Note

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Maritime & Aviation

To:	Milford Haven Port Authority (Tim Bownes)
From:	Mike Chambers,
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Our reference:	PB8556-RHD-ZZ-XX-NT-Z-0001 P01.04
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Checked by	Jamie Gardiner

Subject: **Dredging Strategy: Milford Haven Port Authority Slipway**

The following note presents the proposed approach to the dredging activities related to the modification of the slipway at Gate 4 Pembroke Dockyard. Its purpose is to provide further clarity on the dredge design and anticipated methodology following the findings of the Ground Investigation (GI).

1.0 Site Location & Project Description

The site is located on the north western end of the Pembroke port facility.

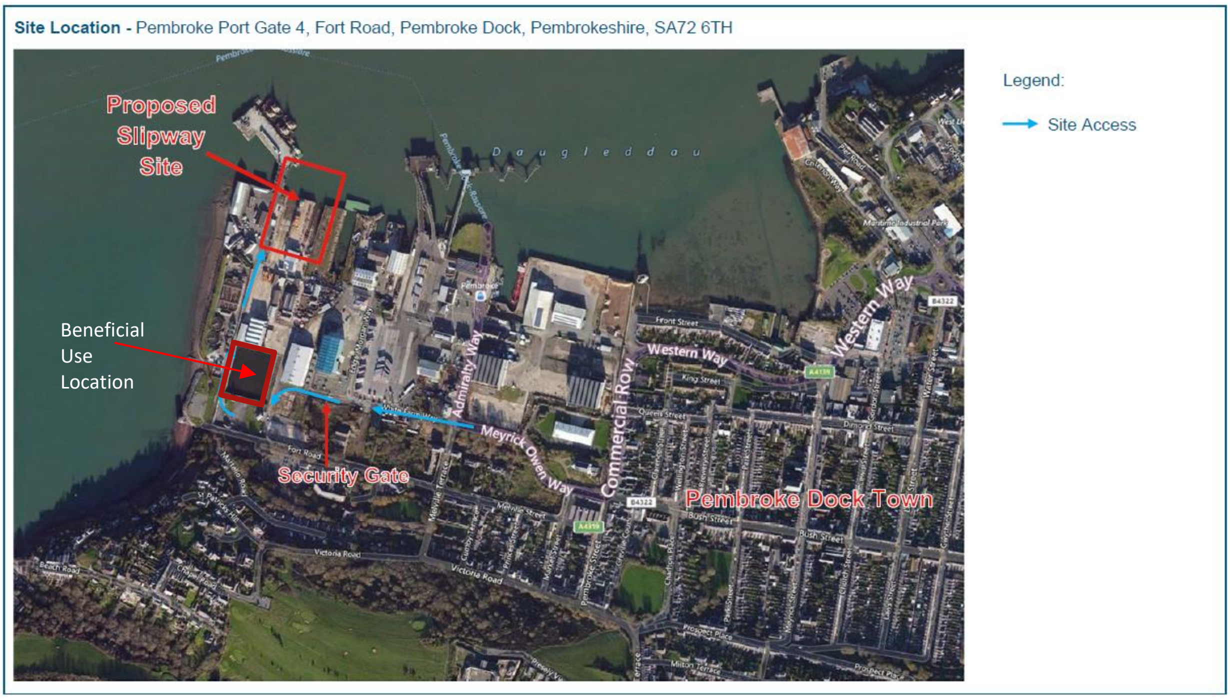

Figure 1-1 -Slipway and Disposal site Location

The currently proposed slipway will be approximately 67m in width and approximately 180m in length, extending around 40m beyond the existing quay wall. The end of the slipway will terminate at −7.98mOD. This will require the level of the existing slipways to be lowered to achieve the desired level and gradient. The middle pier between the two slipways will also be removed as part of the work. The material removed during the slipway construction is intended to be placed in a disused onshore pond circa 300m to the south of the site, within the port area.

2.0 Dredging Requirements

Now there is more recent bathymetry available a 3 D model has been produced so that the volumes of material to be removed can be more accurately calculated. The revised volume of material to be removed below Mean High Water Level (MHWL) approximately 38,740 m^3, including side slopes and dependent on the rock mattress depth. A GI, undertaken in July, has allowed for a more accurate estimate of the type of material to be dredged, as described below which has not changed from the previous estimate.

In considering the potential impact of the dredging and the beneficial use of the material to be dredged or excavated, we consider that material down to the level of mean low water spring tides (MLWS) can be more effectively removed using land based equipment working 'in the dry'. This means that the soft sediments above this level will not be released into the water column, leaving only the materials below MLWS to be considered as material dredged using marine based equipment.

Based on this proposal, Drawing PB8556-RHD-ZZ-XX_DR-C-0019, also attached with this note, presents the types of material and their volumes to be dredged with marine based equipment below MLWS that are located above the rock layer. This is summarised below:

Material Type	Volume m^3
Soft Silts	3,551
Coarse Sandy Sediment	680
Gravel	315
Gravel / Clay Bound Mudstone	2,499
Mudstone	1,859
Total	**8,904**

Figure 1-2 Material above the Rock Layer below MLWS

As can be seen from the table, only 3,551m^3 of the material to be dredged comprises soft silts. This is significantly lower than the previously estimate of 15,000m^3.

The table in Figure 1-2 above has been developed from the initial borehole logs and observations during the GI. This has provided a more accurate assessment of the volume of soft sediments that will need to be removed by marine means. It has also provided more categorisation of the of the types of material to be removed above the rock level. As can be seen in the table, much of the material overlaying the rock is coarse material The actual grading results for the individual materials is are still awaited from the laboratory testing. Following receipt of these, the volumes in the above table will be confirmed; however, the volumes are not expected to change significantly.

3.0 Beneficial use of dredged material

The Port's original proposal was to dispose of dredged material offshore however in consideration of the potential issues raised by NRW i.e. fate of the dredge plume; contaminants, potential invasive non-native species, the port amended its proposal to use the material as reclamation fill. The Port now intends to use all the dredged material as reclamation fill, to fill in the mast pickling pond, located circa 300m to the south of the dredging works. MHPA intends to stockpile and use surplus material elsewhere within the site.

4.0 Description of Available Dredging Techniques

Trailer Suction Hopper Dredger (TSHD) works by trailing a drag head along the bed floor as the vessel is propelled forward. Sediment is mobilised due to combination of drag head teeth and suction driven by dredging pumps This type of dredger pumps a water-sediment mixture (i.e. slurry) from the seabed to an onboard hopper via a suction pipeline. Once in the hopper, the coarse sediment settles to the bottom and the water is returned to the sea via an overflow weir in a process known as overflow.

Due to the constricted access and depth restrictions, it would not possible to use a TSHD to access the area. Furthermore, the material to be dredged includes (weathered) rock and requires sufficient cutting force during the dredging process to remove this material. Based on these two aspects, it is expected that only a Cutter Suction Dredger (CSD) or a Backhoe Dredger (BHD) could be used. These two alternatives are described in more detail below.

Cutter Suction Dredgers use a rotating cutterhead mounted on the end of a suction pipeline. The CSD is fixed in position via a spud leg which creates a pivot point around which dredging operations are undertaken. The CSD then swings in an arc along the face of the material to be dredged. The swing is controlled by a set of anchors typically located a few hundred metres from the port and starboard of the vessel. As the rotating cutterhead moves in an arc along the face, material is mobilised and drawn into the suction pipe. This material is transported via a suction pipe as a slurry (soil-water mixture) to the chosen disposal site.

A suitably sized CSD will be able to remove most of the required material, however the method of working is unlikely to be feasible in all areas of the site due to the working method. As the cutter swings in a series of arcs while dredging it cannot access corners and is limited to how close it can go to existing infrastructure, without damaging the cutterhead or existing infrastructure. It is therefore likely that an alternative dredging method would also need to be deployed such as backhoe dredger.

Further, in order to win material with useful engineering properties, the rock must be raised using a method which does not tend to pulverise it. A cutter suction dredger is likely to do this to a larger proportion of the rock, reducing the proportion which can be used beneficially.

Another disadvantage of cutter suction dredging is that it introduces large quantities of water in order to ensure the dredged material flows along the delivery pipe to the discharge point. This water has to then be left for the fine pulverised material to settle before being discharged into the main body of water. Handling this volume of water can be very problematic without the provision of substantial settlement lagoons.

Backhoe Dredging generally consists of an excavator which is usually mounted on the end of a pontoon which must be fixed into position using spikes (known as spuds) pushed into the seabed. BHDs operate by mechanically removing material from the bed into a bucket. The bucket is then lifted through the water column, out of the water and into a waiting barge for onward transportation.

In case the (weathered) rock cannot be removed with a conventional bucket, then it may be required to install a ripping tool on the excavator to ensure sufficient cutting power can be delivered to cut the rock and to remove these materials. In this way the rock can retain its engineering properties, maximising the beneficial use.

For backhoe dredgers the material is lifted by the excavator bucket. This introduces minimal volumes of water as any lifted by the bucket will drain out before the excavated material is deposited into the waiting barge.

Once the barge has reached capacity the intention is for it to be towed to the shore where it will remain until the tide recedes and it can be emptied by a shore based excavator. Dump trucks will take the material to the beneficial use site.

5.0 Potential for the release of soft silts

There are three primary influences on the generation of sediment plumes: the dredging operation, the material, and the hydrodynamic conditions in which the dredging takes place. This section discusses the potential release of suspended sediment using CSD and BHD.

The Central European Dredging Agency (CEDA) provides the following release rates for CSD and BHD (Ref: CEDA/IDAC, 2018. Dredging for Sustainable Infrastructure).

Plume source	Release Rate		
	Becker *et al* (2015)	Realistic ranges for initial estimates for a common project (% of fines available)	Expected total suspended sediments (% of total dredging volume)
BHD	1-5%	3.5%	1.2%
CSD	1-8%	5%	2.5%

Figure 1-3 – Sediment release

Based on the above table and for the same material, the backhoe would release slightly less sediment through the dredging campaign but that both are reasonably comparable in terms of fines release. Production rates for each methodology are likely to be different as such this impacts on quantum of material introduced at any one time.

Taking a conservative approach to sediment release, it is anticipated that up to approximately 176m^3 of soft silt would be released by BHD and up to 285m^3 when using CSD. As such, it is proposed that the dredging will be carried out using a BHD.

Proposed mitigation measures to minimise the release of dredged material

As shown above, if the upper limit for sediment release of 5% is used this equates to 176m^3; whilst with the more 'realistic' amount of 3.5% used, this is reduced to 124m^3. This is a tiny amount in comparison to, say, the quantities of sediment released into the waterway by the trickle dredging undertaken at Neyland marina which we understand is about 2,500m^3 during their typical annual dredging campaign.

Should mitigation be required to reduce the release of soft silt, the following methods could be adopted during BHD:

- Use of a visor or bucket thumb, this allows the operator to close the top the of the bucket
- Optimising bucket operation and swing velocity
- Silt curtains
- Dredging under specified tidal conditions. (e.g. flood tide, neap tide)

Below is further description of those methods.

Hydraulic Bucket thumb

A hydraulic bucket thumb or otherwise referred to as simply a "bucket with lid" enables the machine driver to close a lid over the bucket. Once the machine driver has a full bucket of material, he can invert the bucket on the sea bed and hydraulically close the lid over the top of the bucket. Therefore, while the bucket is being lifted through the water column the amount of sediment release is reduced as the exposed area on the top of the bucket is not subject to the scouring effect of the bucket being drawn through the water. Images of a bucket thumb can be found in Figure 1-4 below.

Figure 1-4 – Bucket thumb

Optimising Bucket operation and swing velocity

By using experienced operators for a backhoe dredger, the sediment release at the top of the watercourse can be minimised greatly. This includes optimising how the bucket is lifted thought the water column. i.e. Lifting the bucket vertically through the water column rather than slewing and lifting at the same time. This will minimise the exposure of the free surface at the top of the bucket and reduce sediment release near the surface.

Silt Curtains

Silt curtains are an effective way of prevention of silt plumes spreading away from the area of excavation. They prevent any migration of sediments by having a geotextile suspended from a floating boom. The geotextile allows water to pass but not the sediments. This can be deployed in a moon pool arrangement attached to the barge or around the whole area. Both methods are shown on the Figure 1-5 below.

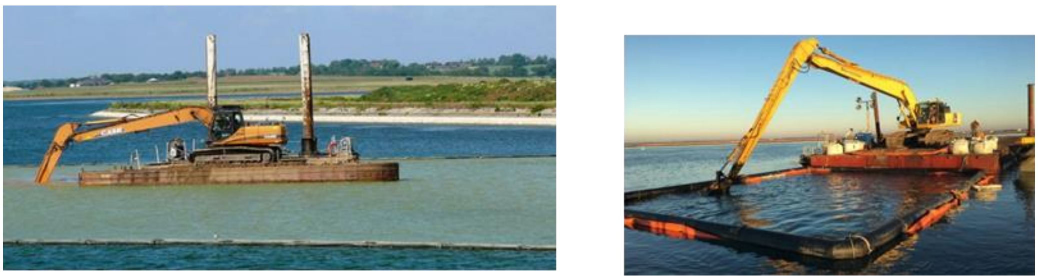

Figure 1-5 – Silt Curtains

Dredging under specified tidal conditions.

The spread of the suspended sediments can be reduced by dredging under specified tidal conditions. Dredging during Neap tides when the tidal flows are less then can greatly reduce the distance any sediments are transported. For the area of soft sediments dredging during slack water when the tidal flows are zero or near to zero will again reduce the travel of suspended sediments.

Based on our experience we do not believe any of the above measures will need to be deployed. If, having assessed the issues it is considered that mitigation measures are required then MHPA agrees they will be considered further and deployed where required.

6.0 Conclusion

RHDHV, together with MHPA, have considered carefully the comments made by NRW. An extensive review of methods, benefits and impacts has been undertaken which has developed over time into the proposal described above. We believe this is a solution which has the least possible impact, and which delivers a number of benefits through the beneficial use of the material excavated and dredged.