REPORT

Selsey Haven Preliminary Consultation Document

Client: Chichester District Council

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Enhancing Society Together

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Disclaimer

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1 Introduction

Chichester District Council believes Selsey would benefit from a small harbour.

The purpose of this document is to help key stakeholders explore the feasibility of constructing such a harbour, especially in respect of gaining the necessary consents.

To facilitate this process this document presents three preliminary conceptual options that provide a framework for identifying key issues and assessing their potential impacts, particularly with regard to obtaining the required approvals and licences.

None of the options necessarily represent a final solution but between them they provide a broad basis for evaluation and comparison. Their purpose is to convey the main principles involved without necessarily representing working general arrangements. Later stages will develop outline designs will which give closer attention to positioning, configurations and forms of construction.

The three options are based on best judgement using readily available data. Key aspects of the options are discussed in brief commentaries that are likewise based on best judgement. It is anticipated that the consultation process will contribute to the understanding of the issues involved and help to identify where further studies are required.

At the end of the consultation process the commentaries will be edited as necessary to suit the various contributions made during the process. Also, conclusions will be added to the document identifying the best way forward based on the consultation, especially in respect of the requirements for a more detailed feasibility report.

It is anticipated that a modest sized feasibility study will be undertaken before proceeding to the formal consent stage.

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2 General Description

2.1 All Options

All three options are located just south of the East Beach car park and green area. Their position coincides with two fisheries compounds and deeper water in the nearshore zone. Also they are relatively close to a residential area set back from the coastline. See Location Plan, Drawing No. PB3807/0001 in the Appendix.

The main difference between the three options is their cross-shore location. Option 1 straddles the land and foreshore, Option 2 straddles the foreshore and nearshore, and Option 3 is entirely located within the nearshore zone. See Drawing Nos. PB3807/0002 – 0004 in the Appendix.

Each option is designed to accommodate 75 No. craft (25 No. 15 metres in length and 50 No. 10 metres in length). The size of the mooring basin is based on guidance provided by The Yacht Harbour Association Ltd. In order keep overall impacts and costs to a minimum the area has been kept as compact as possible. The mooring basin anticipates the use of floating pontoons, a modest sized hardstanding and a slipway.

The mooring basin is dredged to a level of 4 metres below Ordnance Datum which compares with a Mean Low Water Spring tide level of 2.3 metres below Ordnance Datum.

The harbour entrance is located in the South-East corner where the natural seabed levels tend to be at their lowest. The entrance also faces away from the dominant direction of longshore sediment movement.

The typical top level of the harbour piers and breakwaters is 5 metres above Ordnance Datum which coincides with the promenade level of the adjacent seawall. This is seen as a reasonable minimum level, again in order to reduce impacts and costs.

2.2 Option 1

This option straddles the land and foreshore in respect of its cross-shore location.

It involves a deep excavation between the seafront road and the seawall, the removal of the seawall and the re-location of many of the buildings in the fisheries' compounds. The harbour walls are in vertical sided structures, piled into the underlying ground. The excavated materials are used to locally raise ground levels to accommodate quayside facilities.

This option is the most compact of the three and provides a quay wall facility around its full perimeter. It is also the lowest cost option due in part to the use of vertical sided solid piers throughout. These are considerably less expensive than rock breakwaters and although they have a poorer hydraulic performance they may be acceptable in this situation due to the presence of the existing groyne field. In addition this option generates surplus excavation and demolition materials which could be used beneficially elsewhere, such as for improving the sea defences elsewhere along the East Beach frontage.

However, the harbour is particularly close to the residential area, and it involves a significant land take and the need to divert the promenade footpath.

2.3 Option 2

This option straddles the foreshore and nearshore in respect of its cross-shore location.

It involves the enclosure of a length of the frontage and the strengthening of the seawall.

The enclosure is achieved by means of two rock breakwaters, and the wall strengthening by means of a vertical quay wall installed in front of the seawall.

The option provides the best balance between accessibility and low impact on the existing infrastructure and land area.

However, it does represent the highest impact on the coastal processes which in turn affects the conservation areas.

2.4 Option 3

This option is entirely situated within the nearshore zone in respect of its cross-shore location.

It involves the enclosure of an area of seabed offset from the shoreline, and an access link to the shoreline.

The enclosure is achieved by means of a rock breakwater, and the shoreline link by means of an open pier structure that allows free movement of the foreshore beach material.

The option represents the least impact of the land area, infrastructure and foreshore.

However, it is the least accessible of the three options and the most expensive.

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3 Numerical Modelling

3.1 All Options

Numerical modelling is a key tool in developing a better understanding of the performance and impacts of the various options.

For numerical modelling, basic input data such as bathymetry, offshore wave heights, wave periods, wind speeds, and type of boundaries would be required.

It is possible to simulate the growth, decay and transformation of wind-generated waves and swells in offshore and coastal areas. Various physical phenomena can be captured, these include but are not limited to; wave growth by action of wind, on-linear wave-wave interactions, dissipation due to white capping, dissipation due to bottom friction, dissipation due to depth-induced wave breaking and refraction and shoaling due to depth variations. Typical numerical modelling software to use for this would be Mike 21-SW.

It is possible to determine and assess wave dynamics within the harbour and understand the disturbance within for each option. This can help determine the optimum harbour layout in relation to predefined criteria for acceptable wave disturbance, vessel movements, mooring arrangements and handling down-time for example. The following combined effects of all important wave phenomena of interest in harbour engineering can be captured. These include but are not limited to; shoaling, refraction, diffraction, wave breaking, bottom dissipation, wave transmission and directional spreading. Typical numerical modelling software to use for this would be Mike 21-BW – Boussinesq Wave Module.

Wave overtopping assessment can be undertaken in order to identify a required crest level of the harbour breakwaters and piers in terms of pedestrian safety, vehicle safety and property safety (including buildings and boats) for all options. Overtopping assessment can be undertaken for both vertically faced pier structures and breakwaters with side slopes.

Hydrodynamic modelling can be undertaken to help understand complex applications within coastal environments such as the assessment of hydrographic conditions for design, construction and operation of structures in waters. Typical numerical modelling software to use for this would be Mike 21 Flow Model FM.

It is possible to simulate littoral drift and coastline evolution in which the flow and transport can be assumed to be in mainly one direction. Therefore, it would be possible to model each option to help understand the impacts on sediment transport. Typical numerical modelling software to use for this would be LITPACK.

3.2 Option 1

There are no unique numerical modelling techniques that can be applied specifically to this option alone.

3.3 Option 2

There are no unique numerical modelling techniques that can be applied specifically to this option alone.

3.4 Option 3

There are no unique numerical modelling techniques that can be applied specifically to this option alone.

4 Ground Conditions

4.1 All Options

Given the amount of existing works that are performing satisfactorily, including piled structures and gravity structures, it is not anticipated that there will be any major difficulties with the proposed works. Also the rock breakwaters are in a flexible form of construction and have a large footprint, both of which should reduce the likelihood of geotechnical problems arising.

4.2 Option 1

The main potential issue with this option is the relatively close proximity (30 metres) of the landward quay wall to the seafront residential properties. However, it is anticipated that careful attention to the detailed design should be able to overcome any difficulties arising.

4.3 Option 2

The main potential issue with this option is the need to support the existing seawall by means of the new quay wall in order to allow the mooring basin to be dredged down to its design level. However, again it is anticipated that careful attention to the detailed design should be able to overcome any difficulties arising.

4.4 Option 3

The main challenge for this option is the access pier from the shoreline to the rock breakwater. However, a not dissimilar structure has been in operation at the nearby lifeboat station for some decades and therefore no major difficulties are anticipated.

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5 Internal Wave Heights

5.1 All Options

The wave heights occurring within the harbour are mainly a function of the incoming wave energy through the harbour entrance and the reflective nature of the internal harbour walls, although the shape of the harbour also has some influence, where asymmetrical harbours tend to produce less resonance. For each of the three options the incoming wave energy is similar but the reflected waves would differ.

5.2 Option 1

For this option the degree of wave reflection is likely to be high due to the presence of vertical sided structures along each edge of the harbour. However, the problem can be reduced by using structures with a porous face which reduces the amount of wave reflection by partially absorbing wave energy.

5.3 Option 2

For this option the problem of reflected waves is considerably reduced due to the use of porous rock breakwaters with side slopes which would have the capacity to absorb most of the incident wave energy. However, the vertical quay wall along the landward edge would result in some wave reflection.

5.4 Option 3

For this option there is likely to be a negligible problem with wave reflection due to the full construction in rock breakwaters.

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6 Silting Up

6.1 All Options

The existing bathymetry of the mooring basin within the harbour will be deepened to a level of 4 metres below Ordnance Datum. The depression formed by the dredge will create extra accommodation space and a potential sink for deposition of sediment. Given the enclosed nature of the harbour and its relatively small entrance, and the lower energy environment created by this enclosure, it means that siltation is more likely to occur as a result of deposition of sediment settling out of suspension (rather than as bedload transported sediment). The magnitude of siltation will depend on suspended sediment concentrations in the water entering the harbour and the settling velocity that is achieved within the harbour.

Siltation rates on the intertidal areas in Pagham Harbour (the much larger natural tidal embayment north of Selsey) have been between about 4mm/year and 8mm/year over the 20th century. Sediment is imported into Pagham Harbour from offshore during the flood tide and storm events, after which deposition takes place within the landward sheltered environments. It is possible that accretion rates of this magnitude could take place in the proposed harbour at Selsey if the conditions dictate. Given the similar orientations and sizes of the three options, the siltation rates in each are likely to be similar.

6.2 Option 1

In terms of silting up there are no significant unique issues that apply to this option.

6.3 Option 2

In terms of silting up there are no significant unique issues that apply to this option.

6.4 Option 3

In terms of silting up there are no significant unique issues that apply to this option.

7 Seaweed Pollution

7.1 All Options

This stretch of coast is prevalent to receiving large quantities of decaying seaweed deposited on the beaches due to a combination of the high biodiversity of infralittoral and, strong currents and wave action (Jolley, 2008[1]). This is a natural phenomenon and typically the seaweed is deposited along what is known as the 'strandline' along the high water mark. In small quantities this is not regarded as an issue as it is usually washed back offshore in the next few tidal cycles. If longshore drift and wave action are interrupted, i.e. by defences or other man-made structures, this can result in the trapping of seaweed on beaches, as the wave and tidal action is not strong enough to remove the algae. This thereby results in the stagnation of decaying seaweed on the beach, and if this occurs during the summer months, the summer temperatures increase the rate of decay, which can then cause an excessive release of sulphurous gas and natural oils as the seaweed decays and the underlying sediments on the beach become anoxic, resulting in a very unpleasant odour. Depending on the proximity of residential or commercial properties this could be a serious nuisance and impact upon local activities.

The relevance of this natural phenomenon to this consultation is ensuring that detailed planning and design takes into consideration the risk of enhancing seaweed deposition and entrapment, and also considers any necessary measures to reduce this risk. It will also be important to discuss the potential seaweed pollution issue with the local community, as they will be able to indicate if seaweed is already an inherent problem that could be made worse or not.

Seaweed pollution has been a problem at a number of harbours, such as Ventnor Haven on the Isle of Wight and Elizabeth Harbour on Jersey. If this occurs, it can cause significant unpleasant odour in often tourist areas, result in the requirement of difficult and sometimes expensive removal techniques and the requirement to dispose of the waste in a licensed manner. It may not be possible to prevent this phenomenon, however if it is known during the design and planning, the risk can be factored in by modifying the harbour's design and understanding the costs for any removal requirements to ensure the harbour is cost effective.

As stated in Section 6, the options have the potential to attract deposition of silt, and therefore this will be the same for deposition of detached seaweed. However, based on the modest rate of siltation at Pagham Harbour the problem of seaweed pollution should be reasonably manageable. The degree of the problem is not likely to be that different between the three options, as the main difference is their cross-shore location, rather than the orientation or any difference in function. Therefore these options are likely to result in some build-up of seaweed on the basin floor but since the harbour is to be a fully marine harbour the build-up will be underwater and so any odour impacts are likely to be reduced. However, the build-up may exacerbate the rate of siltation, as the seaweed can increase the amount of silt deposited from the water column.

7.2 Option 1

Of the three options this has the potential to be the least effected by the build-up of seaweed because of the use of vertical sided piers rather than rock breakwaters. They are likely to increase the flushing affect of the ebb tides and they lack horizontal surfaces and local recesses where seaweed can be trapped.

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[1] *Jolley, E.C. (2008). The Role of Coastal Defence Structures in Channeling Production in Coastal Ecosystems. Thesis for the degree of Doctor of Philosophy. University of Southampton. June 2008.*

7.3 Option 2

For this option there will be more significant changes to the longshore drift, and therefore could result in the deposition of algae along and within the outside edges of the breakwaters.

7.4 Option 3

Although this option allows longshore drift to continue, the lack of waves allowed to reach the beach behind the harbour is likely to result in the trapping of seaweed between the existing groynes as it is washed in, but if the currents and waves are not strong enough to pick up and carry off any deposited materials, there is the potential for seaweed pollution effects to occur. However, careful management of the local groyne field should mitigate this problem.

8 Land Access

8.1 All Options

In terms of access to the seafront through the town there is no difference between the three options.

8.2 Option 1

By virtue of the landward encroachment of the harbour this is the most accessible of all the options, both for fisheries and recreational purposes.

8.3 Option 2

This option allows ongoing use of the two access routes alongside the fisheries compounds.

8.4 Option 3

Of the three options this option has the most restricted access due to the need for a pier structure from the shoreline to the harbour.

Also there may be issues with the height of the pier above the foreshore and it may prove necessary to raise its level to improve foreshore access. However, this could lead to further complications with the pier structure.

9 Sea Access

9.1 All Options

For the harbour entrances, the orientation, minimum width and seabed levels are identical or very similar for all three options.

9.2 Option 1

The entrance is between two vertically sided pier structures, and the entrance width remains constant for all states of the tide. The pier structures will give rise to some wave reflection which may well make negotiation of the entrance more difficult under certain wave conditions

9.3 Option 2

The entrance is between two rock breakwaters with side slopes. Although the entrance width at seabed level is the same for all options, with the rock breakwaters the effective width increases with higher tide levels. Also due to their porous nature the breakwaters will absorb wave energy and considerably reduce any local wave reflection.

9.4 Option 3

The harbour entrance arrangements are very similar to Option 2. Although the entrance for Option 3 is further offshore, the seabed levels on the approach remain very similar and therefore conditions at the entrance are also likely to be very similar.

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10 Visual Impacts

10.1 All Options

The existing ground levels behind the seawall are typically 3 metres above Ordnance Datum (AOD). The approximate top level of the existing seawall is 6 metres AOD and the typical proposed top level of the harbour works is 5 metres AOD. Therefore, from behind the seawall none of the options have a significant visual impact.

When viewed from the seaward side of the seawall all of the options have a significant visual impact although at Mean High Water Spring tide level (2.4 metres AOD) the impact is considerably reduced.

10.2 Option 1

This option to some extent blends in with the existing topography and existing groyne field. However, the landward quay wall is close to and approximately 2 metres above the road level and is therefore visually intrusive.

10.3 Option 2

This option represents a major change to the foreshore landscape. However, the side slopes and surface texture of the breakwaters soften the visual impact.

10.4 Option 3

This option largely confines the visual impact to the nearshore zone. This may be considered to be the least intrusive of the three options although it will restrict views further out to sea.

11 Land Impacts

11.1 All Options

Due to their different cross-shore locations each of the options have quite a different impact on the land.

11.2 Option 1

Of the three options this option has by far the largest impact both in terms of land take and in creating a discontinuity in the ‘green’ zone immediately behind the seawall.

11.3 Option 2

This option in effect has a positive impact due to the additional quayside area created in front of the seawall.

11.4 Option 3

This option has a neutral impact as it neither decreases nor increases the available land area. However, the landward approach to the access pier may involve some land take.

12 Sea Defence Impacts

12.1 All Options

The sea defences along East Beach comprise a shingle beach controlled by timber groynes with a concrete seawall at the back of the foreshore. For the frontage in question the land behind is low lying and therefore the sea defences act as a flood defence.

Although the current defences are performing satisfactorily their structural factor of safety and standard of protection are marginal.

Each of the options provides a net improvement to the local sea defences.

12.2 Option 1

For this option the piers act as an outer defence thereby creating more sheltered conditions at the land interface. This option also generates surplus excavation material that could be used to improve the sea defences elsewhere along this frontage.

Although the piers are largely contained within the existing groyne field, and will perform in a similar way, there is likely to be some natural reduction in the beach levels immediately to the north of the harbour.

12.3 Option 2

For this option the rock structures act as both an offshore breakwater and a substantial groyne. These will create more sheltered conditions at the land interface of the harbour and result in a larger beach, and therefore improved defences, to the south of the harbour.

However, the rock structure will also give rise to a natural reduction in the beach levels to the north of the harbour, which in turn will reduce the performance of the sea defences. To maintain the sea defences it will be necessary to artificially recharge the beach probably by by-passing beach material from south of the harbour to north of the harbour.

12.4 Option 3

For this option the rock structure acts as an offshore breakwater which creates more sheltered conditions at the adjacent coastline. Due to its detached nature it has less effect on the beach levels to the north and south of the harbour, and by careful management of the local groyne field it should be possible to keep these effects to a minimum.

13 Coastal Process Impacts

13.1 All Options

The coastal processes along this frontage are dominated by a net longshore sediment transport from south to north. With the existing groyne field in place the average net transport rate is estimated to be about 10,000 cubic metres per year, and without the groyne field, 30,000 cubic metres per year. Although designed to hold the beach in place, the groynes do allow some transport of sediment over them and past them. Due to the different cross-shore extents of the potential harbour, each of the options is likely to have a different impact on sediment transport.

13.2 Option 1

For Option 1 the impact is likely to be modest because the piers are largely contained within the groyne field. However, due to their height, the piers will form a greater barrier to sediment transport along the beach. Sediment will build up in the lee of the south pier, until at some point it will be deflected into the nearshore zone in front of the harbour, allowing it to eventually bypass the harbour mouth. The barrier presented by the harbour will therefore initially result in some beach starvation immediately to its north. Once bypass has started, it is anticipated that the majority of the sediment will continue to feed the beaches to the north. However, there is a risk that a proportion of the material will be lost to the nearshore zone.

13.3 Option 2

For Option 2 the impact on sediment transport is likely to be very significant. Due to the height and length of the breakwaters there would be a major build-up of beach sediment to the south of the harbour, in a similar fashion to Option 1 but on a larger scale. However, given the additional length of the southern breakwater, it is likely to form a total barrier to sediment transport to the north. This would result in a long-term interruption in the sediment feed to the beaches to the north and a significant risk of long term permanent sediment loss.

Regular artificial beach sediment by-passing by excavating beach sediment from south of the harbour and placing it to the north would significantly reduce the impact on sediment transport.

13.4 Option 3

For Option 3 the impact on sediment transport has the potential to be minimal. This is because the predominant sediment transport along the beach will not be interrupted by the open pier structure, and sediment will be able to move freely from south of the harbour to the north, although it may be necessary to carefully manage the groyne field in order to facilitate this movement.

14 Environmental Considerations

14.1 All Options

The following issues are applicable to all three options.

Conservation Areas

The proposed location of the new haven does not lie within the boundary of any areas designated for the protection of nature conservation (see Drawing Number PB3807/0001 in the Appendix). The nearest site of conservation importance is Pagham Harbour which lies approximately 2.2km to the north. Pagham Harbour is a Special Protection Area (SPA) designated due to the numbers of breeding, over-wintering and migratory bird species that qualify for protection under the European Birds Directive (79/409/EEC). It is also a Ramsar site, recognised as a wetland of international importance under the Ramsar Convention.

Although the main SPA boundary is some distance from the proposed haven location, the supporting mudflat and sandflat habitat extends west from Pagham Harbour all the way to Selsey Bill passing along East Beach and through the proposed haven location. These supporting habitats offer extended feeding grounds for the protected bird species though are less sheltered than the intertidal habitats within the Pagham Harbour itself.

Approximately 1km to the south of the proposed haven location is Selsey East Beach Site of Special Scientific Interest (SSSI). The site at Selsey East Beach should be seen in conjunction with Selsey West Beach (to be included within the Bracklesham Bay SSSI). Together they form a key Quaternary site for a sequence of freshwater and estuarine deposits of Ipswichian Interglacial age. The deposits at Selsey East Beach are of unique importance in providing Pleistocene vertebrate faunas from the very early part of the Ipswichian Interglacial.

The land behind the beach as well as part of the foreshore is characterised as 'South Coast Plain' The South Coast Plain National Character Area (NCA) is a flat, coastal landscape with an intricately indented shoreline lying between the dip slope of the South Downs and South Hampshire Lowlands and the waters of the English Channel, Solent and part of Southampton Water.

The Selsey Bill and Hounds recommended Marine Conservation Zone (rMCZ) is situated approximately 1km to the south of the proposed haven location encompassing the coastline around Selsey Bill and into Bracklesham Bay. Situated to the south-east of Selsey Bill is an area known as the Mixon Hole. Thought to be a segment of an ancient river gorge, this almost vertical 20 metre high clay cliff has numerous ledges and crevices which provide homes for many marine species. Species include short-snouted seahorses, squat lobsters and crabs along with red algae and kelp in the shallower parts. Selsey is a foraging area for three species of tern and seals also regularly use this area for foraging. Bottlenose dolphins have also been recorded here (Wildlife Trusts, 2014).

Important Habitats

UK BAP priority habitats were those that were identified as being the most threatened and requiring conservation action under the UK Biodiversity Action Plan (UK BAP). The original list of UK BAP priority habitats was created between 1995 and 1999, and was revised in 2007.

Two types of BAP habitat are dominant on the stretch of coastline at the location of the proposed haven: 'coastal vegetated shingle' and 'maritime cliff and slope'.

The communities in '**coastal vegetated shingle'** depend on the amount of finer materials mixed in with the shingle, and on the hydrological regime. Classic pioneer species on the seaward edge include sea kale

Crambe maritima, sea pea, *Lathyrus japonicus,* Babington's orache*, Atriplex glabriuscula,* sea beet, *Beta vulgaris,* and sea campion *Silene uniflora*; which can withstand exposure to salt spray and some degree of burial or erosion. Further from the shore, where conditions are more stable, mixed communities develop, leading to mature grassland, lowland heath, moss and lichen communities, or even scrub. Shingle structures may support breeding birds including gulls, waders and terns. Diverse invertebrate communities are found on coastal shingle, with some species restricted to shingle habitats.

'**Maritime Cliffs and Slopes**' is also listed as a habitat of Principal Importance for Biodiversity in England. Comprising sloping to vertical faces on the coastline where a break in slope is formed by slippage and/or coastal erosion, 'Maritime Cliffs and Slopes' constitutes a cliff with the zone defined as cliff-top extending landward to at least the limit of maritime influence (i.e. limit of salt spray deposition), which in some exposed situations may continue for up to 500 m inland. Maritime cliffs are often significant for their populations of breeding seabirds, many of which are of international importance.

The entire stretch of coastline around the proposed haven location is identified by the Joint Nature Conservation Committee (JNCC) as '**potential reef**' habitat. These are areas where JNCC believe, from the best available evidence, that Annex I reef (as defined under the Habitats Directive) might be present.

Water Framework Directive

The Water Framework Directive (WFD) was introduced in 2000. Its purpose is to establish a framework for the protection of inland surface waters (rivers and lakes), transitional waters (estuaries), coastal waters and groundwater, and to ensure that all aquatic ecosystems and, with regard to their water needs, terrestrial ecosystems and wetlands meet 'good status' by 2015.

The coastal waters in and around the proposed location of the new haven lie within the Sussex Coastal water body (waterbody ID GB640704540003). Classified as 'heavily modified', the Sussex coastal water body is currently considered to be at 'good' status for chemical parameters and at 'moderate potential' status for ecological parameters.

There are no protected shellfish waters in the vicinity of the proposed haven location, the nearest being within Chichester Harbour.

Bathing Waters

The proposed haven location sits within the Selsey Bathing Water which extends between Pagham Harbour and Selsey Bill. The bathing water faces southeast and is primarily a groyned, shingle beach but with some sand exposed at low water. To the north of the bathing water there are underwater rock formations which are exposed at low water. Between 2012 and 2015 this bathing water was assessed as being either 'sufficient' or 'good' in terms of quality. There is a storm overflow just north of the proposed haven called East Beach Road storm overflow. Also, the Bognor Long Sea Outfall (6 km offshore) is now a storm overflow. Discharges occur when heavy rainfall overwhelms the sewerage system but are designed not to affect bathing water compliance.

For all three options consideration will need to be given to implications for the WFD Coastal Waterbody as well as the nearby Bathing Water. Should regular dredging be required to maintain the depth of the new haven this will need to be explored to demonstrate WFD compliance.

Fisheries Interest

Data available from the Centre for Environment Fisheries and Aquaculture Science (Cefas) indicate that in 2010 the waters off of the Selsey frontage were used as spawning grounds for cod, plaice, sandeel and sole. Data from 1998 indicate that Lemon sole and sprat were also spawning in this location.

As well as fish spawning grounds, this area is also used as nursery areas for fish; the 2010 data indicates that plaice, sole, thornback ray and undulate ray made use of the area, whilst in 1998 Lemon sole was also present.

14.2 Option 1

As identified in Section 13, this option is likely to result in some beach starvation immediately to the north of the harbour and possibly some permanent sediment loss in the nearshore zone; however the majority of sediment is considered likely to continue to be deposited on the beaches to the north. Implications for the designated sites to the north and south of the proposed haven location are therefore considered to be minimal.

Due to its location on the foreshore this option will result in the loss of some of the SPA mudflat and sandflat habitat that extends southwards from Pagham Harbour. Consideration will need to be given to the implications of this in relation to the management of Pagham Harbour SPA. Impacts on coastal vegetated shingle will also need to be considered.

In addition, the loss of any intertidal habitat would be of potential concern to the Environment Agency and Natural England as it has implications for their targets of no net loss of intertidal habitats. However it should be noted that the available intertidal habitats, especially mudflats and sandflats are minimal at the proposed haven location.

14.3 Option 2

As this option (without artificial beach by-passing) will significantly impact on sediment supply to the north of the proposed haven location there is potential for impacts on the sediment supply to Pagham Harbour. A significant risk has also been identified in relation to the long term permanent loss of sediment from the nearshore zone which could have implications for invertebrates in the sediment and larger fauna that may be foraging in this location.

Loss of intertidal habitat, including SPA mudflat and sandflat will also be an issue with this option within the footprint of the breakwaters, quay wall and the dredged area, although the available mudflats and sandflats are minimal at this location. Potential impacts on the coastal vegetated shingle could also be of concern.

14.4 Option 3

This option is likely to have lower potential for impact on the designated sites to the north due to a minimal anticipated impact on sediment transport. Loss of intertidal (including SPA mudflat and sandflat) is also likely to be reduced as the footprint within this zone is further offshore. The loss of infralittoral is however likely to be an impact and consideration will need to be given to the potential for impact on any nearby reef features.

15 Renewable Energy

15.1 All Options

In terms of being able to harvest energy from tidal water entering and leaving the harbour, the available energy largely depends on the size of the tidal storage of the harbour and the tidal range. At Spring tide the total energy (assuming 100%) extraction of tidal water would be less than 300 kWh per day given the relatively small size of the harbour. The energy assumption of a typical UK family is 12 kWh per day. Assuming 10% energy can be extracted from the tidal water, it means a tidal turbine would provide energy for 2.5 households and therefore the investment for tidal energy may be difficult to justify.

The ability to harvest solar energy would be possible, however it could take up a significant amount of land and therefore may not be cost effective unless rooftop locations were available.

The ability to harvest wind energy would be possible but there would be a significant visual impact.

15.2 Option 1

In terms of renewable energy there are no unique aspects that apply to this option.

15.3 Option 2

In terms of renewable energy there are no unique aspects that apply to this option.

15.4 Option 3

In terms of renewable energy there are no unique aspects that apply to this option.

16 Aquaculture

16.1 All Options

Chichester District Council are keen to explore opportunities to co-locate aquaculture production within the proposed haven and therefore maximise the economic return for the local area. Given the enclosed nature of the proposed new haven it is anticipated that aquaculture options will be limited to shellfish growth as there is unlikely to be sufficient water movement or depth for the successful farming of mobile fish or crustacean species. Due to the potential problems with seaweed accumulation along this coastline it is also assumed that cultivation of seaweed is not a preferred option in this location.

Shellfish is usually farmed in UK waters in one of two ways: suspended on supporting structures or confined in nets or cages in lakes or coastal waters. The type and intensity of farming depends on the species and on market demand. The most commonly cultivated shellfish species are described below:

- Oysters are common in the UK in both pacific and native species. Oyster production techniques depend on factors including seed supply, environment and region, and can be either entirely sea-based or rely on hatcheries for seed supply.

- Mussels can be harvested from either wild or cultivated stocks. They can be grown either on the seabed or on ropes. Mussels grown in different environments will have different characteristics in terms of meat content, shell strength, shelf life etc.

- Clams have so far had limited success as a cultivated species. Only a very small number of Manila clams are grown in the UK.

- Scallops are cultivated widely across the UK, particularly in king and queen varieties though this site is unlikely to be suitable due to the lack of water depth and suitable substrate.

The table below summarises the key requirements of the different shellfish species along with an overview of the growing techniques recommended by Seafish (2015)[2] and key factors for consideration.

Species	Physical Requirements	Growing Techniques	Key Factors
Oyster	Seawater temperature above 8^{o}C for most of the year; salinity above 30ppm; area sheltered from extreme tidal flows and wave action; tidal flow of 1-2 knots preferable	Usually grown on the seabed or on mats laid on very soft substrate; alternatively grown in mesh bags of varying sizes as the oysters grow.	Cannot cope with high silt burden or poor water exchange leading to reduced oxygen levels; prefers high levels of water flow for food supply
Clam	Seawater temperature above 8^{o}C for most of the year; salinity above 25ppm; intertidal and sub-tidal locations are best; tidal flow of 1-2 knots preferable	Clams live buried in the substrate; survival is better in sand or gravel substrates but it is possible to grow them in muddy areas too.	Take at least 3 years to reach harvest size
Mussel	Seawater temperature above 8^{o}C for most of the year; salinity above 20ppm; tidal flow of 1-2 knots preferable	Can be grown on any substrate they can gain anchorage to, or on ropes suspended from rafts/pontoons	Water depths in excess of 12 m at extreme low water on spring tides are preferable, although shallower sites can also be utilised.

[2] www.seafish.org 'Key Documents for Culturists' 2015

It is recommended that advice is sought from Seafish on the viability of pursuing aquaculture options within the proposed haven when more is known about the detailed design. Advice from www.seafish.org recommends avoiding areas close to boatyards, marinas, industrial developments or large urban areas to minimise the risks from pollutants or other anthropogenic inputs. Potential inputs from within the wider water catchment area (eg land-based farming activity, both arable and livestock, forestry, horticulture, chemical industry etc) should also be investigated.

It is possible that the limited tidal exchange and water flow together with the potential for siltation may limit the opportunities for aquaculture in this location. In addition, it is possible that the intended uses of the haven may be incompatible with aquaculture both in terms of risks of anthropogenic inputs and also potential difficulties with access for maintenance and harvesting.

16.2 Option 1

At this stage there are no obvious unique aspects that apply to this option.

16.3 Option 2

At this stage there are no obvious unique aspects that apply to this option.

16.4 Option 3

At this stage there are no obvious unique aspects that apply to this option.

17 Development Costs

17.1 All Options

These costs relate to the development of the scheme from this preliminary consultation stage up to obtaining all of the necessary permissions and licences ready for detailed design and construction.

These costs include the following:

- Initial site investigation;
- Numerical modelling;
- Development of preferred concept option;
- Development of outline design;
- Method statements;
- Environmental reporting;
- Stakeholder consultation; and
- Consent applications.

These costs focus on the actual construction of the harbour itself and do not include such matters as the business case, obtaining the necessary funds, and putting in place the management arrangements for the operation of the harbour.

The development costs for each of the options is reasonably similar although Option 2 is likely to be the most costly due to its higher impacts on the environment and the need for a higher level of analysis. For different sizes of mooring basin there is unlikely to be any significant differences in the costs involved.

17.2 Option 1

The development costs are as follows:

- £150K - £300K

17.3 Option 2

The development costs are as follows:

- £200K - £400K

17.4 Option 3

The development costs are as follows:

- £150K - £300K

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18 Construction Costs

18.1 All Options

The construction costs relate to the following:

- Further site investigation;
- Detailed design;
- Construction project management;
- Construction works;
- Health and safety management;
- Site supervision, and
- Temporary accommodation works for beach users.

The construction works themselves represent the largest element of the costs. These are heavily influenced by the nature of the works. In particular a rock breakwater compared with a vertical sided solid pier that performs a similar function is very approximately three times more expensive. This is due to a number of factors including a much longer lifespan and a much better hydraulic performance.

For this reason Option 1 is the lowest cost option by a significant margin. Option 3 is the highest cost option due to the full use of rock breakwaters and its ‘offshore’ location.

For the cost variations of larger and smaller mooring basins it is assumed that 30% of the base-line cost is fixed and the remaining 70% is proportional to the number of berths.

18.2 Option 1

The construction costs are as follows:

- 75 berths £8M - £13M
- 50 berths £6M - £10M
- 100 berths £10M - £16M

18.3 Option 2

The construction costs are as follows:

- 75 berths £15M - £24M
- 50 berths £12M - £19M
- 100 berths £19M - £30M

18.4 Option 3

The construction costs are as follows:

- 75 berths £23M - £37M
- 50 berths £18M - £29M
- 100 berths £28M - £45M

19 Operational Costs

19.1 All Options

These costs relate to the ‘technical’ operation of the harbour and include:

- Maintenance of the structures;
- Maintenance of the pontoons;
- Artificial bypassing of beach material;
- Periodic dredging, and
- Periodic removal of seaweed.

The costs relate to the average annual maintenance over the short term (10 years).

Management costs of the harbour such as supervision, administration, services charges, Crown Estate fees etc are not included.

On balance and within the defined tolerances the operational costs are broadly similar for each option and for each size of mooring basin.

19.2 Option 1

The average annual short term maintenance costs are as follows:

- £50K - £150K

19.3 Option 2

The average annual short term maintenance costs are as follows:

- £50K - £150K

19.4 Option 3

The average annual short term maintenance costs are as follows:

- £50K- £150K

20 Conclusions

These will be added on completion of the consultation process and will reflect the outcome of the consultation.

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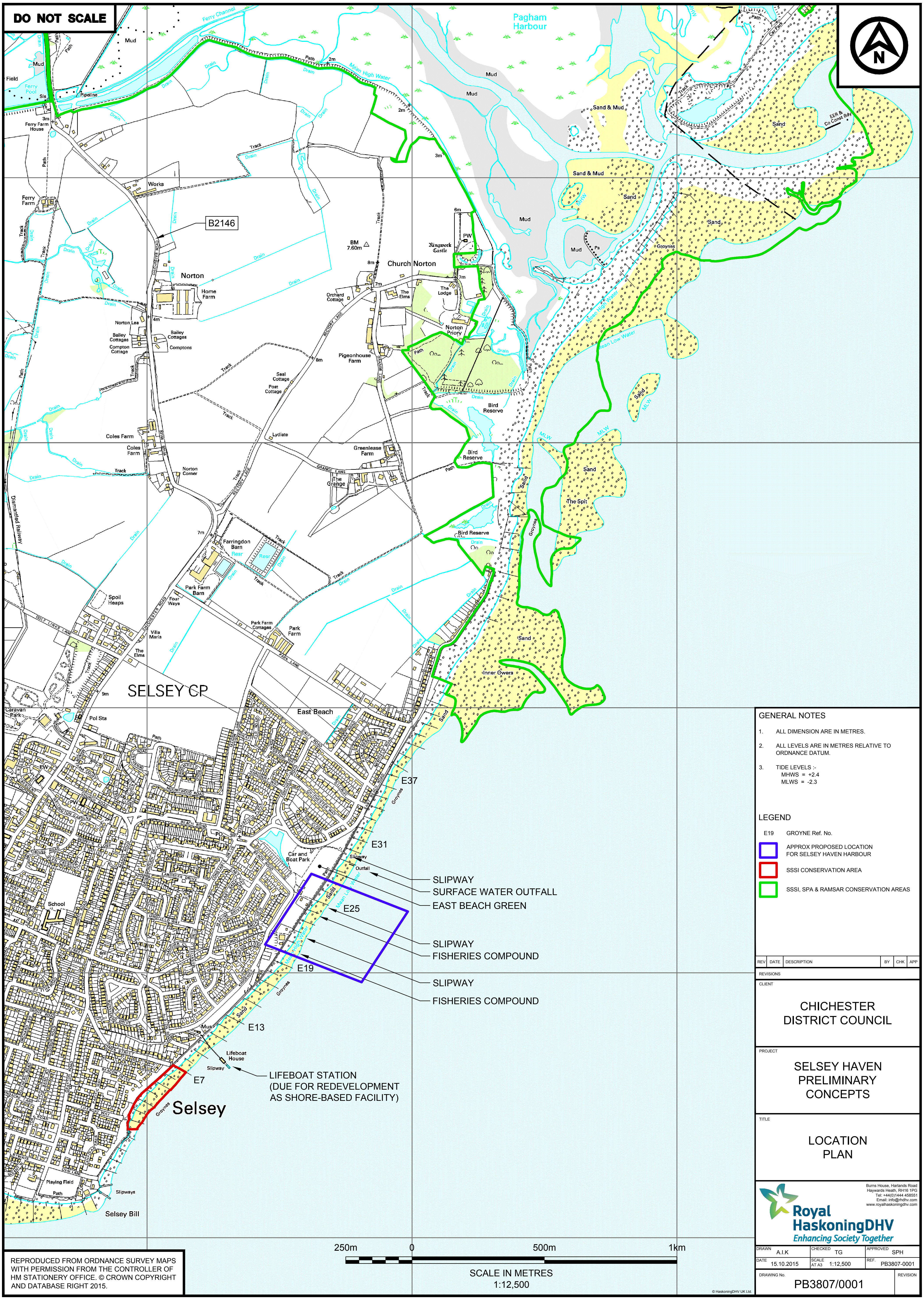
Appendix - Drawings



GENERAL NOTES

1. ALL DIMENSION ARE IN METRES.
2. ALL LEVELS ARE IN METRES RELATIVE TO ORDNANCE DATUM.
3. TIDE LEVELS :-
   MHWS = +2.4
   MLWS = -2.3

LEGEND

- E19 — GROYNE Ref. No.
- Blue box — APPROX PROPOSED LOCATION FOR SELSEY HAVEN HARBOUR
- Red box — SSSI CONSERVATION AREA
- Green box — SSSI, SPA & RAMSAR CONSERVATION AREAS

REV	DATE	DESCRIPTION	BY	CHK	APP

REVISIONS

CLIENT

CHICHESTER DISTRICT COUNCIL

PROJECT

SELSEY HAVEN PRELIMINARY CONCEPTS

TITLE

LOCATION PLAN

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www.royalhaskoningdhv.com

Royal HaskoningDHV
Enhancing Society Together

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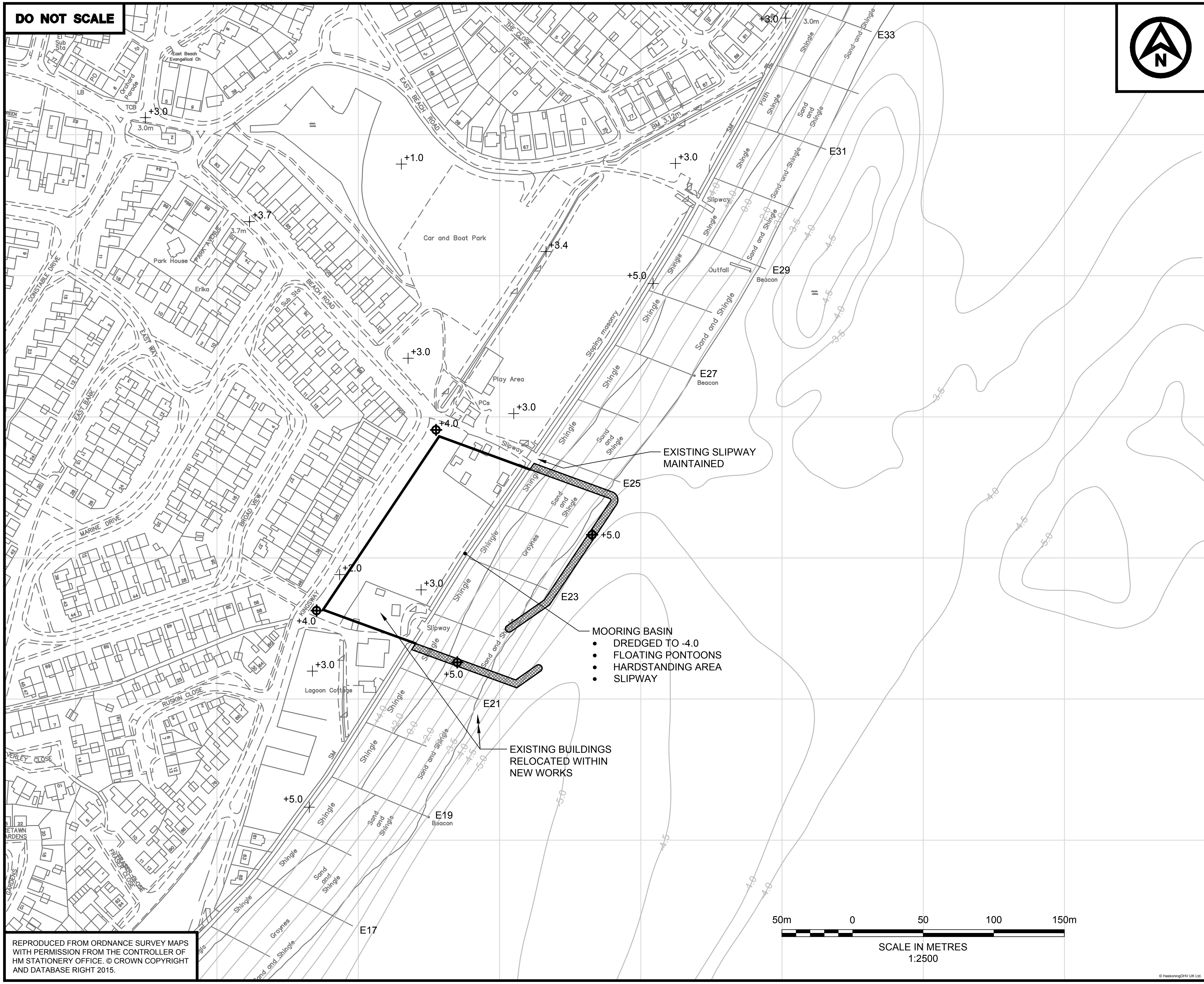

GENERAL NOTES

1. ALL DIMENSION ARE IN METRES.
2. ALL LEVELS ARE IN METRES RELATIVE TO ORDNANCE DATUM.
3. FORESHORE AND NEARSHORE LEVELS OBTAINED FROM CHANNEL COASTAL OBSERVATORY.
4. TIDE LEVELS :-
   MHWS = +2.4
   MLWS = -2.3
5. MOORING BASIN TO ACCOMMODATE 25 No. 15m LONG CRAFT AND 50 No. 10m LONG CRAFT.

LEGEND

E27	GROYNE Ref. No.
-3.0	APPROX FORESHORE AND NEARSHORE CONTOUR
+3.7	APPROX EXISTING LEVEL
+5.0	APPROX PROPOSED LEVEL
	VERTICAL QUAY
	VERTICAL SIDED SOLID PIER

PRELIMINARY CONCEPT TO INDICATE GENERAL LOCATION, SIZE AND TYPE OF CONSTRUCTION

CLIENT
CHICHESTER DISTRICT COUNCIL

PROJECT
SELSEY HAVEN PRELIMINARY CONCEPTS

TITLE
OPTION 1 PLAN LAND BASED HARBOUR

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PB3807/0002	D1

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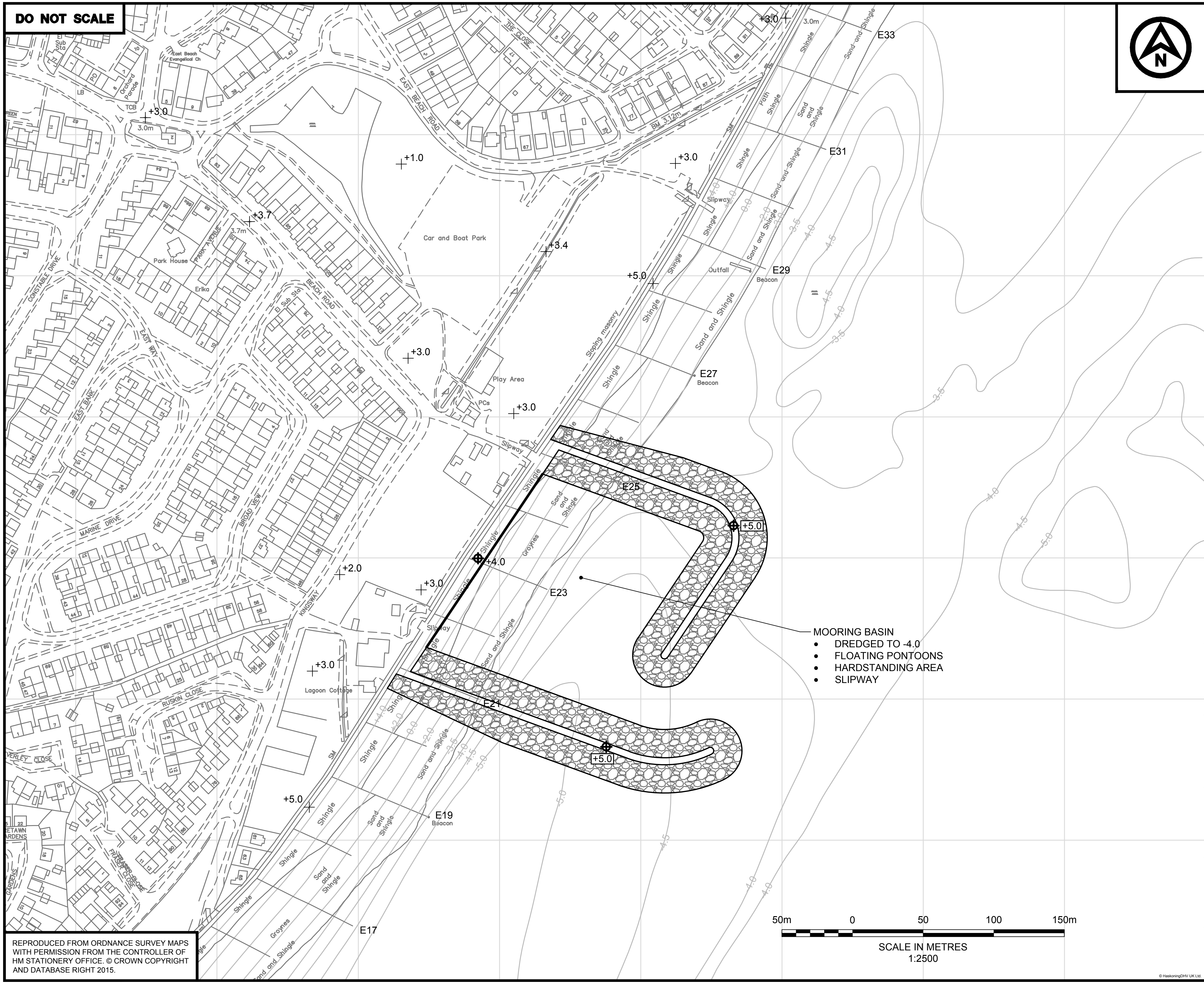

GENERAL NOTES

1. ALL DIMENSION ARE IN METRES.
2. ALL LEVELS ARE IN METRES RELATIVE TO ORDNANCE DATUM.
3. FORESHORE AND NEARSHORE LEVELS OBTAINED FROM CHANNEL COASTAL OBSERVATORY.
4. TIDE LEVELS :-
   MHWS = +2.4
   MLWS = -2.3
5. MOORING BASIN TO ACCOMMODATE 25 No. 15m LONG CRAFT AND 50 No. 10m LONG CRAFT.

LEGEND

- E27 — GROYNE Ref. No.
- -3.0 — APPROX FORESHORE AND NEARSHORE CONTOUR
- +3.7 — APPROX EXISTING LEVEL
- +5.0 — APPROX PROPOSED LEVEL
- VERTICAL QUAY
- VERTICAL SIDED SOLID PIER
- ROCK BREAKWATER WITH ROCK OR CONCRETE CREST

PRELIMINARY CONCEPT TO INDICATE GENERAL LOCATION, SIZE AND TYPE OF CONSTRUCTION

CLIENT

CHICHESTER DISTRICT COUNCIL

PROJECT

SELSEY HAVEN PRELIMINARY CONCEPTS

TITLE

OPTION 2 PLAN FORESHORE HARBOUR

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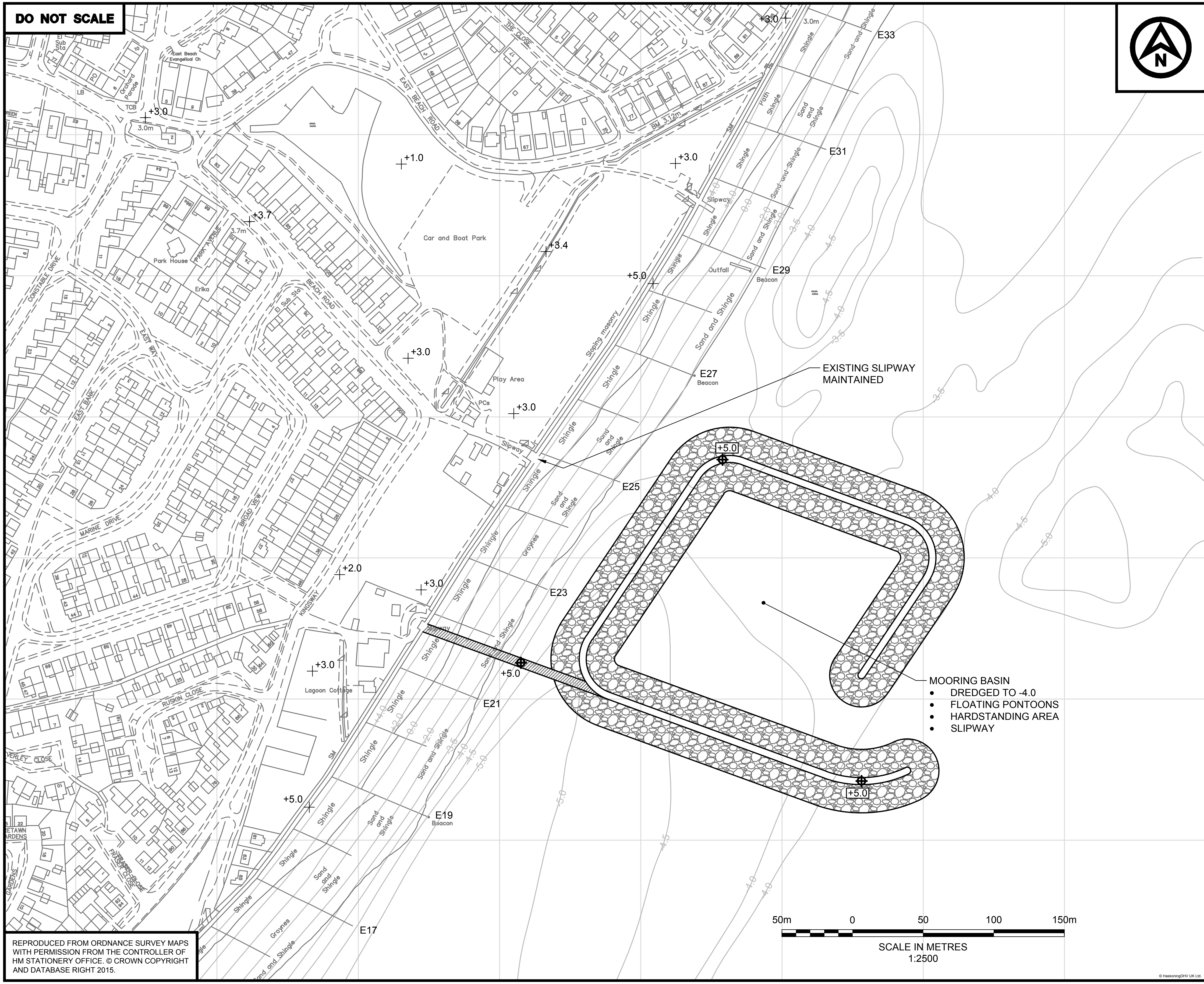

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GENERAL NOTES

1. ALL DIMENSION ARE IN METRES.
2. ALL LEVELS ARE IN METRES RELATIVE TO ORDNANCE DATUM.
3. FORESHORE AND NEARSHORE LEVELS OBTAINED FROM CHANNEL COASTAL OBSERVATORY.
4. TIDE LEVELS :-
   MHWS = +2.4
   MLWS = -2.3
5. MOORING BASIN TO ACCOMMODATE 25 No. 15m LONG CRAFT AND 50 No. 10m LONG CRAFT.

LEGEND

- E27 — GROYNE Ref. No.
- -3.0 — APPROX FORESHORE AND NEARSHORE CONTOUR
- +3.7 — APPROX EXISTING LEVEL
- +5.0 — APPROX PROPOSED LEVEL
- VERTICAL QUAY
- VERTICAL SIDED SOLID PIER
- ROCK BREAKWATER WITH ROCK OR CONCRETE CREST
- OPEN PIER (ON PILES)

PRELIMINARY CONCEPT TO INDICATE GENERAL LOCATION, SIZE AND TYPE OF CONSTRUCTION

CLIENT
CHICHESTER DISTRICT COUNCIL

PROJECT
SELSEY HAVEN PRELIMINARY CONCEPTS

TITLE
OPTION 3 PLAN NEARSHORE HARBOUR

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