals for the site include development for residential purposes. To support these future aspirations, ground raising at the site is required to mitigate flood risk. Consequently, this FCA has been prepared solely to support a planning application for engineering works to raise the ground levels in the full extent of the development site (shown by the red line boundary in Figure 2-1). The proposed ground raising will level the entire site to a minimum level of **9.00mAOd**.

Due to the size and location of the site it is assumed that any future development will house several apartment blocks with associated roads and parking spaces. The Water Activity Centre in the eastern part of the site is likely to be re-located to Easy Quay, adjacent to Ffordd Y Milleniwm Road.

1 <http://www.landis.org.uk/soilscales/>

2 <http://mapapps.bgs.ac.uk/geologyofbritain/home.html>

3 Planning Policy

3.1 Planning context

Planning Policy Wales (PPW) sets out the main planning policies required by the Welsh Government. These policies have the aim that all development in Wales is sustainable and improves the social, economic, environmental and cultural wellbeing of Wales as set out in the Wellbeing of Future Generations Act 2015. PPW uses a series of Technical Advice Notes to provide more guidance on areas of planning and development in Wales. Technical Advice Note 15 (TAN-15) introduced by the Welsh Government in 2004 provides technical guidance relating to development planning and flood risk in Wales. The initial requirement of TAN-15 is to identify vulnerability classifications and flood zones relevant to the proposed development.

3.2 Vulnerability classification

TAN-15 generally assigns one of three flood risk vulnerabilities to a development as shown in Table 3-1. Engineering works, which for this development involves raising ground level, are not classified in the flood risk vulnerabilities in TAN-15. Therefore, the development is classified as 'Other'. Section 5.3 and Section 9 of TAN-15 identifies that there are developments which do not fit in to the three main vulnerability categories as shown in Table 3-1. The Justification Tests do not apply to development classed as Other, although the Acceptability Criteria must still be satisfied.

Table 3-1 Development categories defined by TAN 15

Development category	Types
Emergency services	Hospitals, ambulance stations, fire stations, police stations, coastguard stations, command centres, emergency depots and buildings used to provide emergency shelter in time of flood.
Highly vulnerable development	All residential premises (including hotels and caravan parks), public buildings (e.g. schools, libraries, leisure centres), especially vulnerable industrial development (e.g. power stations, chemical plants, incinerators), and waste disposal sites.
Less vulnerable development	General industrial, employment, commercial and retail development, transport and utilities infrastructure, car parks, mineral extraction sites and associated processing facilities, excluding waste disposal sites.

Little guidance is given in TAN-15 in regard to developments with the vulnerability classification of Other. However, as the site is intended for future residential development it would be prudent to consider a 100 year life time for the development.

3.3 DAM zoning

The Development Advice Map (DAM) created by the Welsh Government is used to trigger different planning actions based on a precautionary assessment of flood risk. Figure 3-1. shows that the site is located within DAM Zone C2, with areas to the west of the site located in Zone B.

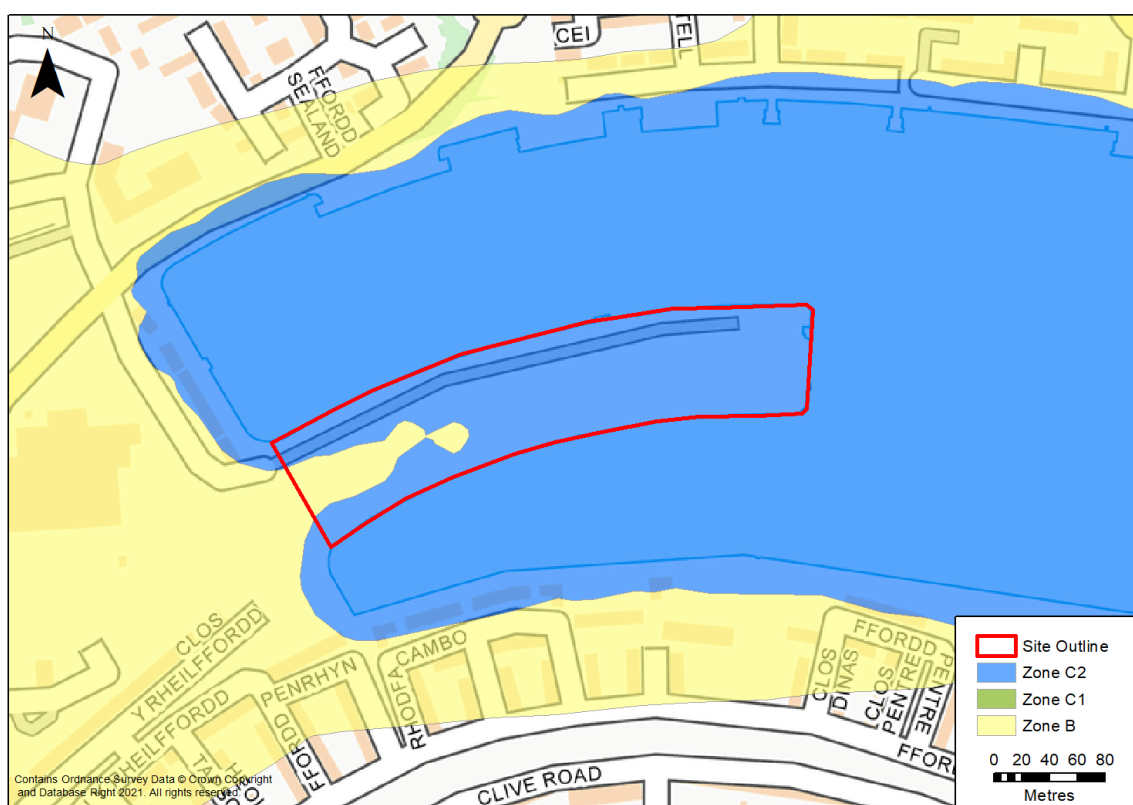


Figure 3-1 Development Advice Map

In October 2020, JBA Consulting submitted to NRW updated tidal flood modelling for a number of sites in the Barry Dock area, including the proposed development site. This established to the satisfaction of NRW new flood risk modelling for the area through the Flood Map Challenge process.

This new modelling showed the current DAM to be inaccurate, with none of the Mole site located within the 0.1% AEP flood extent that defines DAM Zone C2.

Following NRW approval of the updated modelling, the site can be re-classified to Zone A (areas with little to no flood risk). On receipt of this information NRW would usually update the DAM maps to show the change in zone. However, NRW are in the process of updating the DAM maps and during this process they state that:

"We will continue to accept, and review models submitted in support of a planning application consultation, which will be used to inform our technical flood risk advice. However, this information will not be incorporated into the Development Advice Map and there will be no change made to the flood zones."

Figure 3-2 shows how the DAM map would look if NRW updated the mapping as a result of the accepted new flood modelling. The map shows that the development site is no longer located in Zone C2 and is instead located in Zone A (as shown by no shading on the map).

A Flood Consequence Assessment (FCA) is not normally required for developments outside of Zone C. However, recognising the transitional status of the DAM, with a DAM update agreed but not yet implemented online, this FCA has been prepared to document the detailed site-specific appraisal of flood risk at the proposed development site.

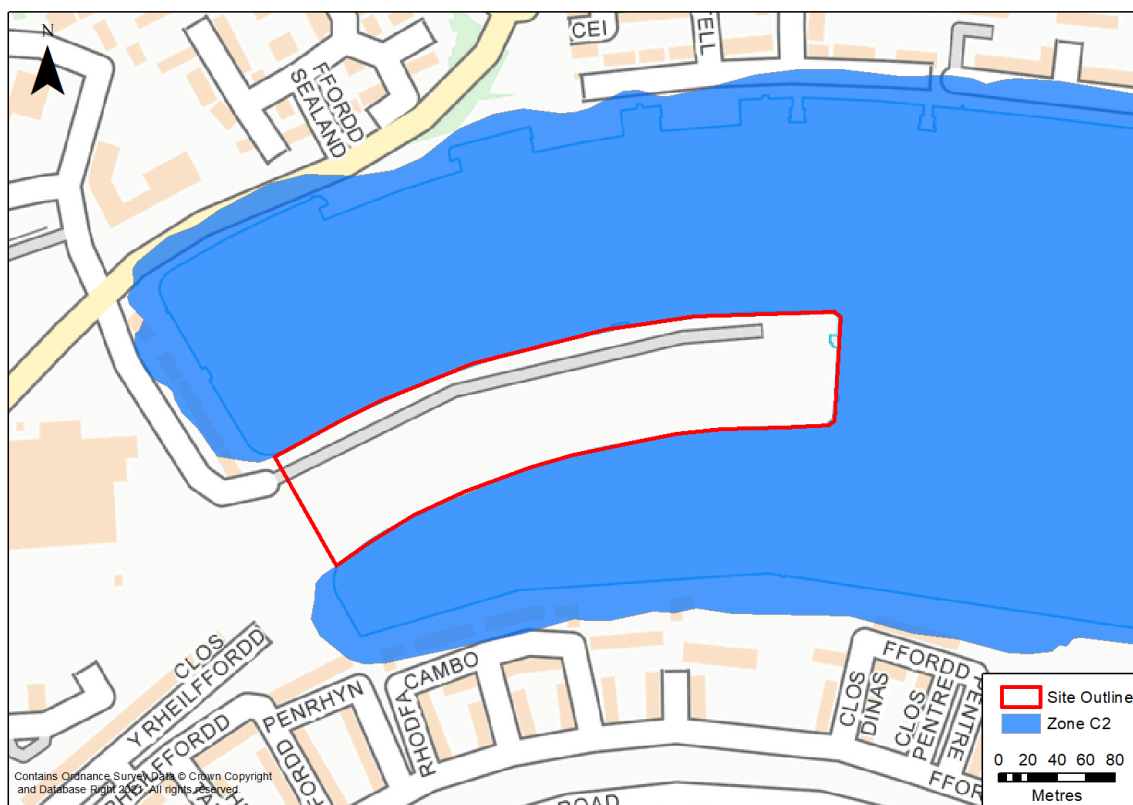


Figure 3-2 Changes to the DAM map as agreed by NRW

3.4 Vale of Glamorgan Local Development Plan (2017)

The Vale of Glamorgan Adopted Local Development Plan (LDP)³, adopted in 2017, sets out the council's vision and objectives for the development and use of land in the Vale of Glamorgan, together with the policies and proposals to implement until 2026.

The proposed development site is located within the Barry Waterfront development identified as a strategic site in the LDP as Policy MG3. The Barry Waterfront development aims to provide 1,700 homes in addition to retail and office space, community leisure and education facilities. The Mole development will eventually contribute towards this aim preparing the site for future residential developments.

3.5 Justification Test

The Justification Test is used to ensure that only development that is justified within flood risk areas is permitted. As the site is categorised as Other, application of the Justification Test is not required. Neither is the Justification Test applicable in DAM Zone A.

³ Vale of Glamorgan Adopted Local Development Plan (2017)
<https://www.valeofglamorgan.gov.uk/Documents/Living/Planning/Policy/LDP/LDP-Adoption/Adopted-LDP-Written-Statement-June-2017-final-interactive-web-version.pdf>

4 Flood Risk Assessment

A review of the existing data on flood risk from all sources has been undertaken and is summarised in Table 4-1 below.

Table 4-1 Summary of flood risk to the site

Source of Flooding	Onsite Presence	Description
Flood Risk from Rivers	×	The site is at very low risk of flooding from rivers (Section 4.1)
Flood Risk from the sea	✓	The site is at low risk of flooding from the sea (Section 4.2)
Flood Risk from Surface Water and Small Watercourses	✓	There are localised areas of low surface water and small watercourse flooding on the northern and eastern boundaries of the site, but the site is predominantly at 'very low' risk from surface water flooding (Section 4.3).
Reservoirs	×	The site is not at risk from reservoir flooding.
Groundwater	×	The site is at very low risk of groundwater flooding (Section 4.5).
Canals	×	The site is not at risk of flooding from canals.
Sewers	×	The site is not considered to be at risk from sewer flooding.

4.1 Flood Risk from Rivers

The NRW Flood Risk Assessment Wales (FRAW) map shows that the site is at very low risk of flooding from rivers. This means that there is less a 0.1% AEP chance of fluvial flooding at the site. No figure is provided as very low risk is shown as a clear layer on the FRAW mapping.

4.2 Flood Risk from the Sea

The NRW FRAW map in Figure 4-1 shows that the site is mainly at very low risk of flooding from the sea. This means that there is less a 0.1% AEP chance of tidal flooding at the site. In the north eastern corner of the site, around the slip way, the chance of tidal flooding is considered to be low risk due to the lower ground levels in this area. Low risk is between a 0.5% and 0.1% AEP event. Section 5 of this report documents the detailed tidal modelling work that has been undertaken to support this FCA which has been submitted and accepted by NRW.

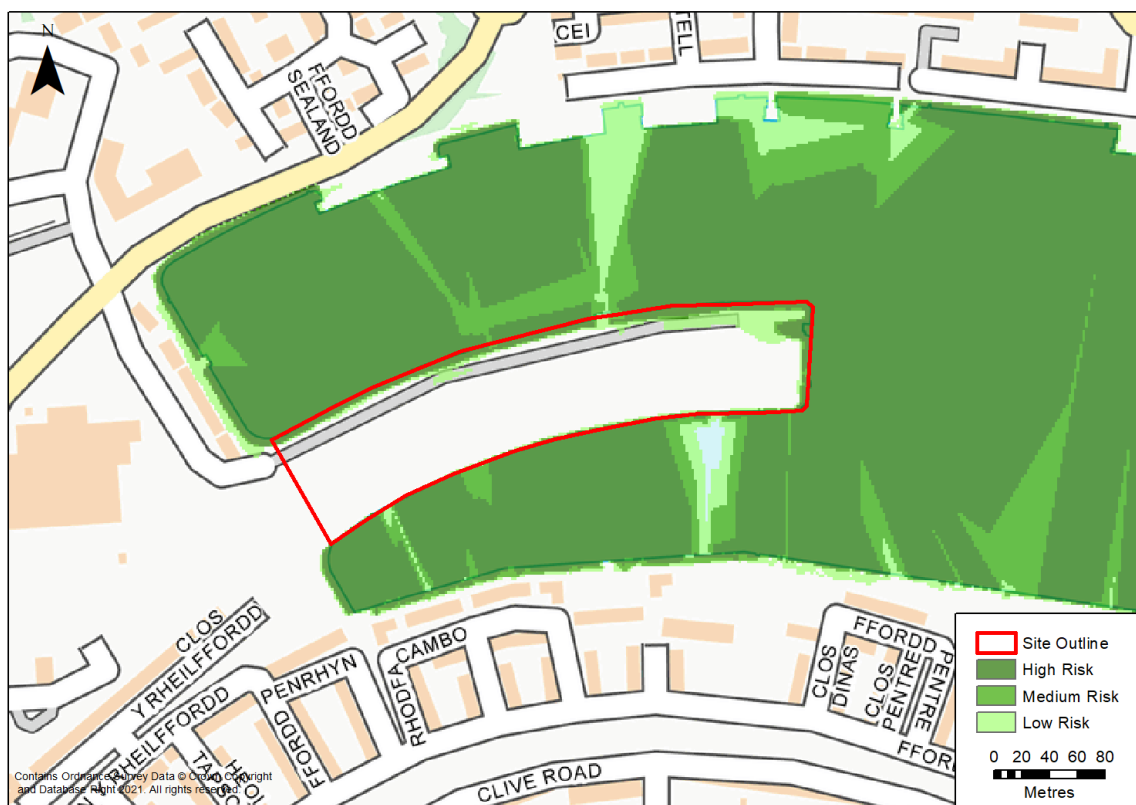


Figure 4-1 NRW FRAW map for tidal flooding

4.3 Surface water and small watercourse risk

The NRW FRAW map for surface water and small watercourses is shown in Figure 4-2. The site is largely at 'very low' risk from surface water and small watercourse flooding where there is a less than a 0.1% AEP chance of flooding in any given year. The northern and eastern boundaries of the site are shown to be at a low risk of surface water flooding. However, this is an artifact of the broadscale modelling approach, as surface water in these areas will rapidly drain to the dock.

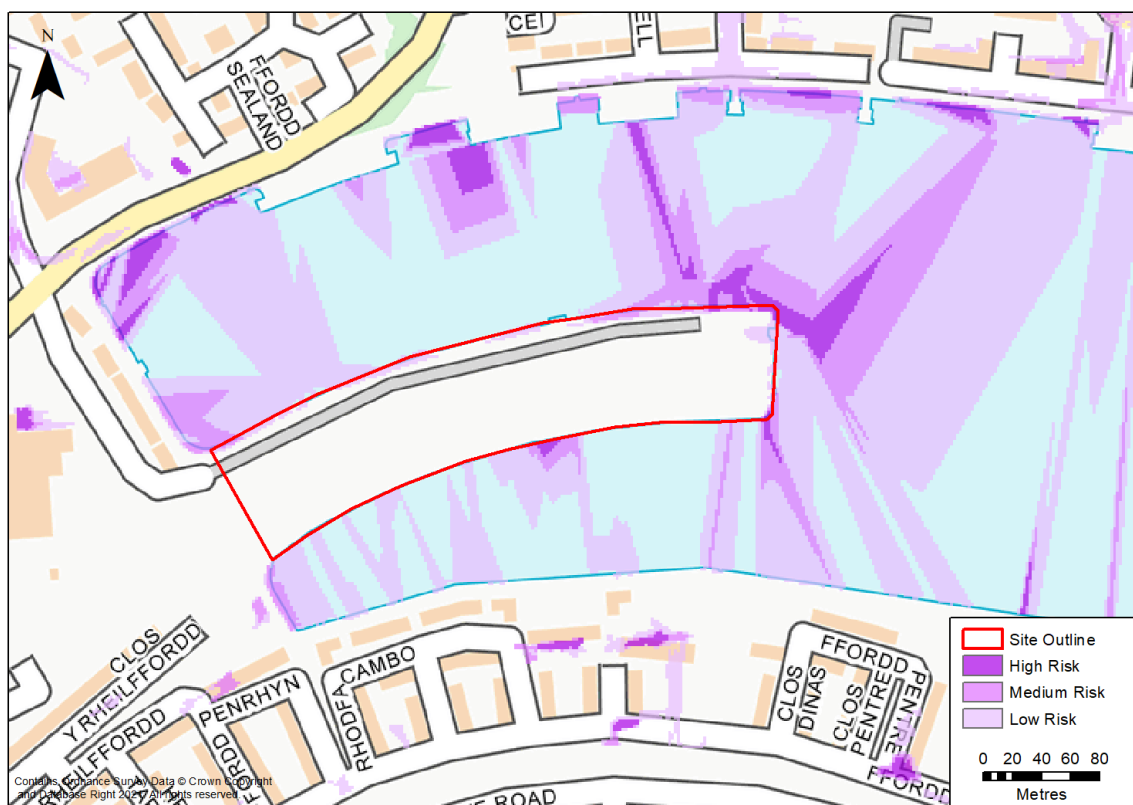


Figure 4-2 NRW FRAW map for surface water and small watercourse flooding

4.4 Risk of flooding from reservoirs

As the site is not located in close proximity to any watercourses the risk of reservoir flooding is considered to be very low.

4.5 Risk of flooding from groundwater

Groundwater flooding is caused by unusually high groundwater levels. It occurs as excess water emerging at the ground surface or within manmade structures such as basements. Groundwater flooding tends to be more persistent than surface water flooding, in some cases lasting for weeks or months, and can result in significant damage to property. The risk of groundwater flooding depends on the nature of the geological strata underlying the sites, as well as on local topography.

The Vale of Glamorgan Local Flood Risk Management Strategy⁴ states that the risk of groundwater flooding in the study area is considered to be between 50% to 75% chance of flooding. Barry has historically been affected by groundwater flooding. However, the risk of groundwater flooding in Barry is typically linked to areas of overlying limestone. This does not apply to the Mole site, which is built on significant made ground and will have a groundwater table directly linked with the water level of the Dock. Consequently, we conclude that the risk of groundwater flooding is very low for the Mole.

4 The Vale of Glamorgan. Local Flood Risk Management Strategy (2013) <https://www.valeofglamorgan.gov.uk/Documents/Living/Environment/Flood-and-coastal-erosion-risk/VoGC-LFRMS.pdf>

5 Detailed Assessment of Tidal Flood Risk

5.1 Barry Port Tidal Modelling

In 2013 JBA Consulting developed a 1D-2D ESTRY-TUFLOW tidal inundation model on behalf of NRW for the Cadoxton Flood Risk Study. Further amendments were made to the model in 2017 as to support production of the Cadoxton FAS Outline Business Case (OBC). This model has been licensed for use in this project and updated to align with the latest tidal change estimates. The focus of this work is to understand the tidal flood risk to Barry Port now and in the future.

The most recent model (2017 Cadoxton OBC) has been reviewed in order to understand if there are any limitations with the model schematisation and what, if any, updates were required. The review recommended the implementation of the following model improvements:

- The version of TUFLOW used to run the model was updated to the most recently available.
- The tidal boundary was updated to include new Extreme Sea Level data and follow current Coastal Flood Boundary (CFB) guidance⁵.
- The 2D Head-Time (HT) tidal boundary was amended to follow the line of seaward overtopping to better reflect the true site conditions and expected flood hydraulics.
- The 2D initial water level was set to 6.2mAOD which covered all of the dock water surface, this is the same level as the top of the tidal lock gates. The elevation of the dock floor had been raised to 5mAOD to help address model instabilities associated with having such a high initial depth of water (an issue for the Shallow Water Equation). However, a document produced by UK Dredging indicated that ABP aim for a constant water level in the dock of 3.9mAOD, a copy of this can be found in Appendix A of the Modelling Technical Note⁶. This suggests that both the 2D initial water level and dock floor elevation are too high.
- The representation of the lock gates has been amended following discussions with ABP on their performance during events when the seaward water level exceeds the impounded dock water level.
- The model has been reviewed to ensure the latest version of LiDAR is represented.
- New tidal boundary conditions were generated for the updated model. The Highest Astronomical Tide (HAT) curve for the Severn Estuary at Barry Docks was obtained from the Admiralty Tide software and was corrected to Ordnance Datum. The 2018 CFB sea level estimates were used to derive the design event still water sea level estimates at Barry using the chainage ID 426.

The flood modelling focused on two design events; 0.5% AEP and 0.1% AEP. Both events incorporated the influence of climate change using the latest guidance⁷ for the present day and three future epochs (2071, 2096 and 2121). Table 5-1 shows the peak still water sea level estimates applied to the model for each of the four epochs looking at the 0.5% and 0.1% AEP events.

The proposed ground raising level of 9.00mAOD has been selected to provide a site that is flood free in the most extreme 0.1% AEP event for a lifetime of development greater than 100 years.

⁵ Environment Agency (2018) 'Coastal Design Sea Levels - Coastal Flood Boundary Extreme Sea Levels (2018)'. LINK

⁶ JBA Consulting. DND-JBAU-XX-XX-FN-HM-0002 (December 2020)

⁷ Welsh Government (2017). Adapting to Climate Change: Guidance for Flood and Coastal Erosion Risk Management Authorities

Table 5-1 Extreme sea level estimates (mAOD)

Event (AEP)	0.5%	0.1%
2021	7.46	7.79
2071	7.90	8.23
2096	8.22	8.55
2121	8.59	8.92

5.2 Pre-development flood risk

5.2.1 0.5% AEP (2121) tidal event

During the 0.5% AEP plus climate change tidal event, the site remains largely flood free as shown in Figure 5-1. There are areas on the northern boundary of the site which experience flood depths to a maximum of 0.9m with 1m recorded in the north eastern part of the site on the slipway to the dock. Flooding along the southern boundary of the site experience depths of up to 0.28m.

Please note that the pink >1.2m category shown along the northern site boundary does not represent flood depths in this area. The depths experience in this area are greater than 6m and this represents the dock rather than the development site. These small issues can sometimes occur due to the resolution used in the model and the LiDAR filtering algorithms.

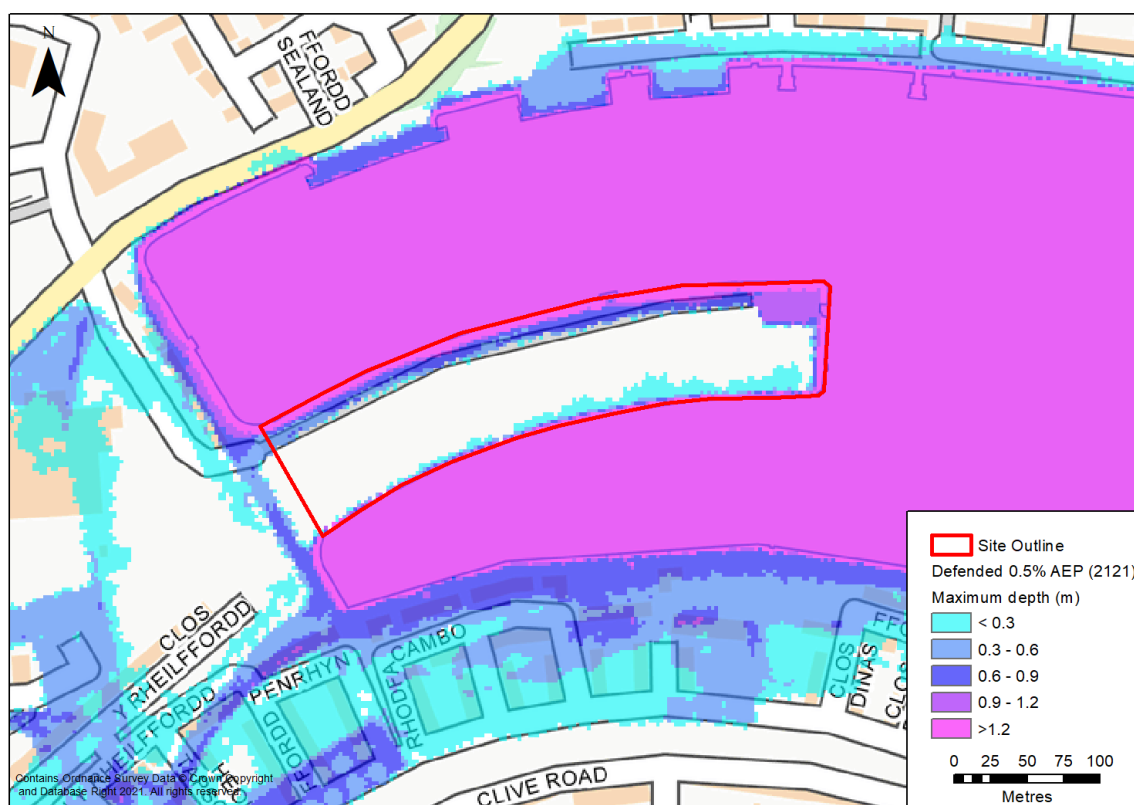


Figure 5-1 0.5% AEP (2121) tidal model - maximum depth

5.2.2 0.1% AEP (2121) tidal event

During the 0.1% AEP plus climate change tidal event, flood depths on the main area of site are generally below 0.4m as shown in Figure 5-2. Flood depths on the northern access road reach a maximum of 1.1m and 1.3m on the slipway to the north east of the site.

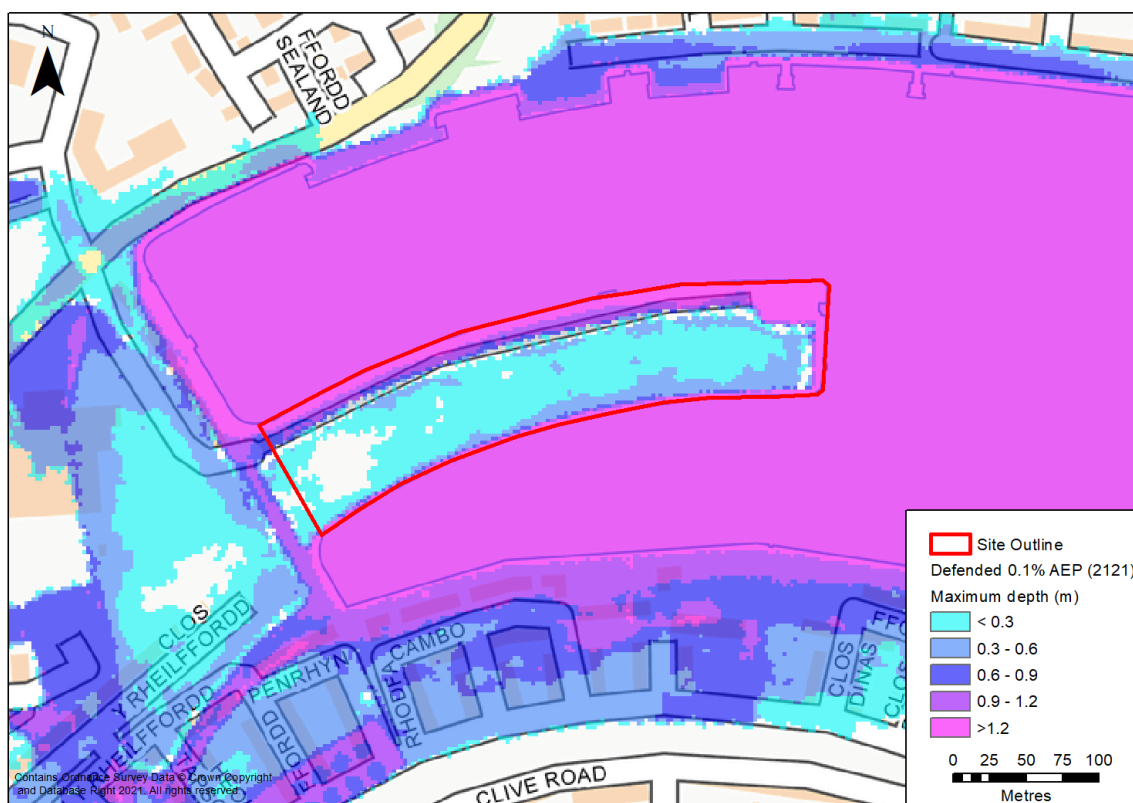


Figure 5-2 0.1% AEP (2121) tidal model - maximum depth

5.3 Post-development flood risk

Based on the pre development detailed hydraulic modelling and assessment of ground levels, it is advised that the ground levels on site are raised to 9.0mAOD. The proposed ground raising level of 9.0mAOD has been selected to ensure that the site is flood free in the most extreme 0.1% AEP event for a lifetime of development greater than 100 years.

The proposed ground raising will not increase flood risk to others as it is not possible to increase flood risk by simple displacement of tidal flood water, given the effectively infinite volume of the sea.

Ground raising should use soil and rubble rather than clay or other impermeable materials to aid surface water drainage. Table 5-2 shows how the site will be flood free in the 0.5% and 0.1% AEP (2121) events following ground raising.

Table 5-2 Flood water levels and proposed ground levels

Levels (mAOD)	Site	
	West	East
Current ground level	8.91	8.52
0.5% AEP (2121) tidal flood level	8.59	8.59
0.1% AEP (2121) tidal flood level	8.91	8.91
Post development ground level	9.00	9.00
Site flood free 0.5% AEP (2121) event	Yes - 0.41m above flood water level	Yes - 0.41m above flood water level
Site flood free 0.1% AEP (2121) event	Yes - 0.09m above flood water level	Yes - 0.09m above flood water level

6 Assessment of Acceptability Criteria

Although application of the Justification Test is not required for this site an assessment of the Acceptability Criteria, as set out in TAN-15, is required. These criteria must be satisfied in order for the proposed development to comply with TAN-15. Table 6-1 shows how the development meets each of the acceptability criteria.

Table 6-1 Acceptability Criteria for TAN-15

TAN-15 Acceptability Criteria	Comments	Assessment
Developer is required to demonstrate that the site is designed to be flood-free for the lifetime of development for a 1 in 200 (0.5% AEP) chance (tidal) flood event including an allowance for climate change in accordance with TAN-15 Table A1.14.	Following the raising of ground levels to 9.0mAOD, the site will not be at flood risk in a 0.5% AEP event.	✓
In respect of the residual risk to the development it should be designed so that in an extreme (1 in 1000 chance) [0.1% AEP] event there would be less than 600mm of water on access roads and within the property, the velocity of any water flowing across the development would be less than 0.4m/s.	Following the raising of ground levels to 9.0mAOD, the site will not be at flood risk in a 0.1% AEP event.	✓
No flooding elsewhere	Given the tidal nature of the flood risk it is not possible to increase flood risk by simple displacement of tidal flood water, given the effectively infinite volume of the sea. It is therefore concluded that the proposed development will not increase flood risk to others.	✓
Flood defences must be shown by the developer to be structurally adequate particularly under extreme overtopping conditions (i.e. that flood with a 1 in 1000 chance of occurring in any given year).	Not applicable. The site is not currently offered protection by formal flood defences.	✓
The developer must ensure that future occupiers of the development are aware of the flooding risks and consequences.	Not applicable for this site at present	✓
Effective flood warnings are provided at the site.	The site is partially covered by the Coast from Aberthaw to Severn Bridge NRW Flood Alert Area and the Coast at Swanbridge and Barry Flood Warning Area. Significant lead-time (+24hrs) is typically provided for tidal flood risk.	✓

Escape/evacuation routes are shown by the developer to be operational under all conditions.	Not applicable for this site at present	✓
The development is designed by the developer to allow the occupier of the facility for rapid movement of goods/possessions to areas away from flood waters.	Not applicable for this site at present	✓
Development is designed to minimise structural damage during a flood event and is flood proofed to enable it to be returned to its prime use quickly in the aftermath of a flood.	Not applicable. During the 0.5% and 0.1% AEP (2121) events the site is predicted to be flood free.	✓

7 Conclusion and Recommendations

- JBA Consulting were commissioned by Associated British Ports (ABP) to undertake a Flood Consequence Assessment to support a planning application for proposed engineering works at the Mole, Barry Docks.
- The proposed engineering works are part of a phase approach to use the site for future residential development. To support these future aspirations, ground raising at the site is required to mitigate flood risk. Consequently, this FCA has been prepared solely to support a planning application for engineering works to raise the ground levels in the full extent of the development site. The proposed ground raising will level the entire site to a minimum level of **9.00mAOD**.
- The topography on site is generally level with a slight slope from 8.9mAOD in the west of the site to 8.6mAOD in the east. An access road on the northern boundary of the site is approximately 0.9m lower than the surrounding ground level. A slipway with a ground level of 7.5mAOD is found in the north eastern part of the site.
- The site has a vulnerability classification of 'Other' as defined by TAN-15. The Justification Test does not apply to Other development, although it must still satisfy the Acceptability Criteria.
- It has been considered appropriate to assume a 100 year life time for the development due to proposed future residential development at the site.
- The site is located in DAM Zone C2 of the Development Advice Map. Flood Zone C2 is defined as areas of the floodplain without significant flood defence infrastructure. JBA submitted updated tidal modelling to NRW to challenge the Zone C2 categorisation. The modelling was accepted by NRW which removes the site from Zone C and reclassifies the site as Zone A, an area with little to no flood risk, although the Development Advice Map has not been updated at the present time.
- The site is at little to no risk of flooding from fluvial, reservoir, groundwater or surface water sources.
- Updated tidal flood modelling was completed as part of this commission which includes a number of sites in Barry Docks. This modelling considered tidal flood risk over a development lifetime of 100 years.
- Tidal modelling shows that raising the site to a minimum level of 9.00mAOD will ensure that the site remains flood free in the most extreme 0.1% AEP event for the next 100years.
- Given the tidal nature of the flood risk it is not possible to increase flood risk by simple displacement of tidal flood water, given the effectively infinite volume of the sea. It is therefore concluded that the proposed development will not increase flood risk to others.
- This FCA has demonstrated that all aspects of the acceptability criteria set out in TAN-15 have been satisfied. Consequently, we conclude that on the grounds of flood risk, the proposed development meets the requirement set out in TAN-15 and the aims of Planning Policy Wales.

A Topographic Survey



LEGEND

- BOL ○ Bollard
- Bottom of Bank
- Concrete
- Fence
- Gate
- Invert Level
- Kerb Channel
- Kerb Dropped
- MH + Manhole Cover
- Post ○ Post
- 0.00 + Spot Level
- Top Of Bank
- Topographic Contour (1m Interval)
- Topographic Contour (5m Interval)
- Track
- Verge
- Wall Bottom
- Building

NOTES:

Site surveyed to Ordnance Survey OSNet™ GB
OSGB36(15) through Leica SmartNet.

CLIENT:

PICK
EVERARD

SITE:

ASSOCIATED BRITISH PORTS
BARRY
THE MOLE

PLAN:

TOPOGRAPHIC SURVEY
6 FEBRUARY 2020

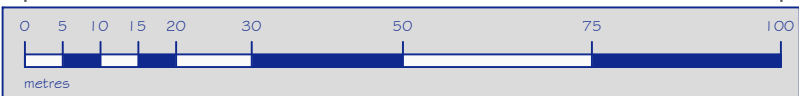
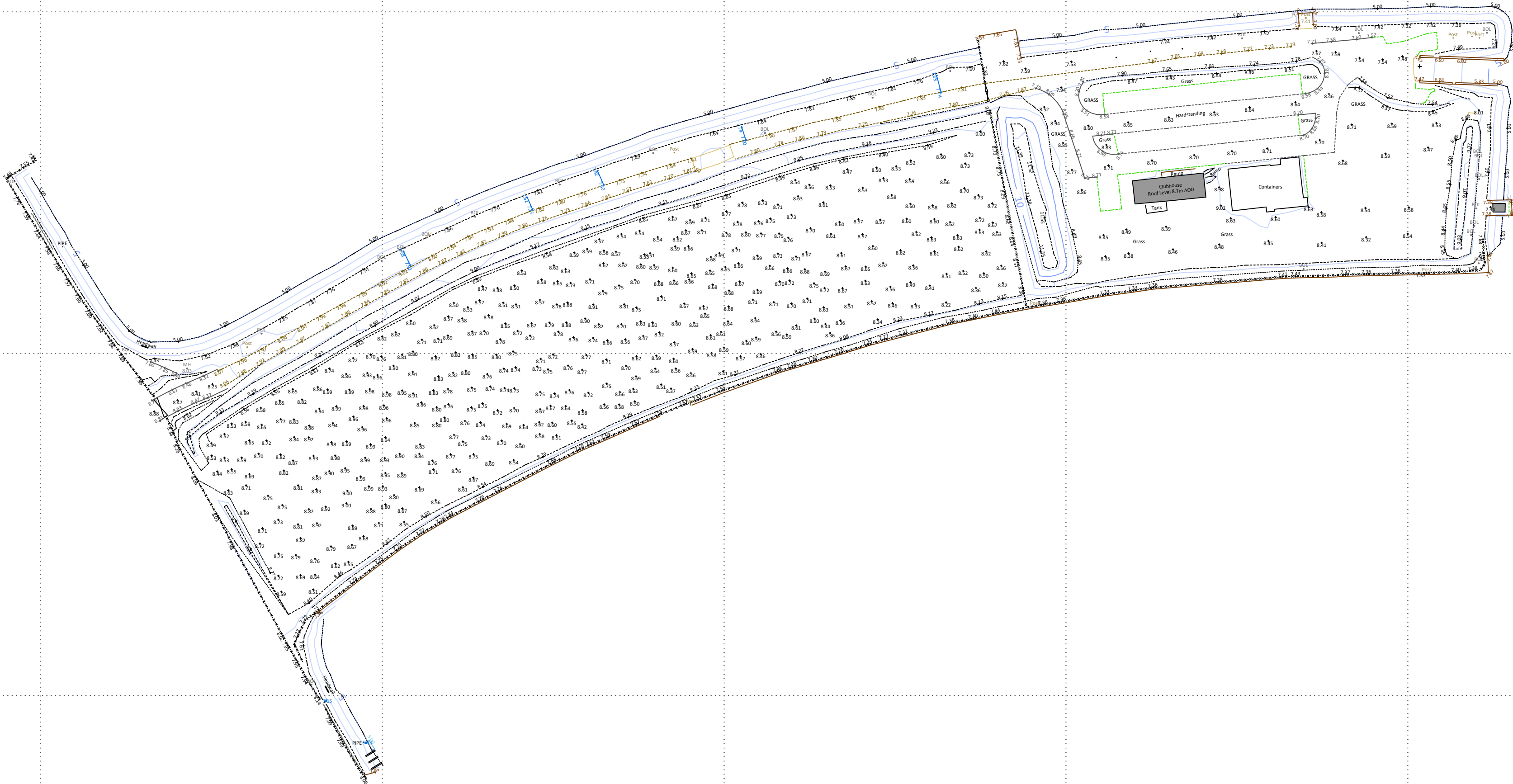
Scale: 1:1000 @ A2

4 March 2020

PSS - 085 - 008 - 001
Drawing No.



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