REPORT

Pembroke Dock Marine Infrastructure

New Mega Slipway

Client: Port of Milford Haven

Reference: PB8556-RHD-ZZ-XX-RP-C-0001

Status: S3/0.1

Date: 23 January 2019

Port of Milford Haven

Royal HaskoningDHV
Enhancing Society Together

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1 Introduction

The Pembroke Dock Marine Infrastructure project is a proposal to develop a centre for wave and tidal stream energy development, fabrication, testing and employment at the former Royal Naval Dockyard at Pembroke Dock. This site is now under the ownership and control of Milford Haven Port Authority (MHPA). The development is part of the Swansea Bay City Deal programme which is supported by the UK and Welsh Governments and administered through a joint committee of four regional local authorities.

The purpose of this report is to provide a high-level study looking at the proposed plan to install a new slipway, and to support the Planning Application and associated Environmental Impact Assessment.

The exercise undertaken by Royal HaskoningDHV, in consultation with MHPA and BAM Nuttall (an experienced marine civil engineering contractor) is to develop an early concept layout based on aspirations set out by MHPA. This is particularly with a view to mitigating the impacts on the slipway structures and the marine environment.

It is intended that the new slipway will be located at the site of the existing Slipways Nos 1 and 2 and will combine these to form a new facility. We understand the slipways were originally built in 1843-5 and note that they are both Grade II Listed Structures.

It is intended that the new slipway will be a multi-purpose facility which will be used to launch and recover a variety of vessels and offshore modules.

Figure 1 - Upper Section of Slipway No 1

2 General Arrangement

It is intended that the new slipway will comprise a simple concrete ramp sloping down into the water. The proposed general arrangement will ensure that the existing historic flank walls will be retained and preserved. The design will also ensure that the extent of the underwater construction at the seaward end will be minimised whilst still maintaining the required water depth for the launch and recovery of a full range of vessels and modules.

The new slipway will be created by demolishing the central section between the two existing slipways; removing the rails, supports and hauling system from Slipway No 2; and regrading the whole area to form a new structure which will be approximately 65m wide. Refer to drawing numbered PB8556-RHD-ZZ-XX-DR-C-0001 for the general layout.

The new slipway will comprise a constant gradient reinforced concrete slab with anchorage points at the top for hauling purposes, and with the provision to include rails on one side to launch and recover vessels on wheeled cradles. A transition will be provided at the change of gradient at the crest of the slipway.

The existing flank walls and adjacent quay walls will be retained and restored to preserve their historic and architectural interest. Initially it was intended that the flank walls would be underpinned. As part of the concept layout process we believe it will be better to construct a retaining wall in front of the line of the existing flank wall. The top of the wall will be at a level which leaves the existing wall visible. This will result in the slipway being slightly narrower than previously intended but this small change is not considered critical at this stage.

The new slipway will extend further into the water than the existing so that vessels and modules with deeper draft requirements can have access to and from the water over a greater range of the tidal cycle. The relatively large tidal range at Milford Haven will be beneficial in this respect.

The construction of the new slipway is likely to be undertaken in phases to ensure that an operational slipway remains available at all times. This will affect the cost of undertaking the works and the overall programme but it has the benefit that work to the listed structures can proceed in a very controlled manner. The central section between Slipways 1 and 2 will be carefully removed to enable the new slipway to be constructed. This removal and excavation work will have to be carried out with due care to ensure the listed elements can be carefully recorded and removed as well as to enable one of the slipways to remain operational. Temporary works such as trench sheeting may be needed to achieve this.

Where possible, materials arising from the demolition and removal of the central section between Slipways 1 and 2, will be re-cycled to provide infilling of associated elements of the Pembroke Dock Marine Development. Although it might be possible to use stonework recovered from the removed central section to repair any damaged sections of the existing flank walls.

Figure 2 – Lower Section of Slipway No 1 showing Carr Jetty beyond

3 Outline Design

The proposed general arrangement of the new slipway has been based on topographic and bathymetric survey information provided by MHPA. Tide levels have been taken from the 2019 edition of the Admiralty Tide Tables and are as follows in metres relative to Chart Datum (levels to Ordnance Datum are in brackets):

Highest Astronomical Tide (HAT)	+7.90	(+4.19)
Mean High Water Springs (MHWS)	+7.00	(+3.29)
Mean High Water Neaps (MHWN)	+5.20	(+1.49)
Mean Sea Level (MSL)	+3.80	(+0.09)
Mean Low Water Neaps (MLWN)	+2.50	(-1.21)
Mean Low Water Springs (MLWS)	+0.70	(-3.01)
Lowest Astronomical Tide (LAT)	±0.00	(-3.71)

Ordnance Datum is 3.71m above Chart Datum.

It has been assumed that vessels and modules using the slipway will typically include the following:

Parameter	Tug	Cargo	Offshore Module
Length (m)	45	80	55
Beam (m)	13	14	18
Bow docking draught (m)	4.8	2.0	2.5
Docking displacement (T)	1,600	1,500	2,500
Trimming	0	500 mm aft	0

Table 3-1 - Vessel and Module Parameters

Given the early stage of development of the industry, little information is available about the proposed offshore energy-based operations and thus the module parameters taken are very provisional and the slipway loadings are not yet known. At this stage we consider that the founding of the slipway on rock is likely to be the most practical solution.

From the bathymetric survey and from the longitudinal sections shown on drawings numbered PB8556-RHD-ZZ-XX-DR-C-0002 and -0003 it can be seen that approximately 40m from the quay wall/end of the existing slipways the rock stratum drops away quite quickly. In order to minimise the extent and complexity of the underwater construction at the seaward end of the new slipway it has been decided to increase the gradient from 1 in 17 (at the existing slipways) to 1 in 12 and move the slipway crest landward by approximately 36m.

This approach will avoid having to place a significant thickness of fill and construct an underwater retaining wall at the end of the slipway, or alternatively support this section of the works on piles. It does reduce the yard space to some extent but we understand the swept path analysis for the proposed layout still works and does not affect the proposal to retain the listed former foreman's office.

The 1 in 17 gradient of the existing slipways is fairly typical for this type of facility. The proposed gradient of 1 in 12 is relatively steep and at the upper end of the range normally taken for commercial slipways. It is likely that rock excavation will be required at the seaward end of the slipway. Further ground investigation work will be needed at a later stage to confirm the rock levels and the quantities involved, as well as the strength and integrity of the rock.

As the gradient of the new slipway has been increased and the crest moved landward, the new slab level will be below the foundation level of the existing flank walls. This means that these walls will have to underpinned. The underpinning will need to be carefully organised and executed to maintain the integrity of the existing walls, but it should be possible to undertake this work tidally 'in the dry'. The underpinning concept will need to be looked at carefully, but it likely that a new reinforced concrete boundary wall will be constructed below the existing wall. We understand that this concept is likely to be acceptable in principle, particularly as it will secure the long-term integrity of the flank walls and provides the opportunity for the careful recording of the original construction work.

As described in Section 2 above, a new retaining wall will be needed at the upper end of the slipway on the east and west sides because of the level difference between the new slab and the existing ground. Currently the levels are similar so no retaining wall exists. A similar form of construction is likely to be required to ensure the long-term integrity of the river walls and the arches forming the first section of Carr Jetty.

It is anticipated that the new slipway might comprise a 500mm thick reinforced concrete slab over 1,000 mm of compacted granular sub-base or a bed comprising single sized rock, although this will have to be confirmed when there is more information available on the ground conditions and imposed loadings, design work has been undertaken and construction methods confirmed. The slab will be anchored to prevent the slipway migrating towards the sea.

4 Operation

Due to the early stages of offshore renewable energy devices, it is not clear how the energy-related offshore modules will be launched and recovered, and further discussion will be needed with the operators of the facility in the future. The solution proposed aims to allow maximum flexibility for manufacturers and developers. However, we believe one solution would be to transport the modules from the laydown/ assembly areas to the slipway at low tide using self-propelled modular transporters (SPMTs). The units could then be positioned on steel trestles or concrete blocks before being floating off on the rising tide. This method could impose high concentrated loads on the slipway at the points where the unit lifts off and these would need to be checked in the slab design. Alternatively, the units could possibly be moved onto greased timber slideways and a 'traditional' launching method used. It should be noted that SPMTs will not operate in the water. We would expect that device developers will want to consider the launch and recovery operations as part of their design and development programmes so the proposed slipway solution is not likely to preclude any particular device.

Recovery would generally be the reverse of the launching process, although it will not be possible to use the greased slideways in this situation.

For tugs, freighters, tankers and other vessels, consideration could be given to providing a rail system with cradles. A twin-rail arrangement with a gauge of 6-8m would suffice for the design vessels shown above in Table 1. The rails would be recessed within the concrete slab so access around the slipway would not be affected.

The hauling and anchorage loads for the example 1,600T displacement tug in Table 1 are as follows:

	2% Friction – Roller Bearings	5% Friction – Plain Bearings
Uphaul - recovery	190T	245T
Anchorage - launch	120T	60T

Table 4-1 - Tug Hauling and Anchorage Loads

The loads involved are significant but not excessive and a multi-part hauling and anchorage arrangement will be required. The friction values relate to the type of bearings used for the cradle wheels.

Anchorage points for the hauling system have been indicated on the drawings. These are likely to comprise large concrete blocks incorporated within the slab, or piled foundations. The construction will be such that they not impact on the historical parts of the facility.

It is intended that, unless the turnaround time is very short, all vessels and modules will be moved from the slipway to the laydown/assembly areas for repair. It will be necessary to use the SPMTs to negotiate the change in gradient at the crest between the slipway and the generally flat area landward, and a transition has been shown for this purpose. The rails will stop before the slipway crest.

This movement at the crest will not be an issue with the offshore modules (which will already be supported on the SPMTs), but will be not as straightforward for vessels on the cradles. One solution could be to have a removable support frame which would be bolted to the cradle. The vessel could then be picked up on the frame using the SPMTs and moved to the designated working area. It would not be practical or safe to pick up the vessel directly from the cradle.

Alternatively, a triangular profile cradle unit with the top support frame horizontal could be considered. Other options for smaller vessels might include a tipping cradle arrangement or an amphibious boat hoist.

As stated above, there will be a number of options for launching and recovery which we expect will be developed in parallel with the device developers.

The longitudinal sections on drawings numbered PB8556-RHD-ZZ-XX-DR-C-0002 and -0003 are shown with the vessels and modules being recovered at mean high water neap tides for reference purposes. However, it will be feasible to launch and recover craft with greater draughts at higher water levels, and accommodate other smaller vessels and units at lower tide levels.

The following table gives an approximate comparison between the parameters (length, beam, draught and displacement) of the maximum sized craft that could be recovered at mean high water spring and neap tides:

Parameter	MHWS (+3.29mOD)		MHWN (+1.49mOD)	
Vessel Type	Tug	Cargo	Tug	Cargo
Length (m)	65	100	45	80
Beam (m)	15	16	13	14
Draught (m)	5.0	2.2	4.8	2.0
Approximate Displacement (T)	2,700	2,500	1,600	1,500

Table 4-2 - Recovery at MHWS and MHWN

Shown in table 4 below is a schedule of water depths at distances from the toe of the slipway. This table is also replicated on both long section drawings. It should be noted that the table shows the depth of water only, when assessing vessels to use the slipway allowance for draft of the vessels and the cradle to be used should be considered against the water depth in the table.

Distance from Bottom of Slipway (m)	Min Water Depth at MHWN (m)	Min Water Depth at MHWS (m)
0	9.47	11.27
5	9.05	10.85
10	8.63	10.43
15	8.22	10.02
20	7.80	9.60
25	7.38	9.18
30	6.97	8.77
35	6.55	8.35
40	6.13	7.93
45	5.72	7.52
50	5.30	7.10
55	4.88	6.68
60	4.47	6.27

Table 4 - Slipway Water Depths

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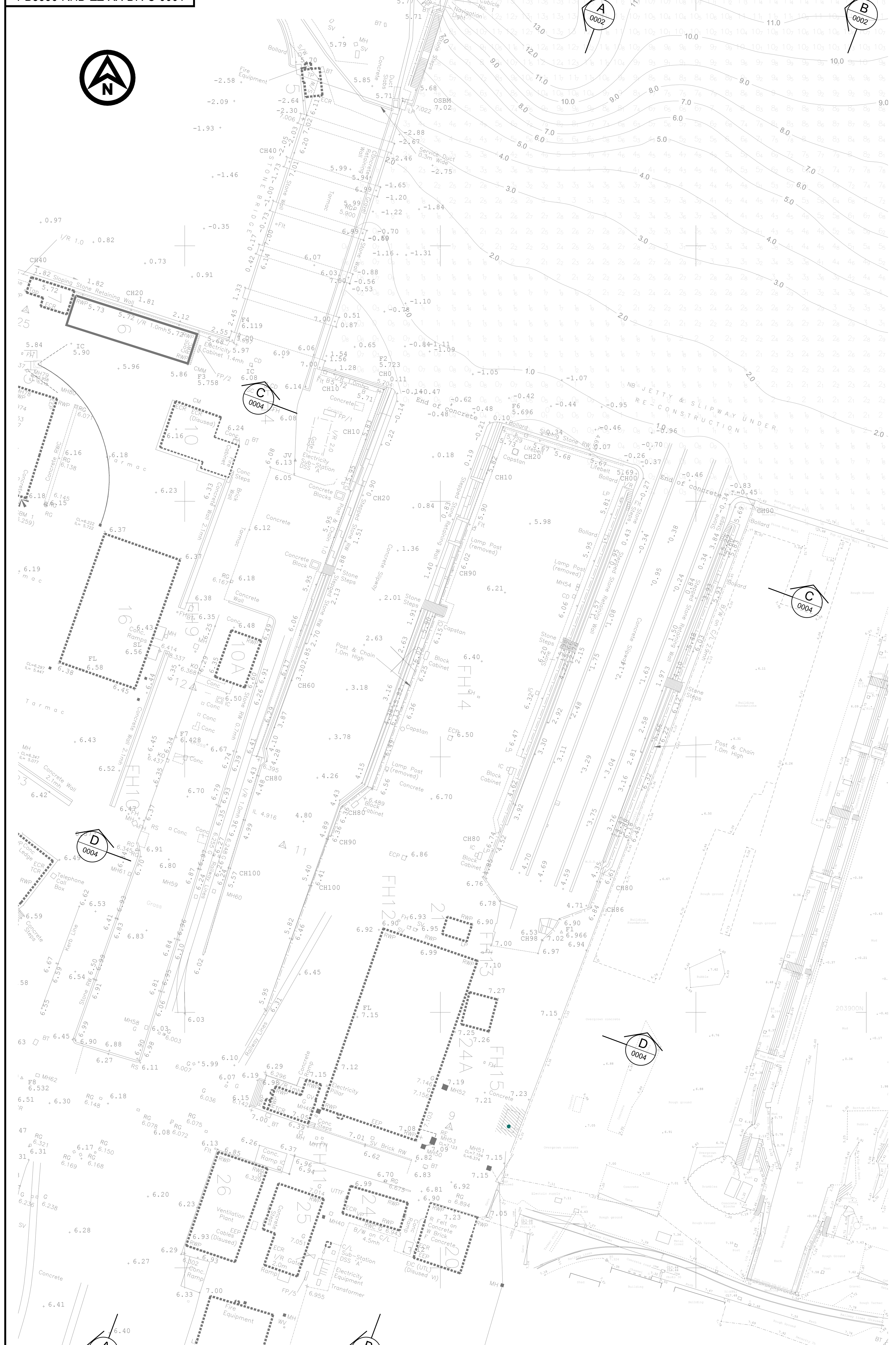
Drawings

PB8556-RHD-ZZ-XX-DR-C-0001	Existing and Proposed Layouts
PB8556-RHD-ZZ-XX-DR-C-0002	Longitudinal Sections Sheet 1 (On Slipway No 1)
PB8556-RHD-ZZ-XX-DR-C-0003	Longitudinal Sections Sheet 2 (On Slipway No 2)
PB8556-RHD-ZZ-XX-DR-C-0004	Cross Sections

Appendix A – Drawings

DRAWING No.
PB8556-RHD-ZZ-XX-DR-C-0001

DO NOT SCALE



EXISTING LAYOUT (1:500)

PROPOSED LAYOUT (1:500)

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NOTES

1. ALL DIMENSIONS ARE IN MILLIMETRES, UNLESS NOTED OTHERWISE.
2. ALL LEVELS ARE IN METRES ABOVE ORNANCE DATUM.
3. CHART DATUM = -3.71mOD.

REV	DATE	DESCRIPTION	BY	CHK	APP
P02	24.01.19	ISSUED FOR INFORMATION & COMMENT	NAT	VRW	MC
P01	23.01.19	ISSUED FOR INFORMATION & COMMENT	NAT	VRW	MC

REVISIONS

CLIENT

Port of Milford Haven

PROJECT

PEMBROKE DOCK
MARINE INFRASTRUCTURE
NEW MEGA SLIPWAY

TITLE

EXISTING AND PROPOSED LAYOUTS

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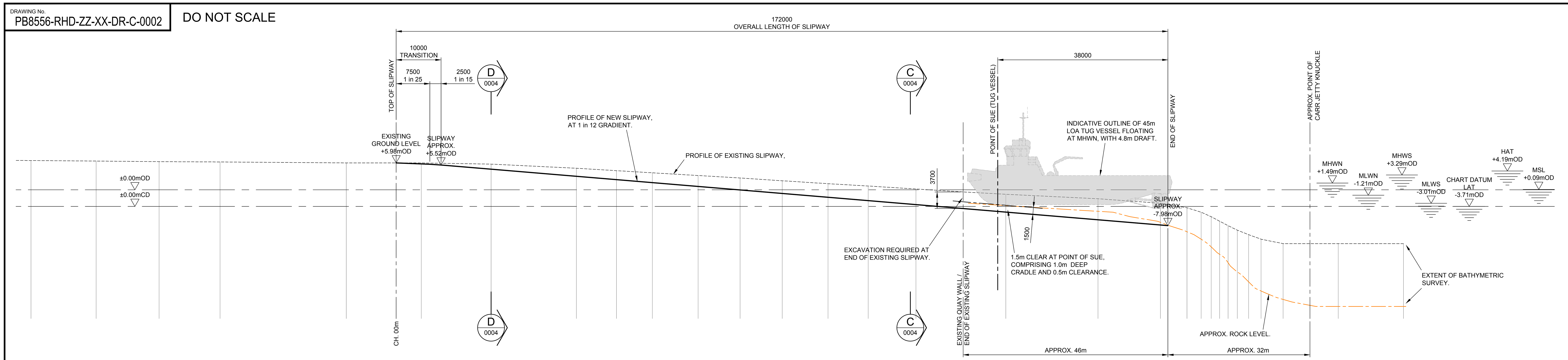
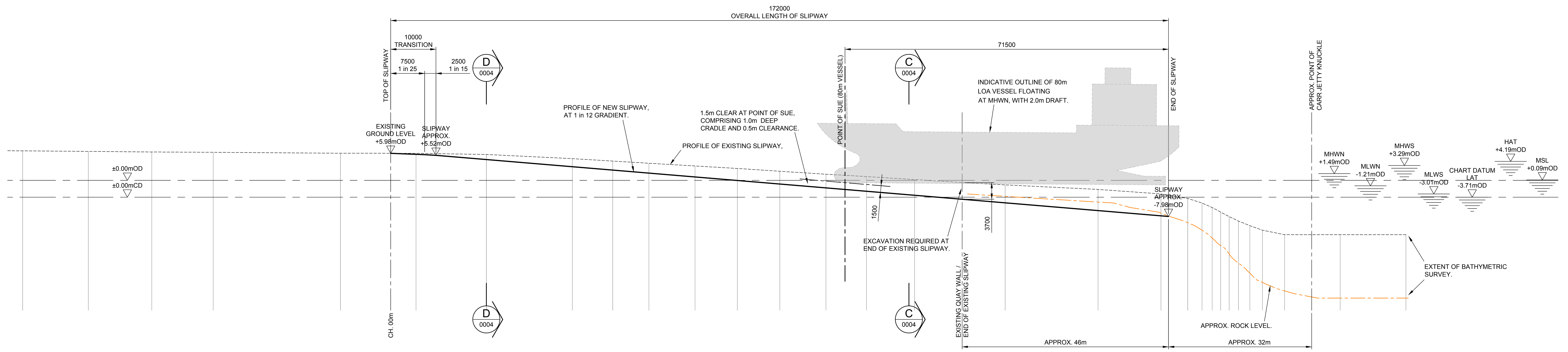
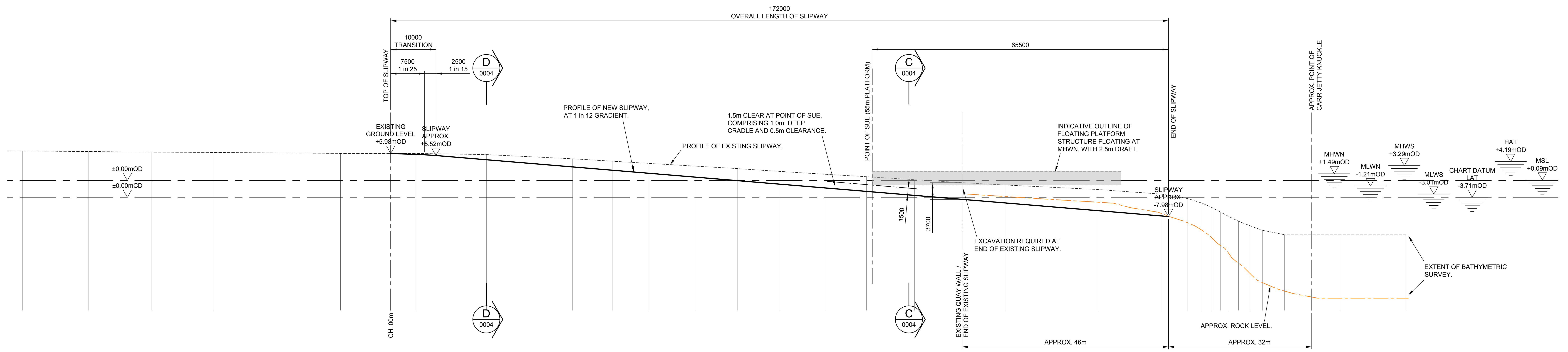


LONGITUDINAL SECTION A-A (1:500)
SHOWING TUG VESSEL (4.8m DRAFT) FLOATING AT MHWN



LONGITUDINAL SECTION A-A (1:500)
SHOWING 80m VESSEL (2.0m DRAFT) FLOATING AT MHWN



LONGITUDINAL SECTION A-A (1:500)
SHOWING FLOATING PLATFORM (2.5m DRAFT) FLOATING AT MHWN

NOTE:
POINT OF SUE IS WHEN VESSEL FIRST TOUCHES DOWN ON CRADLE.

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DISTANCE FROM BOTTOM OF SLIPWAY (m)	MIN. WATER DEPTH AT MHWN (m)	MIN. WATER DEPTH AT MHWS (m)
0	9.47	11.27
5	9.05	10.85
10	8.63	10.43
15	8.22	10.02
20	7.80	9.60
25	7.38	9.18
30	6.97	8.77
35	6.55	8.35
40	6.13	7.93
45	5.72	7.52
50	5.30	7.10
55	4.88	6.68
60	4.47	6.27

NOTE: WATER DEPTHS ARE TO TOP OF NEW SLIPWAY. ALLOWANCES FOR DEPTH OF CRADLE AND CLEARANCE AT POINT OF SUE TO BE CONSIDERED.

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REVISIONS

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Port of Milford Haven

PROJECT

PEMBROKE DOCK
MARINE INFRASTRUCTURE
NEW MEGA SLIPWAY

TITLE

LONGITUDINAL SECTIONS
SHEET 1
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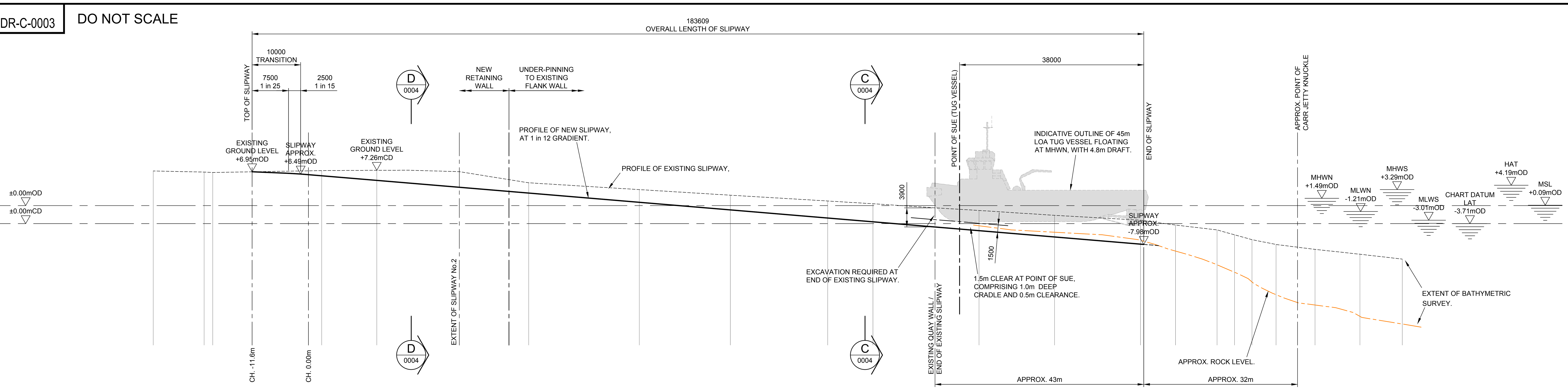
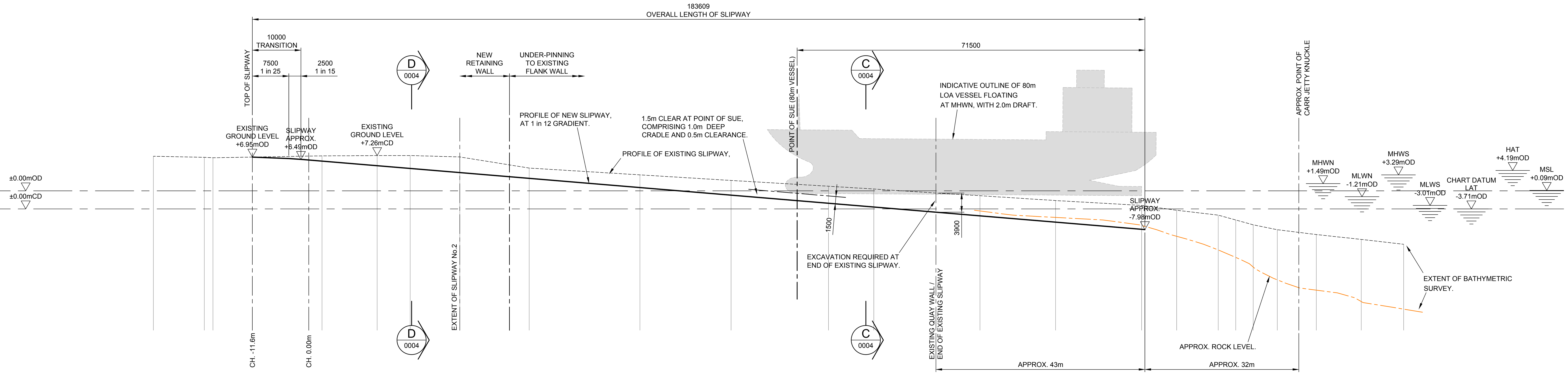


LONGITUDINAL SECTION B-B (1:500)

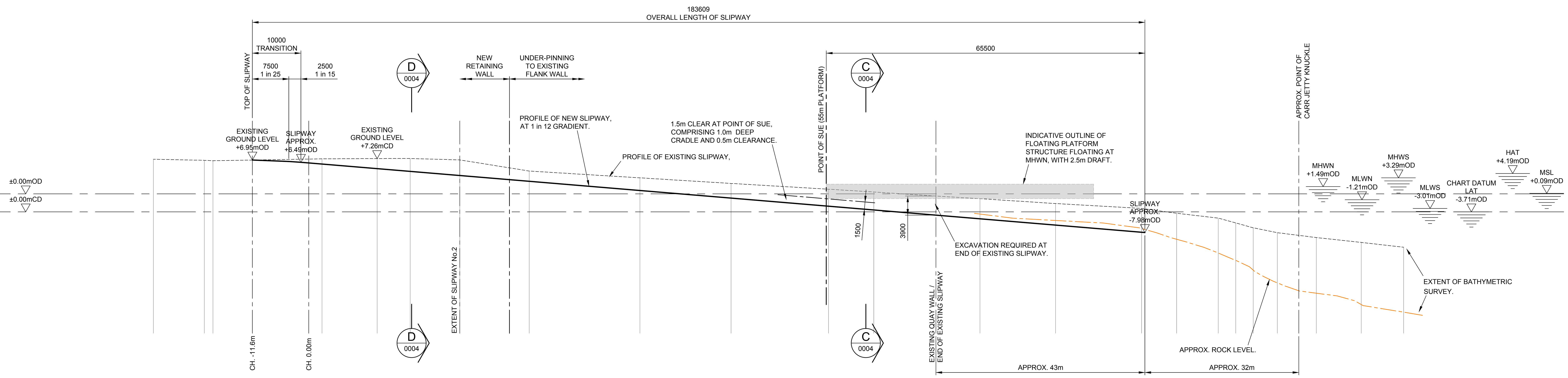
SHOWING TUG VESSEL (4.8m DRAFT) FLOATING AT MHWN

NOTE:
POINT OF SUE IS WHEN VESSEL FIRST TOUCHES DOWN ON CRADLE.



LONGITUDINAL SECTION B-B (1:500)

SHOWING 80m VESSEL (2.0m DRAFT) FLOATING AT MHWN



LONGITUDINAL SECTION B-B (1:500)

SHOWING FLOATING PLATFORM (2.5m DRAFT) FLOATING AT MHWN

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25	7.38	9.18
30	6.97	8.77
35	6.55	8.35
40	6.13	7.93
45	5.72	7.52
50	5.30	7.10
55	4.88	6.68
60	4.47	6.27

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REVISIONS

CLIENT

Port of Milford Haven

PROJECT

PEMBROKE DOCK
MARINE INFRASTRUCTURE
NEW MEGA SLIPWAY

TITLE

LONGITUDINAL SECTIONS
SHEET 2
(ON SLIPWAY No.2)

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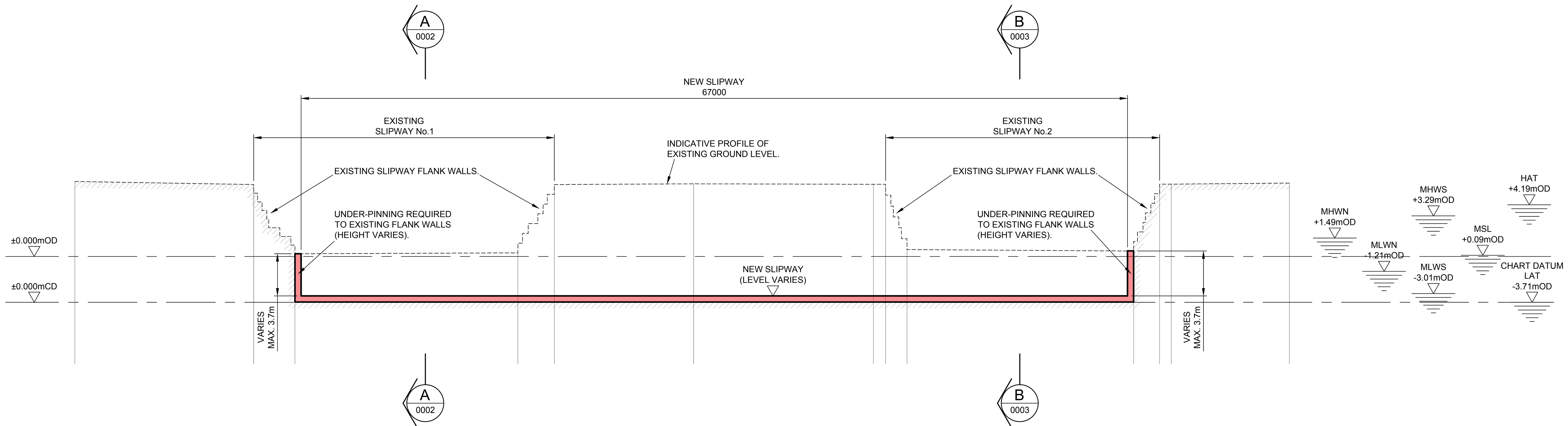
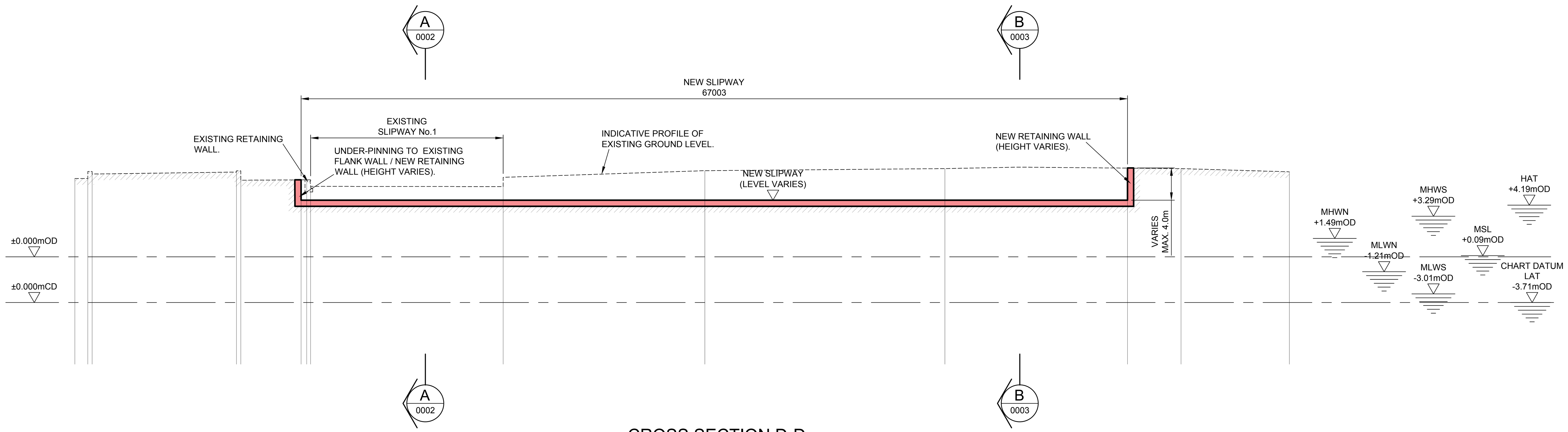


CROSS SECTION C-C (1:250)



CROSS SECTION D-D (1:250)

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CROSS SECTIONS

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