REPORT

Boston Alternative Energy Facility

Response to Environment Agency's queries on Estuarine Processes (Tracked)

Client:	Alternative Use Boston Projects Ltd
Planning Inspectorate Reference:	EN010095
Document Reference:	9.44(1)
Pursuant to:	APFP Regulation: 5(2)(g)
Reference:	PB6934-RHD-ZZ-XX-RP-Z-4072
Status:	Final/~~0.0~~1.0
Date:	~~06 December 2021~~24 March 2022

HASKONINGDHV UK LTD.

Westpoint
Peterborough Business Park
Lynch Wood
Peterborough
PE2 6FZ
United Kingdom
Industry & Buildings
VAT registration number: 792428892

+44 1733 3344 55 **T**
info@uk.rhdhv.com **E**
royalhaskoningdhv.com **W**

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Document short title:	Response to Environment Agency's queries on Estuarine Processes
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Status:	~~0.0~~1.0/Final
Date:	~~06 December 2021~~24 March 2022
Project name:	Boston Alternative Energy Facility
Project number:	PB6934
Author(s):	David Brew

Drafted by:	David Brew
Checked by:	~~Matt Hunt~~Abbie Garry
Date:	24/03/22~~06/12/21~~
Approved by:	Paul Salmon
Date:	24/03/22~~06/12/21~~

Classification
Project related

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1 Introduction

1.1.1 In a letter dated 11th November 2021, the Environment Agency provided clarification on their position in relation to Estuarine Processes issues raised in their Written Representations (document reference 9.22, REP2-006). These clarifications, which relate to Impacts on Geomorphology, are reproduced in Section 1.2 below. The Applicant's responses to these outstanding issues are provided in Section 1.3.

1.2 Environment Agency Deadline 2 Representations – Impacts on Geomorphology and Deadline 8 Submission

1.2.1 The following text sets out the Environment Agency's points (including the original paragraph numbering).

4.1. 'Further to our Written Representations, we do not consider that the applicant has fully addressed our concerns regarding local impacts on geomorphology. We accept that the expert assessment used to determine the increase in wave action in The Haven is reasonable, and that the overall increase in energy into the system will be 0.22%. We accept that although this represents an increase of approximately 145% in terms of ship wash, this is a relatively low amount in terms of the overall system.

4.2. However, although the overall system effects on The Wash EMS and Havenside LNR receptors have been assessed to be of no or negligible effect (APP-054, 6.2.16 Environmental Statement Chapter 16 - Estuarine Processes, Section 16.12), the localised impacts of ship wash and dredging on erosion of the shoreline do not appear to have been fully assessed. We therefore remain concerned at the lack of assessment of potential localised damage to flood defences, saltmarsh and morphology due to the combination of changes to be made in the area around the proposed wharf and in particular on the bank immediately opposite.

4.3. We consider that the development includes three significant changes to the dynamics of the system which may lead to an increase in erosion as a result of ship wash:

- *The introduction of harder surfaces through the creation of the wharf (both from the wharf itself and moored ships);*
- *The speed, frequency and nature of ship movements around the wharf area; and*
- *The effect of capital and maintenance dredging on the movement of sediment.*

Harder surfaces

4.4. The introduction of harder surfaces from the hulls of moored vessels and the wharf structure will alter the dynamics of wave movements and may lead to more energy being exerted on the bank opposite the proposed wharf. This could lead to more rapid erosion of the bank opposite, which could affect the integrity of the defences and destroy any existing or nascent salt marsh and mudflat habitats.

4.5. We ask that the applicant provides a more detailed assessment of the impact on wave action in the area immediately opposite to ensure that the proposals do not increase the risk of flood defences failing or destroy habitats important to maintaining/improving the ecological quality of the waterbody.

Speed, frequency and nature of ship movements

4.6. The assessments of ship wash in Chapter 16 - Estuarine Processes of the Environmental Statement (document reference 6.2.16, APP-054) do not appear to take into account the variations in ship wash from the speed and size of the different ships expected due to the development. We note that this assessment has been done in Chapter 17 – Marine and Coastal Ecology of the Environmental Statement (document reference 6.2.17, APP-055). Ship wash will vary depending on the size and speed of the vessel. Smaller craft, travelling at greater speeds, will produce a larger and more energetic bow wave and stern/propeller wash, although for a shorter duration.

4.7. Ship wash may also be more severe when vessels designed for higher speeds are restricted to lower speeds, such as pilot boats restricted to 4 knots as proposed for vessels passing ships moored at the proposed wharf. We also note that the REP1-027 (Deadline 1 Submission - 9.14: Addendum to Environmental Statement Chapter 17 and Appendix 17.1 - Marine Mammals) identifies that ships will be limited to 6 knots rather than 4, and we question what impact if any this will have on the effect of ship wash.

4.8. We therefore ask that the detailed assessment of ship wash requested above takes into account the variation of ship types and speeds expected in the location of the proposed wharf.

Capital and operational dredging

4.9. We are concerned that the localised effects from ship wash and the proposed capital and maintenance dredging at the wharf location have not been assessed in combination. We understand that dredging is not currently carried out in the location of the proposed dredging. This suggests that very little sediment is currently deposited within the shipping channel.

4.10. If sediment is currently being deposited on the banks/mudflats/saltmarshes in this location, rather than the main channel, there is the possibility that dredging of the berth pocket may upset this process. The dredging may provide extra accommodation space, *potentially leading to a reduction in the deposition of sediment on the channel edges. This may lead to increased erosion of the mudflats/saltmarsh opposite the proposed development site.*

4.11. Mudflats and saltmarshes act as wave attenuation features and protect flood banks/sea walls from direct wave attack. We are concerned that the loss of these features, through erosion or dredging, may impact on the integrity of the flood defences.

4.12. We therefore consider that the detailed assessment of ship wash requested above should also consider the impact of dredging on the movement of sediment in The Haven. In particular the assessment should identify whether, as a result of dredging, there would be any increase in the rate of erosion on any part of The Haven that could affect the integrity of flood defences or destroy habitats important to maintaining/improving the ecological quality of the waterbody.'

1.2.2 In a subsequent Deadline 8 Submission~~Representation~~ by the Environment Agency (REP8-019), they stated:

Effect of Ship Wash (EA 1.2 and EA 2.3)

2.5. We are concerned to note that Paragraphs 3.3.5 and 3.3.6 in document ref REP7-003 (Outline Mammal Mitigation Protocol) states that the speed of ships cannot be effectively regulated to 4-6 knots as stated in document ref REP3-020 (Response to Environment Agency's Queries on Estuarine Processes), and is more likely to be in the order of 12 knots in places along the Haven.

2.6. We consider that the evidence in document REP3-020 is therefore out of date and must be revised to demonstrate that the impact of ship wash at these speeds will not lead to increased rates of erosion affecting the ecological quality of the water body and/or undermining the toe of the flood defences.

1.3 Deadline 3 Response – Impacts on Geomorphology

1.3.1 Response to 4.1 and 4.2. The Environment Agency's acceptance of the Applicant's expert assessment method that shows an increase in ship wash, and the Environment Agency's acceptance that the additional energy generated by this change is relatively low for the entire Haven system is noted. However, the Environment Agency's remaining concerns relate to local rather than system-wide impacts of ship wash and dredging at the wharf on erosion of the bank directly opposite, including potential local damage to flood defences and saltmarsh.

1.3.2 Response to 4.3. The rest of this section responds to the Environment Agency's outstanding issues for potential causes of increased erosion as a result of ship wash, highlighted in Sections 1.1.1 (harder surfaces), 1.1.2 (speed, frequency and nature of ship movements) and 1.1.3 (capital and operational dredging) and the in-combination effects on ship wash of harder surfaces and dredging.

Harder surfaces

1.3.3 Response to 4.4 and 4.5. You have asked for more detail on the potential for changes to waves generated by vessels passing the wharf caused by their interaction with:

- the hulls of vessels moored at the wharf; and
- the wharf structures.

1.3.4 The Applicant accepts that the hulls of vessels moored at the wharf may alter waves generated by ship wash of vessels passing the wharf, compared to the wave processes currently acting across the existing intertidal mudflat slope and backing saltmarsh. These changes to processes would be caused by changes to the waves reflected off the vessel hulls that travel back across The Haven towards the opposite bank. The reflection of waves off the sloping revetment would be minimal because the slope and structure type would be able to absorb/attenuate most of the direct wave energy across its surface. It is likely that waves impacting on the slope would spill with some limited backwash, rather than be reflected back across The Haven. Reflection off the wharf piles would also be minimal because of their limited width.

1.3.5 The potential changes to ship wash wave energy on the opposite bank due to the hulls of vessels moored at the wharf is assessed in-combination with the changes in channel morphology generated by the wharf and berthing areas in Section 1.2.3 below, covering the Environment Agency comments 4.4, 4.5, and 4.9 to 4.12 together.

Speed, frequency and nature of ship movements

1.3.6 Updated rResponse to 4.6 to 4.8 including 2.5 and 2.6 of the Deadline 8 Submission (REP8-019). The queries raised in these responses are to differentiate the magnitudes of ship wash that may be experienced at the location of the proposed wharf due to:

- variations caused by different speeds and sizes of vessels (smaller vessels travelling at higher speeds compared to larger vessels travelling at lower speeds) expected due to the Facility;
- variations caused by vessels travelling at lower speeds than they are designed for (e.g. pilot boats restricted to four knots as proposed for vessels passing vessels moored at the proposed wharf); and
- cargo vessels travelling through The Haven at up to approximately 12 knots, but slowing as they move further up The Haven to between 4 and 6 knots near the Port itself speeds of limited to a maximum of approximately six knots rather than four knots (Port of Boston, *pers com*.).

1.3.7 It is likely that ship wash may vary as the size and speed of the vessel vary. With respect to the sizes of the vessels using The Haven, they will be of a very similar size than the commercial vessels already using The Haven, and so from the perspective of size alone, the ship wash generated by them should be no greater than exists already. With respect to the speed of the vessels using The Haven, the maximum speed that will be allowed is signage is present stating 'six knots' but this is not a speed limit and this is not enforced the Port of Boston as the

Statutory Harbour Authority who instead rely on the Convention on the International Regulations for Preventing Collisions at Sea, 1972 (COLREGS) 'safe speed'. In the case of large shipping, safe speed is set by the onboard pilot and is based on the prevailing circumstances, conditions and proximity of other vessels. The actual speed will vary depending on the type and size of the vessel but will not exceed six knots. It is accepted that smaller vessels travelling at higher speeds (although no higher than six knots) would potentially create ship wash waves that are relatively high, but they would exist over a shorter period of time, than for a larger vessel travelling more slowly. Typically, waves created by ship wash only last for less than 10 seconds with peaks heights of around 0.4m (**Figure 1.1Figure 1.1**) (Gourlay, 2011). Hence, if higher waves are generated over a shorter period of time (by faster moving small vessels), they would produce similar levels of energy at the shoreline compared to relatively low waves generated over a longer period of time. The possible height and time scale combinations that could be caused by different vessel sizes and speeds, would effectively balance each other out in terms of the energy impinging on the shoreline.

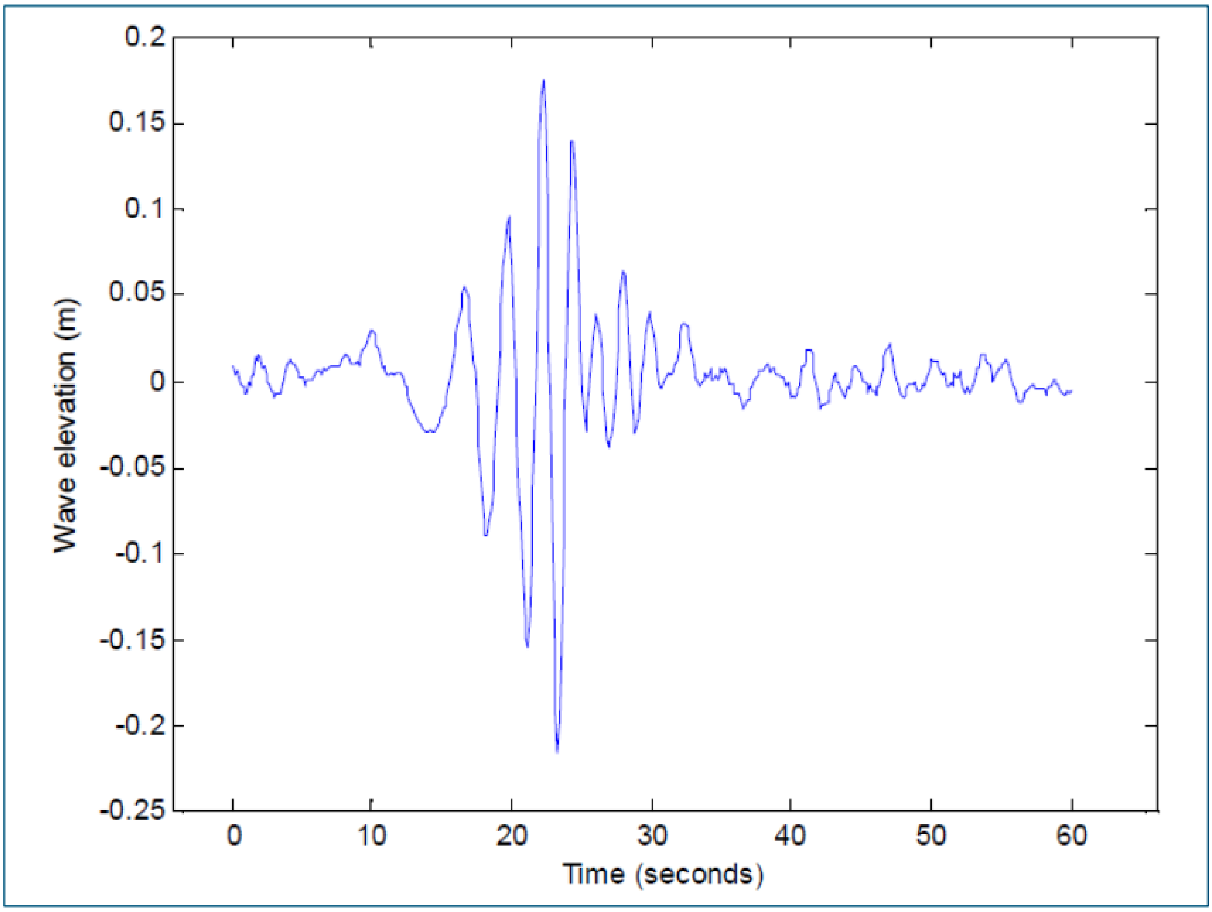

Figure 1.1. Ship Wash Wave Height Development over time as a Vessel Passes a Point (Gourlay, 2011)

1.3.8 Regardless of the height and duration of the ship wash, it is accepted in ES Chapter 16 Estuarine Processes (document reference 6.2.16, APP-054) that baseline ship wash is eroding the adjacent banks, and this is the premise upon which the assessment is based. So, even though there would be variations in the type of ship wash encountered at the shoreline, it is accepted that as a worst-case scenario, there is likely to be some erosion. Hence, an increase in the shipping traffic would result in an increase in erosion. However, the key element in the assessment set out in the ES, is whether any increase in erosion induced by extra vessels that are visiting the wharf is significant or not. This response is restricted to the vessels visiting the wharf only, because the numbers of other vessels in The Haven (that are not visiting the wharf) would continue to move past the wharf in either direction is the same as the current baseline case, as would be the magnitude of ship wash generated by them. The rational for the balancing out of wave energy caused by variations in vessel speed is outlined earlier in this section.

1.3.9 It is concluded that the increase in erosion created by the ship wash of the additional vessels mooring at the wharf would be negligible. As discussed in ES Chapter 16 Estuarine Processes (document reference 6.2.16, APP-054), this is because the increase in time that ship wash would be active on the intertidal mudflats (from 0.15% of a year pre the Facility to 0.37% of a year post the Facility) will still be very small compared to the relatively large amount of time that natural wind-waves are active (greater than 99.6% of a year both pre- and post-Facility). The estimated 0.37% of a year may vary slightly depending on the speeds and sizes of the vessels that actually use The Haven, but it is considered to be such a small standard deviation around this percentage that the overall conclusion is still valid (given the similarity in energy levels experienced by the shoreline discussed above).

1.3.10 So, even though the percentage of time that ship wash is active would be doubled, the relative amount of time it is active compared to natural wind-waves is still small. Hence, the annual effect of erosion by wind-waves (and tidal currents) would continue to significantly exceed the erosion caused by ship wash, and the latter increase in erosion is considered to be negligible. Furthermore, with respect to the bank opposite the Facility, as ships approach the wharf, they will be travelling very slowly so although the incidence of ship wash would be doubled, the wave heights would be small and would not create additional erosion.

Capital and operational dredging

1.3.11 Response to 4.9 and 4.10. Dredging is currently not carried out in the channel near the proposed Facility because the tidal currents in the channel are strong enough to keep it clear of sediment and navigable. However, along the adjacent intertidal areas, where the tidal currents are much slower, the system is accretionary. This is because The Haven is a sink for sediments entering from the Wash and the tidal currents are not strong enough to re-suspend the sediment that is deposited on the mudflats on the previous high-tide slack water.

1.3.12 According to Regime Theory in estuaries (O'Brien, 1931; HR Wallingford et al. 2007), increased accommodation space would lead to a potential increase in sedimentation rather than a decrease because it provides more space for deposition of sediment (i.e. a bigger sink). Also, because of the increase in space created by the wharf, the adjacent Haven would become over-sized compared to its existing equilibrium size. In this over-sized part of The Haven, there would be a tendency for accretion by natural processes to re-develop intertidal habitat that has been lost due to dredging, and to re-equilibrate with the tidal current processes.

1.3.13 This new sediment demand or 'sink' could potentially affect The Haven's bathymetry because it has been removed as potential deposition elsewhere on the mudflats and saltmarshes. The estimated annual volume of sediment deposition created by this accommodation space is approximately 8,000m^3. Given that the annual input of suspended marine sediment into The Wash has been estimated at around six million tonnes, 8,000m^3 is one to four orders of magnitude lower than this. Hence, the removal of sediment from the system due to deposition at the wharf (created by additional accommodation space) will have little effect on the overall budget of The Wash and The Haven system as a whole, because it is a very small component of the overall contribution of sediment.

1.4 In-combination effects of harder surfaces and capital and operational dredging

1.4.1 Response to 4.4, 4.5 and 4.9 to 4.12 together.

1.4.2 The Environment Agency have requested the Applicant to consider the potential changes to ship wash wave energy (and overall erosion potential) on the opposite bank from the wharf, due to a combination of wave reflection from the hulls of vessels moored at the wharf and the change in channel geometry as a result of dredging.

1.4.3 The in-combination effects will depend on how often vessels are moored at the wharf. As a worst case scenario, an assumption is made that vessels occupy the berth every day. When vessels are moored at the wharf, their size is large relative to the height of ship wash that may interact with them. Hence, the ship wash will not move them and they will act as vertical static structures from which any ship wash waves will be reflected back across The Haven to the opposite bank. For every vessel that passes the wharf, the worst case scenario is for 100% of the ship wash to be reflected.

1.4.4 A typical ship wash wave is about 0.4m high, lasting for about 10 seconds and reducing to less than 0.1m after that (**Figure 1.1**~~**Figure 1.1**~~) (Gourlay, 2011). In this case, a wave 0.4m high would impact on the opposite shore a short time after the direct ship wash wave impacts that shore. So, for every day of a year the number of ship wash events on the bank opposite the wharf will be doubled compared to the current baseline. If a situation arises where the berths are empty, ship wash would be restricted to the direct wave from a vessel travelling past the wharf, and there will be no reflected wave off the sloping revetment and wharf piles for the reasons stated in Section 1.2.1.

1.4.5 The conclusion is that the increase in erosion created by doubling the ship wash events on the opposite bank would be negligible. Excluding the vessels that approach and berth at the wharf, the number of vessels passing the wharf would be the same as today. The berthing vessels are excluded from the assessment because at the wharf these vessels are moving very slowly or are stationary in the water and so ship wash generation is minimal. So, only vessels that are passing the wharf at speeds up to 12~~six~~ knots are included, noting that vessels are slowing down as they approach the upper estuary/port.

1.4.6 As discussed in ES Chapter 16 Estuarine Processes (document reference 6.2.16, APP-054), the number of vessels arriving and leaving along The Haven would be approximately 400 commercial and cargo vessels visiting the Port of Boston each year (a total of 800 movements passing the wharf each year). With vessels moored at the wharf, each movement would create two ship wash events; the direct wave and the reflected wave, equating to a worst case of 1,600 ship wash waves impacting the bank opposite the wharf each year.

1.4.7 The annual development of ship wash from 800 vessel movements has occurred over a worst case cumulative period of about 13 hours (800 x 60 seconds). This equates to 0.15% of a year. The doubling of ship wash events to 1,600 would lead to a future worst case cumulative period of about 26 hours over which the ship wash would affect the opposite bank. This equates to 0.3% of a year.

1.4.8 The increase in time that ship wash would be active on the opposite bank (from 0.15% of a year pre the Facility to 0.3% of a year post the Facility) will be very small compared to the relatively large amount of time that natural wind-waves are active (greater than 99.7% of a year both pre- and post-Facility). The estimated

0.3% of a year may vary slightly depending on the speeds and sizes of the vessels that actually use The Haven, but it is considered to be such a small standard deviation around this percentage that the overall conclusion is still valid (given the similarity in energy levels experienced by the shoreline discussed above).

1.4.9 Dredging and the establishment of the wharf and the sloping revetment would remove the existing mudflats and saltmarsh at this location. However, the revetment and the wharf themselves would be the flood defences at this location. Elsewhere in The Haven, the flood defences would continue to be fronted by mudflats and saltmarsh. The Applicant agrees that saltmarsh is effective at attenuating waves and provides a level of protection to the backing flood defences from wave attack. Erosion of the saltmarsh could increase due to increased ship wash, but the effect of this increase is negligible. Hence, the saltmarsh in The Haven will continue to provide the same level of protection to the flood defence with the wharf in place as it does today, and there is no reason to believe that the effect of the Facility would change the quality or level of protection afforded by the flood defences through the life of the Facility or beyond.

1.4.10 Overall, it is considered that the potential changes to ship wash on the opposite bank from the wharf due to changes in wave reflection caused by the wharf and changes in morphology, to be very small and the impacts to be negligible.

1.5 References

Gourlay, T. 2011. Notes on shoreline erosion due to boat wakes and wind waves. CMST Research Report, November 2011.

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