

Technical Response to the Representation Submitted by Llanbedr and Pensarn Yacht Club in Relation to Marine Licence Application DML2622

Date: 22 September 2026
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1. Introduction

This technical note has been prepared in response to representations submitted by Llanbedr and Pensarn Yacht Club (LPYC) during consultation on Marine Licence Application DML2622 for maintenance dredging of the Shell Island entrance channel and disposal of dredged sediment at Bar Newydd. The note focuses specifically on the technical issues raised within the LPYC representation and the requests made by LPYC to Natural Resources Wales (NRW).

Maintenance dredging at Shell Island has been undertaken periodically for more than twenty years. Following development of the original dredging strategy in 2000/01, major dredging campaigns were undertaken in 2001/02, 2006, 2013/14 and 2020. Following the original 2001/02 campaign, further consent applications and re-consenting exercises were undertaken e.g., in 2010/11. However, not all consented dredging works were subsequently completed, and some licences expired without the proposed works being undertaken. The current application therefore represents the continuation of a long-established maintenance regime that has been repeatedly reviewed through environmental assessment, consultation and marine licensing processes (ABP Research, 2001; Halcrow, 2005; Halcrow, 2006; Halcrow, 2010; Natural Resources Wales, 2013; Natural Resources Wales, 2019).

This review considers whether the concerns and requests raised by LPYC provide sufficient evidence to question the existing understanding of coastal processes at the Artro estuary entrance, the long-established

disposal strategy at Bar Newydd, or the conclusions reached within previous environmental assessments and licence applications.

Table 1 provides a summary of the concerns and requests raised by LPYC together with the conclusions reached within this review. Section 3 presents the detailed responses to each of the concerns and requests raised by LPYC, whilst Section 4 draws together the principal conclusions arising from the review.

2. Summary of LPYC Concerns, Requests and Responses

Table 1 summarises the principal concerns and requests raised by LPYC, the conclusions reached within this review, and the sections of the note where each issue is considered in detail.

Table 1. Summary of LPYC Concerns, Requests and Responses

LPYC concern / request	Summary response	Additional detail in Section of this report
Concern 1: Material remained on Bar Newydd following the 2013/14 dredging campaign, causing shoaling and affecting navigation.	LPYC's observations are acknowledged. However, no bathymetric surveys or other quantitative evidence have been provided demonstrating that the alleged shoaling resulted from disposal activities rather than the natural evolution of Bar Newydd, a naturally dynamic feature that undergoes recurring cycles of extension, breaching and reformation. No equivalent concerns have currently been identified for the larger 2001/02 dredging campaign.	Section 3.1
Request 1 to NRW: Require applicant to address 2014 and 2020 outcomes and reconsider disposal location.	The reported outcomes have been reviewed. However, the observations presented by LPYC do not currently provide sufficient evidence to demonstrate that the long-established rationale for selecting Bar Newydd is fundamentally unsound. Alternative disposal locations have been considered repeatedly through environmental assessment and consultation. The Dinghy Beach disposal site does not remain available as a contingency location as CCW previously expressed concerns regarding routine use of the Dinghy Beach because of potential impacts on <i>Sabellaria</i> habitat and also it is currently not feasible to access safely. Therefore, Bar Newydd has consistently remained the preferred disposal site (Halcrow, 2006; CCW, Shell Island and Halcrow, 2010).	Section 3.1
Concern 2: Sediment placed on Bar Newydd returned to Mochras Lagoon and affected moorings within the estuary.	Existing studies recognise that Mochras Lagoon is a naturally sediment-importing system with multiple sediment sources (ABP Research, 2001; ABPmer, 2010). No evidence has been presented demonstrating that sediment observed within the lagoon originated from disposed material rather than offshore sources, adjacent coastal landforms or sediment already present within the estuary. The scale and location of the alleged sediment accumulation are also insufficiently defined to establish a clear transport pathway from Bar Newydd.	Section 3.2
Request 2 to NRW: Require updated evidence to support the conclusion that estuary re-entry is negligible.	Additional evidence may improve understanding of sediment behaviour. However, the coastal process understanding underpinning previous assessments has been revisited as part of this review and remains supported by the available evidence (ABP Research, 2001; Halcrow, 2005; Halcrow, 2006; ABPmer, 2010). Bathymetric surveys alone would not establish sediment provenance, and a programme capable of determining sediment fate would require substantially more extensive monitoring than	Section 3.2

	currently proposed. Given the absence of quantitative evidence demonstrating that disposal activities have caused the effects alleged by LPYC, such an investigation would be disproportionate to the scale of the proposed maintenance dredging operation.	
Concern 3: The assumption of northward sediment transport is incorrect and was not borne out by the 2013/14 and 2020 operations.	Net northerly littoral transport is supported by multiple independent studies, including ABP Research (2001) and the West Wales SMP2 assessment (ABPmer, 2010). LPYC's observations do not currently disprove this broader process understanding and relate principally to the short-term behaviour of sediment following individual disposal campaigns.	Section 3.3
Concern 4: The Environmental Report, HRA and WFD conclusions should be treated as unconfirmed because they rely on the disputed sediment-fate assumption.	The environmental assessments rely on a broader understanding of coastal and estuarine processes than a single assumption regarding sediment fate. The observations presented by LPYC do not currently provide sufficient evidence to demonstrate that the underlying process understanding or resulting assessment conclusions are materially incorrect.	Section 3.4
Request 3 to NRW: Treat the HRA conclusions as unconfirmed pending clarification of sediment fate.	The Environmental Report, Appropriate Assessment and HRA are based upon a broader understanding of coastal and estuarine processes than a single sediment-fate assumption. The evidence currently available does not provide sufficient grounds to conclude that the underlying process understanding or resulting HRA conclusions are fundamentally unsound (ABP Research, 2001; Halcrow, 2005; ABPmer, 2010).	Section 3.4
Concern 5: The proposed monitoring programme is not capable of identifying the effects reported by LPYC.	Photographic monitoring has limitations, but bathymetric surveys alone would not establish sediment provenance. Any monitoring programme intended to determine sediment fate would require substantially more extensive investigation. Given the absence of quantitative evidence demonstrating that disposal activities have caused the effects alleged by LPYC, such a monitoring programme would be disproportionate to the scale of the proposed maintenance dredging operation.	Section 3.5
Request 4 to NRW: Require bathymetric monitoring, intervention thresholds and monitoring of the LPYC mooring area.	Additional monitoring could provide useful information regarding future changes in bar morphology, channel position and sediment accumulation. However, the scope of any monitoring should be proportionate to both the scale of the proposed dredging works and the uncertainties associated with sediment movement within a naturally dynamic estuary-coast system. The information currently available does not demonstrate that an extensive monitoring programme is necessary in order to determine the current application.	Section 3.5

3. Detailed response to LPYC Concerns, Requests and Responses

3.1 Shoaling of Bar Newydd Following Previous Disposal Operations

LPYC concern

LPYC state that following the 2013/14 maintenance dredging campaign, completed by February 2014, sediment deposited on Bar Newydd remained on the bar for approximately six months, causing shoaling and affecting navigation. LPYC report that vessels entering and leaving the estuary were required to alter their approach route and navigate closer to the beach to avoid swell breaking over the shoaled bar.

Response

The observations reported by LPYC are acknowledged. However, no bathymetric surveys, navigation records, hydrographic surveys or other quantitative evidence have been provided to demonstrate the magnitude of the reported shoaling, the duration of any change, or the extent to which conditions differed from the normal variability of Bar Newydd.

It is also noted that no evidence has currently been identified of formal concerns regarding shoaling of Bar Newydd being raised with regulators following completion of the 2001/02 or 2013/14 dredging campaigns (Natural Resources Wales, 2013). Furthermore, subsequent licence applications prepared for later dredging campaigns (Natural Resources Wales, 2019) continued to propose the same disposal approach at Bar Newydd, suggesting that neither the applicant nor the relevant regulatory authorities considered that the earlier works had demonstrated an obvious or unacceptable failure of the disposal strategy.

Bar Newydd forms part of a naturally dynamic coastal system subject to longshore sediment transport, strong tidal currents and periodic changes in bar and channel morphology. The West Wales SMP2 assessment (ABPmer, 2010) identifies significant sediment exchange between the Artro Estuary and the adjacent coastline. The assessment also identifies the estuary mouth as an area of significant interaction between estuarine and coastal processes.

Long-term observations by the applicant Richard Workman also indicate that both the entrance channel and Bar Newydd undergo recurring natural adjustment (Richard Workman, pers. comm., 2026). These include progressive northward migration of the channel on the Llandanwg side of the estuary, periodic relocation of navigation markers, extension of Bar Newydd towards the north-east and occasional breaching of the bar during periods of high river flow. Following such events, the bar subsequently reforms and continues its natural cycle of extension and erosion. These processes are driven by the interaction of river flows, tidal currents and coastal sediment transport and form part of the normal evolution of the estuary entrance. Consequently, substantial changes in the length, position and configuration of Bar Newydd can occur without any dredging activity.

Historical aerial imagery also demonstrates that Bar Newydd undergoes substantial natural changes in morphology over time. Comparison of aerial photographs shows periods when the bar extends significantly towards the north-east (e.g., October, 2016) and periods when it is breached and considerably shorter (e.g., March, 2026). These observations are consistent with Richard Workman's description of recurring cycles of extension, breaching and reformation and demonstrate that substantial changes in bar morphology occur naturally, independent of dredging activity (Figure 1).

Technical Memorandum

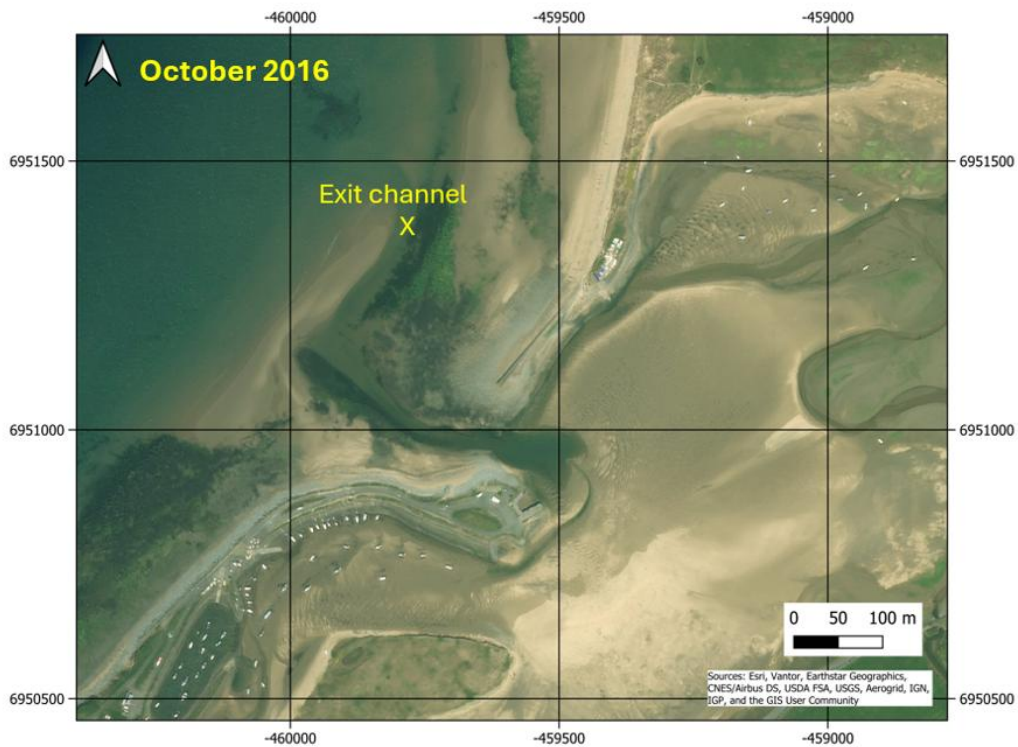


Figure 1. Examples of contrasting Bar Newydd configurations illustrating periods when the bar is extended to the north east (2016) and periods when the bar is breached offering a shorter navigation route to the sea (2026).

LPYC report that elevated bed levels remained present on the bar for approximately six months following completion of the 2013/14 dredging campaign. Even if this observation is accepted, the presence of a shoal over an extended period does not demonstrate that the same body of dredged sediment remained in place throughout that period. Between February and approximately August 2014, the bar would have been exposed to numerous tidal cycles, periods of wave activity, storm events and ongoing longshore sediment transport processes. Consequently, sediment originally placed on the bar may have been progressively reworked and redistributed within the wider coastal system. The continued presence of an elevated shoal does not therefore demonstrate that the same body of dredged sediment remained in place throughout the period observed. Instead, bar morphology reflects the balance between erosion, redistribution and the continuing supply of sediment from the wider coastal system.

The reported period during which shoaling persisted coincided with the exceptionally stormy winter of 2013/14. The Met Office records that the period from December 2013 to January 2014 was characterised by a succession of major winter storms which brought widespread impacts across the UK, including severe wave conditions, coastal flooding and significant impacts along the Welsh coastline (Met Office, 2014). The combination of strong winds, high spring tides, elevated river flows and large waves would be expected to influence sediment redistribution and coastal morphology. Such conditions are capable of driving substantial short-term changes in bar position, bar elevation and channel configuration. Consequently, any assessment of the causes of shoaling observed during 2014 should consider the influence of these storm conditions alongside any potential effects of the disposal operation.

It is also relevant that observations reported by the Shell Island Yacht Club Commodore indicate that Llandanwg Beach became noticeably sandier during and shortly after previous dredging and disposal operations. If correct, such observations would be consistent with at least some of the disposed sediment becoming incorporated into the northward littoral transport pathway identified by the 2001 Environmental Report and subsequently supported by the West Wales SMP2 assessment (ABP Research 2001; ABPmer, 2010). Whilst these observations do not prove the fate of the disposed sediment, they indicate that movement of material away from Bar Newydd and towards the north is a plausible outcome.

Conclusion

The observations reported by LPYC may indicate that shoaling occurred on Bar Newydd following the 2013/14 disposal operation. However, the available information does not demonstrate that the reported shoaling was caused solely or predominantly by disposal activities, nor does it establish that disposed sediment remained in place on the bar for the duration of the reported effects. Bar Newydd is a naturally mobile coastal feature subject to continual reworking by waves, tides and sediment transport processes. Long-term observations indicate that the bar undergoes recurring cycles of extension, breaching and reformation, whilst the period identified by LPYC also coincided with the exceptionally stormy winter of 2013/14.

Accordingly, the observations presented by LPYC are insufficient to demonstrate that the reported shoaling represented an unexpected consequence of the disposal strategy rather than the operation of natural estuarine and coastal processes.

Implications for LPYC's Request to NRW

LPYC propose that alternative disposal locations should be considered, including Dinghy Beach or locations further north-east on Bar Newydd. However, the selection of disposal locations has been the subject of

repeated environmental assessment, option appraisal and consultation over more than two decades. The 2001 Environmental Report considered a range of alternative disposal options before identifying Bar Newydd as the preferred disposal location because it enabled sediment to be returned to the active littoral drift system whilst minimising environmental impacts (ABP Research, 2001).

The suitability of disposal locations was subsequently revisited through the 2005 Appropriate Assessment, the 2006 Long-Term Management Plan, the 2010 discussions with CCW, the 2013 marine licence application and the 2019 application supporting the 2020 dredging campaign (Halcrow, 2005; Halcrow, 2006; Halcrow, 2010; Natural Resources Wales, 2013; Natural Resources Wales, 2019). Throughout this process, Bar Newydd consistently remained the preferred disposal location.

In terms of the Dinghy Beach disposal site, the 2010 CCW meeting records that CCW expressed a preference to avoid routine use of the Dinghy Beach because of concerns regarding potential impacts on *Sabellaria* reef habitat. The Dinghy Beach was therefore retained principally as an emergency or adverse-weather option rather than as the primary disposal location. This approach was carried forward into subsequent licence applications (CCW, Shell Island and Halcrow, 2010; Jacobs, 2023). However, it is currently not viable owing to access constraints and safety concerns (Richard Workman, pers. comm., 2026).

The available evidence therefore suggests that the alternatives proposed by LPYC have already been considered through previous environmental assessments and regulatory consultations. Whilst any disposal location can be revisited if new evidence becomes available, the observations presented by LPYC do not currently provide sufficient evidence to demonstrate that the long-established rationale for selecting Bar Newydd is fundamentally unsound or that the Dinghy Beach would have represented a clearly preferable alternative (if it was viable to access).

The suggestion by LPYC that material should instead be placed further north-east on Bar Newydd should be considered in the context of current operational practice. Historical assessments have consistently sought to maximise incorporation of sediment into the northerly littoral drift pathway by placing material as far north on Bar Newydd as practicable. However, the extent to which placement can be moved northwards within the approved disposal area is influenced by tidal conditions, weather conditions, access constraints and the morphology of the bar at the time the works are undertaken. Further discussion with the applicant would therefore be useful in order to confirm the degree of flexibility available within the approved disposal area and whether any adjustment to the preferred placement location is both practicable and consistent with the approved disposal strategy.

3.2 Return of Sediment to Mochras Lagoon

LPYC concern

LPYC state that sediment placed on Bar Newydd during the 2013/14 dredging campaign did not migrate northwards as predicted but was instead transported back into Mochras Lagoon, affecting moorings within the estuary. LPYC further suggest that a similar process may have occurred following the 2020 dredging campaign.

Response

The observations reported by LPYC are acknowledged. However, these observations are not accompanied by bathymetric surveys, topographic surveys or other quantitative measurements demonstrating the volume, location or timing of the alleged sediment movement. Whilst first-hand observations are an important source of information, the absence of supporting survey data makes it difficult to determine the magnitude of the

reported changes or to distinguish between natural morphological adjustment and the consequences of a specific disposal operation.

It is also noted that no evidence has currently been identified of formal concerns regarding sediment accumulation within Mochras Lagoon being raised with regulators following completion of the 2013/14 dredging campaign or during preparation of the subsequent 2020 licence application. Furthermore, the 2019 application (Natural Resources Wales, 2019) prepared in support of the 2020 dredging campaign records does not identify any apparent failure of the disposal strategy or present evidence that sediment return to the estuary had become a significant operational or navigational issue.

The possibility of sediment re-entering the estuary following disposal at Bar Newydd was recognised from the outset of the disposal strategy development process. The 2001 Environmental Report explicitly considered this possibility and concluded that it could be minimised by placing material as far north on Bar Newydd as practicable, thereby maximising incorporation into the northerly littoral drift system (ABP Research, 2001). The subsequent Appropriate Assessment similarly acknowledged that some sediment may return towards the estuary but concluded that such re-entry would be negligible compared with natural sediment inputs from offshore sources (Halcrow, 2005). The West Wales SMP2 assessment (ABPmer, 2010) reached a broadly consistent conclusion, recognising that the Artro remains a net sink and importer of sediment and identifying multiple potential sediment sources, including offshore supplies, adjacent coastal landforms and redistribution of sediment already present within the estuary. The possibility of estuary re-entry was therefore neither overlooked nor treated as incompatible with the overall understanding of sediment behaviour within the system.

Consequently, even if sediment accumulation within Mochras Lagoon is accepted as observed, it does not automatically follow that the accumulated sediment originated from material previously deposited on Bar Newydd. The representation does not provide direct evidence demonstrating that sediment observed within the lagoon was the same material previously disposed at the bar. Existing studies indicate that the estuary forms part of an open sediment system receiving sediment from multiple sources and subject to continual sediment exchange with the adjacent coastline and offshore environment.

Even if sediment accumulation occurred in the area identified by LPYC, it is difficult to demonstrate that the sediment originated from Bar Newydd, and the volume involved would be relatively small when distributed over the areas concerned. Figure 2 shows the approved disposal area together with the broad area within which LPYC allege sediment accumulation may have occurred (the smaller blue hatched area). The figure illustrates the spatial separation between the disposal area and the mooring areas referred to in the representation, together with the complexity of the potential sediment pathways between the two locations.

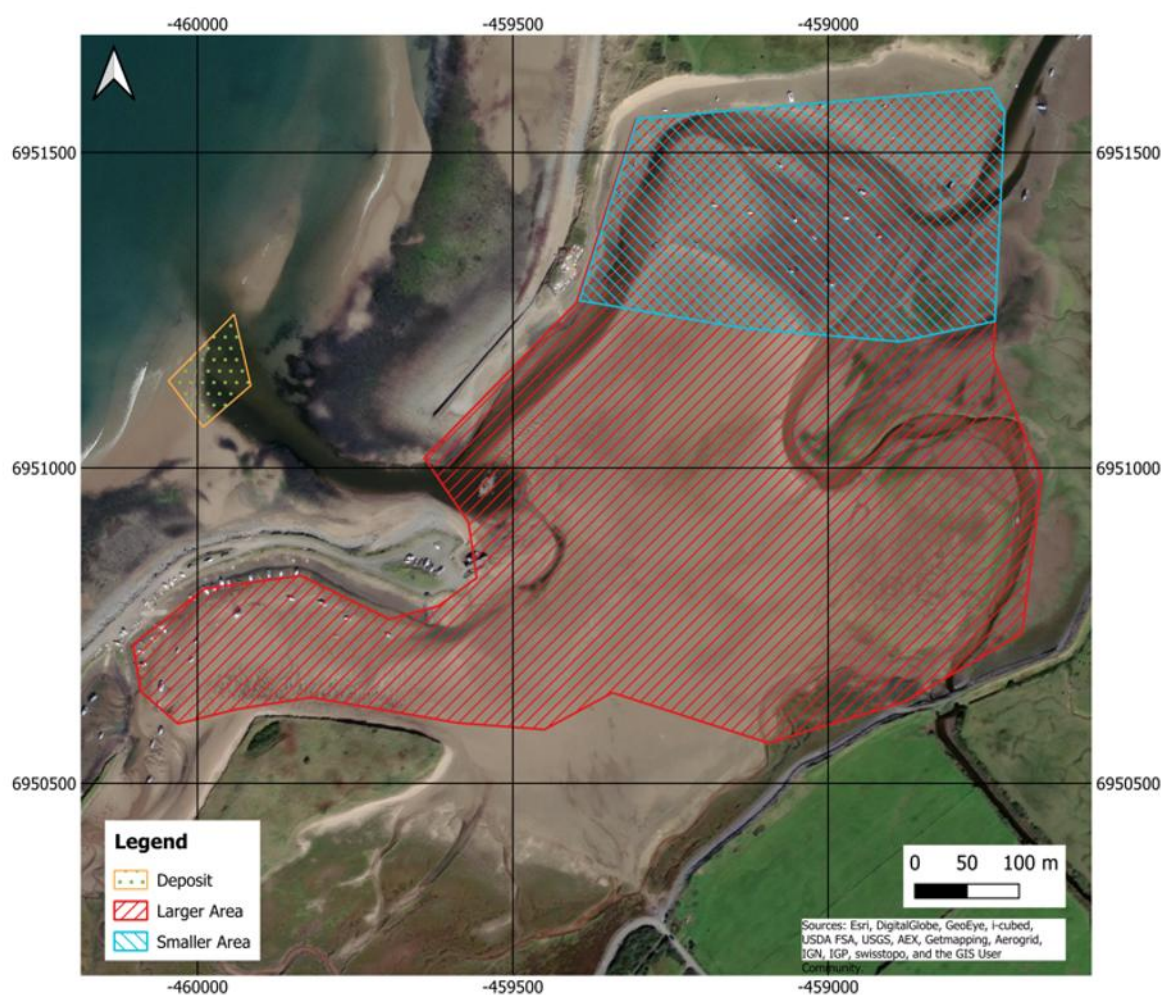


Figure 2. Approved disposal area at Bar Newydd and approximate area of alleged sediment accumulation referred to within the LPYC representation.

The quantities of sediment involved should also be considered in context. Assuming a dredged quantity of approximately 4,000 tonnes and a bulk wet sediment density of approximately 2.0 t/m^3 , the disposed volume would be approximately $2,000 \text{ m}^3$. If this entire volume were distributed across the broader area of Mochras Lagoon identified by Jacobs as potentially influenced by sediment redistribution (approximately $307,000 \text{ m}^2$), the equivalent average increase in bed level would be approximately 7 mm. Even if the material were assumed to accumulate solely within the smaller area corresponding approximately to the LPYC mooring area where increased siltation has been alleged (approximately $80,000 \text{ m}^2$), the equivalent average increase in bed level would be approximately 3 cm. Whilst these calculations are highly simplified and do not represent actual sediment behaviour, they illustrate both the relatively small average thicknesses involved and the difficulty of inferring sediment provenance from observed changes in bed levels alone.

In addition, sediment accumulation on the LPYC side of the estuary may be influenced by factors other than the fate of dredged material disposed at Bar Newydd. Previous studies have identified the estuary as a naturally sediment-importing system and have recognised that sediment may be derived from offshore sources, adjacent coastal landforms and redistribution of sediment already present within the estuary (ABPmer, 2010). Local bed levels may also be influenced by changes in channel alignment, tidal flow patterns and variations in freshwater discharge from the Afon Artro. For example, changes in channel position

may alter zones of erosion and deposition within the estuary, whilst periods of lower river flow may reduce the capacity of the river to transport sediment seaward. LPYC's own published moorings guidance notes (https://www.lpyc.org.uk/?page_id=74) that the position of the navigable channel can vary considerably from year to year depending on winter storm conditions and that, in some years, moorings may need to be relocated to avoid obstructing the channel. This indicates that channel migration and associated changes in local bed levels are recognised characteristics of the system. Consequently, any observed sediment accumulation within the lagoon or around mooring locations cannot automatically be attributed to material previously disposed at Bar Newydd and may instead reflect broader changes in estuary morphology and sediment dynamics (ABP Research, 2001; ABPmer, 2010).

A further point that requires clarification is the apparent sequence of events described within the LPYC representation. LPYC state that elevated bed levels remained present on Bar Newydd for approximately six months following the 2013/14 dredging campaign. LPYC also state that sand was carried back into Mochras Lagoon and affected moorings within the estuary. However, the representation does not provide evidence regarding the timing or mechanism of the alleged transfer of sediment from the bar to the lagoon.

If the bar remained elevated until approximately August 2014, this would imply that any substantial transfer of sediment from the bar to the estuary occurred after a prolonged period of exposure to tidal currents, wave action and longshore sediment transport processes. It is therefore unclear how a significant quantity of sediment would remain available for transport into the estuary after such an extended period of reworking by natural coastal processes. In the absence of supporting survey data, it is therefore difficult to understand the mechanism by which large quantities of sediment would remain on the bar for several months before subsequently being transported into the estuary. This does not mean that sediment exchange between the bar and estuary cannot occur, but it does indicate that the relationship between the observed shoaling and the alleged accumulation of sediment within the lagoon may be more complex than implied by the LPYC representation.

The SMP2 assessment (ABPmer, 2010) also identifies the continuing requirement for maintenance dredging as evidence that the estuary remains a net importer of sediment. This suggests that sediment accumulation within the lagoon is an ongoing characteristic of the estuary rather than a phenomenon necessarily associated with a particular disposal operation.

Furthermore, observations reported by the Shell Island Yacht Club Commodore indicate that Llandanwg Beach became noticeably sandier during and shortly after previous dredging and disposal operations. If correct, such observations would suggest that at least some of the disposed sediment became incorporated into the northward littoral transport pathway predicted by the earlier studies. Whilst such observations do not establish the ultimate fate of the material, they indicate that sediment movement away from Bar Newydd and towards the north is a plausible outcome and that sediment pathways within the system are likely to be more complex than implied by the LPYC representation.

Conclusion

The observations reported by LPYC may indicate that sediment accumulated within Mochras Lagoon following previous dredging campaigns. However, the information presented does not demonstrate a direct causal link between that accumulation and sediment previously deposited at Bar Newydd. Existing studies recognise that Mochras Lagoon is a naturally sediment-importing system, identify multiple potential sediment sources, and indicate that local patterns of erosion and deposition are influenced by a range of estuarine and coastal processes. No evidence has been presented demonstrating that the alleged bed-level increases within the lagoon originated from material previously disposed at Bar Newydd rather than these other natural causes.

Furthermore, even if sediment accumulation has occurred within the areas identified by LPYC, the simplified calculations presented above demonstrate that changes in bed levels alone would not provide sufficient evidence to determine sediment provenance within such a large and dynamic estuarine system. Accordingly, the observations reported by LPYC should be interpreted with caution and do not currently provide a basis for concluding that disposal at Bar Newydd represents the dominant cause of the alleged siltation.

Implications for LPYC's Request to NRW

LPYC request that NRW should not accept the conclusion, presented within previous assessments, that re-entry of sediment to the estuary is likely to be negligible without requiring updated evidence, such as comparison of bathymetric surveys undertaken before and after the 2020 dredging campaign.

The request for additional evidence is understandable given the observations reported by LPYC. However, further information would first be required regarding the location, extent and magnitude of the alleged sediment accumulation within the lagoon. The representation refers generally to impacts on moorings but provides limited information regarding where sediment accumulation was observed or how conditions differed from historic conditions.

Bathymetric surveys alone would not establish sediment provenance. A monitoring programme capable of reliably determining the fate of disposed sediment would require substantially more than isolated pre- and post-dredge surveys and would likely need to cover the disposal site, estuary entrance, adjacent coastline and lagoon over an extended period.

Whilst uncertainty remains regarding the detailed fate of sediment disposed during previous campaigns, we remain of the opinion that the predominant long-term pathway for sediment placed on Bar Newydd is northwards within the littoral system, consistent with the conclusions of the 2001 Environmental Report, subsequent Halcrow assessments and the West Wales SMP2 assessment.

Accordingly, whilst additional monitoring may improve understanding of sediment behaviour, the observations currently presented by LPYC do not demonstrate that the previous conclusion regarding negligible estuary re-entry is incorrect. Bathymetric surveys alone would not resolve the question of sediment provenance, and a programme capable of reliably determining sediment fate would require substantially more extensive investigation. Given the limited evidence currently available to demonstrate significant adverse effects, such work would be disproportionate to the scale of the proposed maintenance dredging operation.

3.3 Assumption of Northward Sediment Transport

LPYC concern

LPYC argue that the current application relies upon an assumption that sediment disposed at Bar Newydd will be transported northwards along the coast. LPYC contend that observations following the 2013/14 and 2020 disposal operations do not support this prediction and suggest that sediment may instead remain within the vicinity of the disposal site and subsequently return to the estuary. LPYC further note that the favourable conclusions presented within the Environmental Report, Habitats Regulations Assessment (HRA) and Water Framework Directive (WFD) assessment rely upon this sediment-transport assumption being correct.

Response

The existence of a net northerly sediment transport pathway along this section of coastline is supported by multiple independent studies undertaken over a period of more than two decades. The ABP Research

Environmental Report (ABP Research, 2001) concluded that sediment transport along the Morfa Dyffryn frontage is predominantly northwards and used this understanding as part of the basis for selecting Bar Newydd as the preferred disposal location.

This interpretation was subsequently supported by the West Wales SMP2 Estuaries Assessment (ABPmer, 2010). The SMP assessment identified a predominant south-westerly wave climate, recognised evidence of net northerly longshore transport along the Morfa Dyffryn frontage, and noted that closure of the former estuary mouth south of Mochras Point provided evidence of this transport pathway. The SMP assessment also recognised that sediment may be supplied from offshore sources and adjacent coastal landforms, and noted that the sediment requiring dredging may derive from sediment already present within the estuary system as well as external sources.

Figure 3 illustrates the principal sediment pathways identified within previous studies and assessments, including northward littoral transport along the Morfa Dyffryn frontage and sediment exchange between the estuary and adjacent coast.

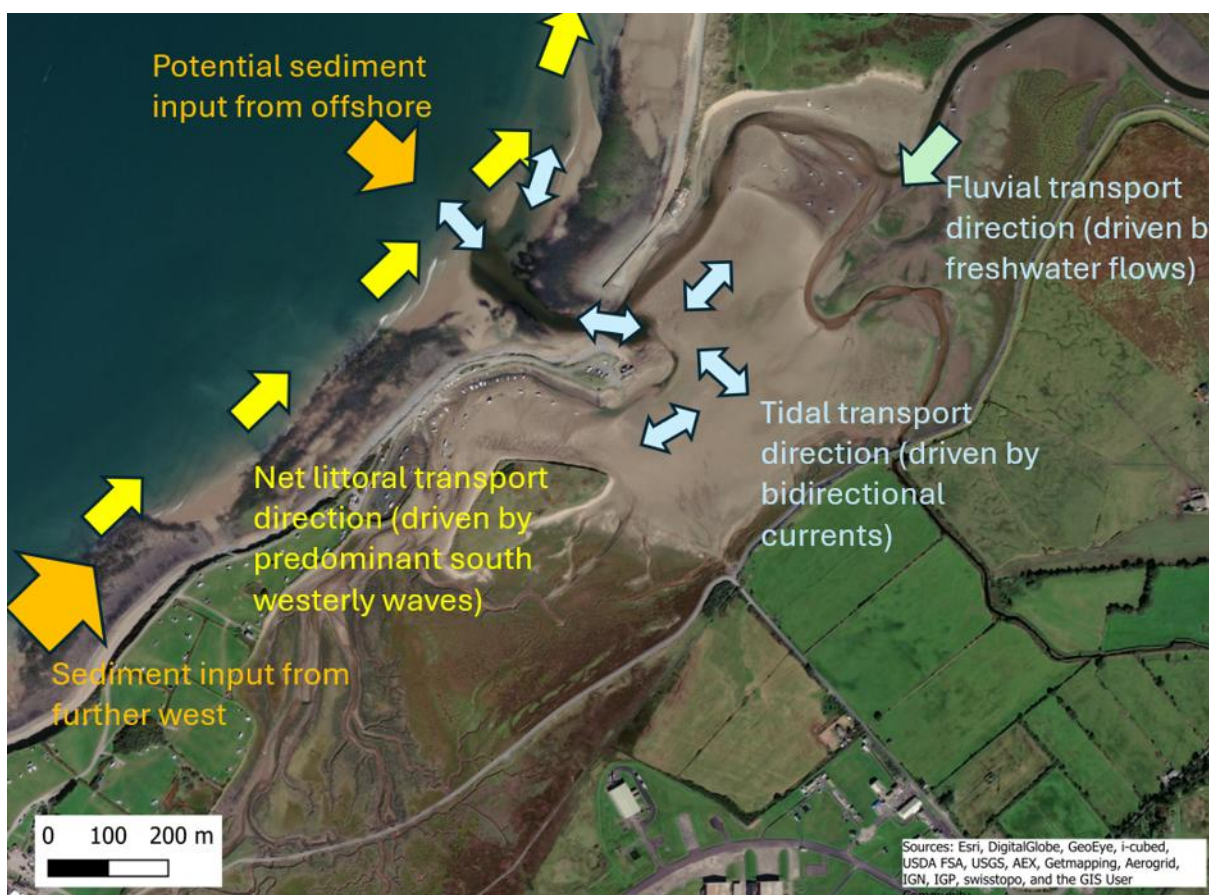


Figure 3. Principal sediment pathways identified within previous studies and assessments.

Importantly, the existence of a net northerly transport pathway does not imply that all sediment placed on Bar Newydd will move northwards, nor that movement will occur at a constant rate. Longshore sediment transport describes the net movement of sediment within the coastal system over time. Individual sediment deposits may be temporarily reworked, redistributed or stored within bars, beaches and shoals before becoming incorporated into the wider transport system. Consequently, short-term observations following a particular disposal campaign do not necessarily provide a reliable basis for evaluating longer-term coastal sediment transport patterns.

The disposal strategy was also influenced by discussions with regulators and statutory consultees regarding the potential benefits of retaining sediment within the active coastal system. The 2001 Environmental Report (ABP Research, 2001) and subsequent management documents record that material was to be placed as far north on Bar Newydd as practicable in order to maximise incorporation into the established northerly littoral drift pathway. Subsequent discussions with the Countryside Council for Wales (CCW) also recognised the potential value of sediment supply to Llandanwg Beach and the adjacent dune frontage, and the 2006 Long-Term Management Plan notes that direct nourishment of Llandanwg Beach was considered a potentially beneficial option should practical constraints be overcome.

Furthermore, observations reported by the Shell Island Yacht Club Commodore indicate that Llandanwg Beach became noticeably sandier during and shortly after previous dredging and disposal operations. Whilst anecdotal, such observations are consistent with at least some of the disposed material being incorporated into the northerly transport pathway predicted by the earlier studies.

Conclusion

A net northerly littoral transport pathway along the Morfa Dyffryn frontage is supported by the 2001 Environmental Report (ABP Research, 2001) and independently corroborated by the West Wales SMP2 Estuaries Assessment (ABPmer, 2010). LPYC's observations do not currently disprove the existence of this pathway. Rather, they raise questions regarding the short-term behaviour of sediment following individual disposal operations and the timescale over which sediment becomes incorporated into the wider littoral transport system.

Implications for LPYC's Request to NRW

LPYC request that NRW reconsider the assumption of northerly sediment transport used within the environmental assessments. However, the available evidence indicates that the existence of a net northerly littoral transport pathway remains supported by multiple independent studies and is not dependent upon the outcome of any individual dredging campaign. Whilst there may be uncertainty regarding the short-term behaviour of sediment following disposal, the observations presented by LPYC do not currently provide sufficient evidence to conclude that the wider understanding of regional sediment transport processes is incorrect.

3.4 Whether LPYC's Observations Affect the Conclusions of the Environmental Assessment and HRA

LPYC concern

LPYC argue that the favourable conclusions presented within the Environmental Report, Habitats Regulations Assessment (HRA) and Water Framework Directive (WFD) assessment rely upon the assumption that sediment disposed at Bar Newydd will migrate northwards along the coast. LPYC contend that if sediment instead remained on the bar and re-entered the estuary, then conclusions regarding negligible impacts and potential benefits to dune and reef habitats would be undermined. LPYC therefore request that NRW treat the "No Likely Significant Effect" and "Potentially Beneficial" conclusions as unconfirmed until the fate of sediment disposed during previous campaigns has been clarified.

Response

It is recognised that assumptions regarding sediment transport form an important component of the environmental assessments undertaken for Shell Island dredging activities. However, the conclusions of the

Environmental Report, Appropriate Assessment, HRA and related environmental assessments were not based solely upon a single assumption regarding northward sediment transport (ABP Research, 2001; Halcrow, 2005; Halcrow, 2006). Rather, they were informed by a broader understanding of coastal processes, sediment dynamics, disposal volumes, disposal methods, environmental sensitivities, the scale of the works and the behaviour of the estuary system as a whole.

Furthermore, the assessment process did not assume that all sediment placed at Bar Newydd would move northwards, nor that no sediment could return towards the estuary. The possibility of sediment re-entering the estuary was explicitly considered during development of the disposal strategy. The 2001 Environmental Report (ABP Research, 2001) recognised that material placed on Bar Newydd could be reworked by waves and tidal currents and potentially transported back towards the estuary entrance. As a consequence, the preferred disposal strategy was specifically designed to minimise this possibility by placing material as far north on Bar Newydd as practicable in order to maximise entrainment into the established northerly littoral drift pathway (ABP Research, 2001). The 2005 Appropriate Assessment (Halcrow, 2005) subsequently revisited this issue and explicitly acknowledged that some sediment placed on Bar Newydd could re-enter the estuary on a rising tide. However, the assessment concluded that any such re-entry would be negligible in comparison with the quantities of sediment naturally entering the estuary from offshore sources. The possibility of estuary re-entry was therefore considered directly within the assessment process and was not overlooked.

The broader process understanding underpinning the environmental assessments has also been independently supported by the West Wales SMP2 Estuaries Assessment (ABPmer, 2010). Although prepared for a different purpose, the SMP similarly identifies northerly longshore sediment transport, significant estuary-coast sediment exchange, offshore sediment supply and continued sediment accumulation within the Ardro estuary (i.e. Mochras Lagoon) requiring periodic maintenance dredging.

The disposal strategy was also influenced by consultation with regulators and statutory consultees. The 2001 Environmental Report (ABP Research, 2001) and subsequent management documents record that sediment was to be placed as far north on Bar Newydd as practicable to maximise incorporation into the northerly littoral drift system. Subsequent consultation also recognised potential benefits to Llandanwg Beach and the adjacent dune frontage (Halcrow, 2006).

Consequently, the concept of sediment contributing to beaches and coastal features north of the estuary formed part of the wider management approach discussed with consultees over many years.

LPYC are correct in noting that limited information is currently available regarding the detailed fate of sediment disposed during previous campaigns. However, the absence of such information does not in itself invalidate the wider body of evidence on which the environmental assessments were based. The observations presented by LPYC do not currently demonstrate a causal link between disposal activities and the effects alleged, nor do they disprove the established understanding of sediment transport, sediment exchange and estuary evolution developed through multiple assessments over more than twenty years. It should be noted that the 2013 and 2019 applications continued to rely upon the same broad process understanding and disposal strategy when supporting successive dredging campaigns, suggesting that the conclusions of earlier assessments remained considered valid at the time of those applications (Natural Resources Wales, 2013; Natural Resources Wales, 2019).

In addition, the environmental assessments considered a broader range of factors than sediment fate alone, including disposal volumes, scale of individual disposal events, habitat sensitivities, separation distances from designated features, expected rates of sediment dispersion, monitoring proposals and the wider coastal-process understanding of the site. Consequently, even if uncertainty remains regarding the detailed fate of sediment disposed during previous campaigns, such uncertainty does not automatically invalidate the wider conclusions of the Environmental Report, HRA or WFD assessment.

Conclusion

LPYC correctly identify that assumptions regarding sediment transport underpin some elements of the environmental assessment process. However, the observations presented do not demonstrate that the broader process understanding underpinning the Environmental Report, Appropriate Assessment, HRA and related assessments is materially incorrect. Consequently, the information currently available does not provide sufficient grounds to conclude that the Environmental Report, HRA or related assessment conclusions are fundamentally unsound (ABP Research, 2001; Halcrow, 2005; Halcrow, 2006; ABPmer, 2010).

Implications for LPYC's request to NRW

LPYC request that NRW treat the HRA conclusions as unconfirmed pending clarification of sediment fate. Whilst further evidence regarding sediment pathways may improve understanding of the system and assist future licence reviews, the observations currently presented do not provide sufficient grounds to conclude that the Environmental Report, HRA or related assessment conclusions should be treated as invalid or unconfirmed pending further investigation.

3.5 Adequacy of the Proposed Monitoring Programme

LPYC concern

LPYC note that the monitoring proposed within the current application primarily comprises photographic monitoring of the disposal site. LPYC argue that such monitoring would not be capable of identifying the specific outcomes they report following previous dredging campaigns, namely shoaling of Bar Newydd, alterations to navigational conditions and sediment accumulation within Mochras Lagoon. LPYC therefore request bathymetric monitoring of the bar, channel and estuary, together with defined intervention thresholds and remedial actions.

Response

It is recognised that photographic monitoring alone provides only limited information regarding changes in bed levels, channel morphology or sediment accumulation elsewhere within the estuary. Consequently, LPYC are correct in observing that photographic monitoring is unlikely to determine whether sediment has accumulated elsewhere within the system or to establish the provenance of sediment observed at a particular location.

However, bathymetric surveys alone would not necessarily resolve this uncertainty. As discussed in Section 3.2, a change in bed level at a particular location may demonstrate that sediment accumulation or erosion has occurred, but would not in itself establish whether the material originated from Bar Newydd, offshore sediment sources, adjacent coastal landforms or redistribution of sediment already present within the estuary.

A monitoring programme capable of reliably determining the fate of dredged sediment would therefore require substantially more than a small number of isolated bathymetric surveys. Multiple repeat surveys would likely be required over an extended period, together with coverage of the disposal site, estuary entrance, adjacent coastline and lagoon. Depending on the objectives, sediment tracing or similar techniques may also be required. Given the limited evidence currently available to demonstrate significant adverse effects, such an investigation would represent a substantial and potentially disproportionate undertaking relative to the scale of the proposed maintenance dredging operation.

Conclusion

LPYC are correct in observing that the proposed photographic monitoring programme provides only limited information regarding wider sediment redistribution within the estuary. However, the information currently available does not demonstrate that previous dredging operations have caused significant adverse effects that would necessarily justify an extensive monitoring programme. Furthermore, determining sediment provenance would require a substantially more extensive investigation than the bathymetric surveys proposed by LPYC.

Implications for LPYC's Request to NRW

Additional monitoring could provide useful information regarding future changes in bar morphology, channel position and sediment accumulation. However, the scope of any monitoring should be proportionate to both the scale of the proposed dredging works and the uncertainties associated with sediment movement within a naturally dynamic estuary-coast system. The information currently available does not demonstrate that an extensive monitoring programme is necessary in order to determine the current application. Furthermore, given the limited evidence currently available to demonstrate significant adverse effects, a monitoring programme capable of reliably determining sediment provenance and sediment fate would be disproportionate to the scale of the proposed maintenance dredging operation.

4. Conclusions

The available evidence indicates that the Artro estuary (Mochras Lagoon) entrance is a naturally dynamic environment characterised by ongoing sediment exchange between the estuary, adjacent coastline and offshore sediment stores. This includes natural cycles of extension, breaching and reformation of Bar Newydd, which can result in substantial changes in bar morphology and navigation conditions through time (ABP Research, 2001; Halcrow, 2006; ABPmer, 2010).

Existing studies consistently indicate that the estuary remains a net importer of sediment. Changes in bed levels within Mochras Lagoon may therefore arise from a range of causes, including offshore sediment inputs, redistribution of sediment already present within the estuary, channel migration and variations in river flow, in addition to any contribution from previously disposed sediment (ABP Research, 2001; Halcrow, 2005; ABPmer, 2010).

LPYC's observations raise legitimate questions regarding the behaviour of sediment following previous disposal operations. In particular, LPYC consider that disposal at Bar Newydd caused prolonged shoaling of the bar and that a substantial proportion of the deposited material subsequently returned to the lagoon and affected LPYC moorings.

However, the evidence currently presented does not establish a clear causal link between disposal at Bar Newydd and the effects alleged. Whilst some sediment may return to the estuary, it is more likely that sediment redistribution begins immediately following placement. Furthermore, the long-term evolution of Bar Newydd is likely to reflect the combined influence of wider coastal processes, including northerly littoral transport, storm events and ongoing sediment supply to the frontage rather than the small volume of dredge disposal.

No evidence has been presented demonstrating that the alleged bed-level increases within Mochras Lagoon originated from material previously disposed at Bar Newydd rather than natural sediment import from longshore and offshore sources, redistribution of sediment already present within the estuary, or adjustments in bed levels associated with channel migration.

The information currently available does not demonstrate that the broader process understanding underpinning the Mochras Lagoon, Shell Island: Maintenance Dredging and Disposal Environmental Report, subsequent Halcrow assessments or the West Wales SMP2 assessment is materially incorrect (ABP Research, 2001; Halcrow, 2005; Halcrow, 2006; ABPmer, 2010). Nor does it provide sufficient evidence to conclude that the current disposal strategy, first developed through the 2001 Environmental Report and subsequently retained through repeated environmental assessment, consultation and licensing reviews, is fundamentally unsound (ABP Research, 2001; Halcrow, 2005; Halcrow, 2006; Halcrow, 2010; Natural Resources Wales, 2013; Natural Resources Wales, 2019).

Finally, whilst additional monitoring may improve understanding of sediment behaviour, determining sediment provenance and quantifying the relative contribution of different sediment sources would require a substantially more extensive programme of investigation than that proposed by LPYC. Given the limited evidence currently available to demonstrate significant adverse effects, such an investigation would be disproportionate to the scale of the proposed maintenance dredging operation.

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