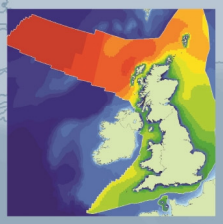
Marina Projects Ltd

Royal Southern Yacht Club: Hydrodynamic and Geomorphological Assessment

Report R.2021

October 2012

Creating sustainable solutions for the marine environment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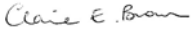
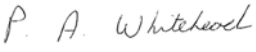
Date: October 2012

Project Ref: R/4108/1

Report No: R.2021

Version	Details of Change	Authorised By	Date
1	Draft for Comment	B J Carroll	21.09.2012
2	Final Draft	B J Carroll	08.10.2012
3	Final	B J Carroll	25.10.2012

Document Authorisation		Signature	Date
Project Manager:	B J Carroll		25.10.2012
Quality Manager:	C E Brown		25.10.2012
Project Director:	P A Whitehead		25.10.2012

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Summary

The River Hamble is part of the Solent Maritime Special Area of Conservation (SAC). The Solent encompasses a major estuarine system on the south coast of England with four coastal plain estuaries made up of the Rivers Yar, Medina, King's Quay Shore and River Hamble; and four bar-built estuaries namely Newtown Harbour, Beaulieu, Langstone Harbour and Chichester Harbour. The designation covers the sub-tidal area with a boundary that is generally noted along the line of MLW. The Royal Southern Yacht Club (RSrnYC) and RAF Yacht Club (RAFYC) sites straddle this boundary with any work on the intertidal areas being outside of the SAC, however generally, works on the existing or proposed pontoons will take place within the SAC.

Due to the small scale of the development works proposed, the overall direct effects will be minimal and local to the development site. General changes to flows rates are considered marginal, albeit there is a shift of flow dynamics from the RAFYC Slipway to the RSrnYC pier. The following summary statement is provided to highlight the pertinent findings of the desk study assessment:

The capital dredge works will have the effect of increasing the cross-section of the estuary in front of the RSrnYC and RAFYC (berths), thus leading to localised changes in tidal flows. Flows will be drawn into the new dredged pocket, in the same way that currently occurs to the north of the development site into Port Hamble Marina. This existing pattern of tidal flows into the Port Hamble Marina dredge pocket (both on the flood and ebb tide) creates an eddy in the very south west corner, adjacent to the RAFYC facilities. As a result of the works, tidal flows will be drawn in earlier on the flood tide (and extended for longer on the ebb) creating a smoothing of the tidal effects at this location. As a consequence the most noticeable effect of the works will be to remove or significantly reduce the current eddy and create a new smaller eddy effect in the south west corner of the new dredge pocket in front of RSrnYC. In addition, the flows in the area of the works will be more consistent and reliable than they currently are due to these localised hydrodynamic changes.

More specifically the key findings and impacts of the works are summarised as:

- The maximum flow velocity recorded at the southern end of the inner mid-stream pontoon (over a spring ebb tide of 3.5m range) is less than 0.4m/s (less than 0.77 knots). At this location the proposed marine works are likely to increase the flow velocities in the order of 0.01 to 0.02m/s;
- As a direct consequence of the capital dredge and the removal of the intertidal mud flat directly affronting the RSrnYC, the cross-sectional area of the river is increased at this point. This increased cross-sectional area amounts to 114m^2;
- An existing eddy created by the flood and ebb tidal flow in the vicinity of the RAFYC slipway is removed or significantly reduced as a consequence of the capital dredge;
- An easterly flow stream from the RAFYC slipway to the main channel (over an ebb tide) is reduced as a result of the removal of the intertidal mud;
- Flow directions throughout the proposed development are more consistent and reliable as a consequence of the capital dredge;

- A small eddy will be created in the south west corner of the RSrnYC pier as the complex flow patterns seen at the RAFYC slipway will be reduced and transferred southwards as a consequence of the capital dredge;
- A minor increase in flow rates around will occur in the areas of remaining intertidal (south of the scheme) as a consequence of the re-profiled bed levels;
- There will be no significant direct impacts upon any designated areas, and any indirect impacts are considered to be insignificant as they may be undetectable; and
- The sediment budget in the vicinity of the proposed works is likely to remain similar, with a shift of sedimentation away from Port Hamble Marina and the RAFYC to the RSrnYC due to the migration of eddies noted above.

Overall, the effect of the proposed marine works on the marine environment is considered small and will be local to the RSrnYC. Any change will not adversely affect the overall integrity or functioning of the estuary. Furthermore, the changes predicted to tidal flows will not adversely affect navigation along the River Hamble.

Abbreviations

ABP R&C	ABP Research & Consultancy Ltd (Now ABPmer)
ABPmer	ABP Marine Environmental Research Ltd
CD	Chart Datum
HAT	Highest Astronomical Tide
HW	High Water
LiDAR	Light Detection And Ranging
LW	Low Water
MHWN	Mean High Water Neaps
MHWS	Mean High Water Springs
MLW	Mean Low Water
MLWN	Mean Low Water Neaps
MLWS	Mean Low Water Springs
MSL	Mean Sea Level
ODN	Ordnance Datum Newlyn
RAF	Royal Air Force
RAFYC	RAF Yacht Club
RSrnYC	Royal Southern Yacht Club
SAC	Special Area of Conservation
SSC	Suspended Sediment Concentrations
UKHO	United Kingdom Hydrographic Office

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1. Introduction

Plans have been put forward for the replacement of the current frontage structure (with a new sheet piled wall) and the reconfiguration of the pontoons/berths at the Royal Southern Yacht Club (RSrnYC) and RAF Yacht Club (RAFYC) on the River Hamble; this would also include a small capital dredge to increase the depth of the berthing facility. The reconfiguration has been designed to provide direct land access to all berths by replacing existing detached pontoons with finger pontoons.

ABP Marine Environmental Research Ltd (ABPmer) has been commissioned to undertake a desk study assessment of the proposed scheme in order to determine the likely:

- Hydrodynamic effects, e.g. changes to flow patterns and flow speeds, placing these into the context of the existing baseline flows, and how these may affect the local sedimentary patterns;
- Geomorphological impacts both locally and for the estuary as whole, with an interpretation of the likely longer term impact on the estuary sediment budget; and
- The construction impacts and localised effects of the permanent structures on the bed of the estuary, including an estimation of the footprint of disturbed sediment from the capital dredge, and the likely depth of any accumulation and temporary increases in suspended sediment concentrations.

This study is based on existing bathymetric and field observations as well as knowledge gained from previous studies. These studies are listed in the reference section.

It is worth noting that the small scale of the works means that numerical modelling of the proposals would not be effective as all of the impacts are likely to be minor in scale, local to the works and generally too fine for a standard model grid. As a result a desk based study of the potential for impacts is considered the most appropriate way forward.

2. Proposed Marine Works

The proposed works will include the replacement of *circa* 43m of sheet piling and *circa* 63m of brick, concrete and gabion retaining structures by approximately 106m of new vertical sheet piling. This replacement is aimed to increase the security of the landside (as a retaining structure), whilst also providing an effective flood risk barrier.

The proposed reconfiguration of pontoons/berths at the RSrnYC is designed to bring the site up to modern operational standards and to make better use of the water-space. The number of berths at the facility will remain the same although it is likely that the average size of vessel will be increased under the new configuration. The reconfiguration is to be achieved by the connecting of two existing detached pontoon structures, which are aligned parallel with the bank and tidal flows, and introducing finger pontoons and pontoon 'hammerheads'. The new pontoons will be secured in place by steel piles which are driven into the riverbed. These

changes however, will require the extraction of many of the 25 existing piles, and replacing them with 32 piles (an increase of 7 piles) of maximum 471mm diameter.

In addition, a capital dredge will be undertaken to a depth of 1.6m below Chart Datum (CD) in order to provide deeper water throughout the RSrnYC berthing facility, thereby allowing all tide access to the new berths. The total capital dredge volume is estimated at around 8,540m³ (across a dredge area of *circa* 3,050m²), which will comprise of approximately 3,400m³ and 5,140m³ of intertidal and subtidal dredging respectively. It is likely that this dredging will be undertaken by a small backhoe dredger loading small self propelled barges, with the dredge material then being disposed of at a licensed deposit ground, probably Nab Tower (to the east of the Isle of Wight). A full plan of the proposed works, in comparison with the existing bed level found at the RSrnYC, can be seen in Figure 1.

3. Baseline Conditions

In order to assess the effects of the proposed works on the estuary dynamics, a conceptual understanding of the present (baseline) conditions is necessary. This is derived from consideration of the bathymetry, tidal regime (water levels and flows), waves and sediments (both bed and suspended) in the area of the development.

3.1 Bathymetry

A bathymetric survey of the River Hamble in the vicinity of the RSrnYC, taken in June 2007, identified that the two existing detached pontoons are currently located near to the deepest point of the main channel. At this location, approximately 72 to 91m from the shore, depths range from approximately 3m to 4m below CD. Depths then rapidly shallow towards the RSrnYC, to approximately 1m below CD at *circa* 48m from the shore (i.e. just beyond the extent of the inner 'shore-accessible' pontoons). No bathymetric readings are available shoreward of this location; however, observations and LiDAR data clearly indicate that inside of the inner pontoons depths are very shallow. The intertidal area (i.e. above mean low water (MLW)) extends approximately 15 to 30m from the shore depending on the location along the frontage.

3.2 Tides

3.2.1 Water Levels

The mean tidal range at Warsash is 3.7m on springs and 1.9m on neaps, and the tidal levels are presented in Table 1.

The tidal regime of the River Hamble is largely controlled by the tidal characteristics of the English Channel with a unique tidal curve that is also seen in Southampton Water and the Solent. These unique tidal features consist:

- A 'double high water': This is a period of small decrease (or little change) followed by a second rise in water level, where the whole event can last for up to about 3 hours; and
- A 'young flood stand': This is a period, within the flood tide, when the rate of tidal rise slows or completely stops for a period of around 2 hours. This period of slowing in tidal rise is followed by an accelerated rise to the first high water (HW), being particularly noticeable on spring tides.

These features are illustrated in Figure 2 for Warsash Jetty, approximately 700m down estuary of the proposed works at the RSrnYC. The presence of this double HW and young flood stand within the Hamble can have a major influence on the flow and sedimentary characteristics of the estuary, and are therefore important when assessing the geomorphological effects of the proposed dredge and pontoon reconfiguration.

Table 1. Warsash tide levels

Tidal State		Level (Metres Relative to CD)
Highest Astronomical Tide	(HAT)	+5.00
Mean High Water Springs	(MHWS)	+4.50
Mean High Water Neaps	(MHWN)	+3.80
Mean Sea Level	(MSL)	+2.95
Mean Low Water Neaps	(MLWN)	+1.90
Mean Low Water Springs	(MLWS)	+0.80
Chart Datum (CD) is 2.74m below Ordnance Datum Newlyn (ODN)		

(Source: UKHO, 2011)

3.2.2 Tidal Flows

Flow velocities were measured in the vicinity of the RSrnYC between 1977 and 1979. The locations of these measurements are shown in Figure 3. Changes within the estuary since that time are not likely to have significantly altered this flow regime.

The data shows that at Point A, found at the southern end on the RSrnYC inner detached pontoon, flood velocities on a spring tide (3.5m tidal range) peak at around 0.2m/s at the start of the flood tide (see Figure 4); with flows predominantly in a north-northwest direction (345°), as shown in Figure 3. Approximately 3 to 4 hours before the first HW, flow velocities fall to less than 0.05m/s, corresponding to the time of the 'young flood stand'; this reduction is also seen at Point B (Figure 4), situated further towards the centre of the estuary in shallower water depths, where higher flow velocities are typically seen. Following the 'young flood stand', peak flood velocities of around 0.35m/s occur about 1.5 hours before the first HW at Point A; with peak flood velocities in the order of 0.55m/s at Point B approximately 1 hour before HW. During the flood tide, tidal flows in this section of the estuary are generally pulled towards the western bank (on the outside of the bend) due to the location of the deeper channel but also to accommodate the deepened areas of Port Hamble Marina, situated to the north, whilst flows within the main channel generally follow the alignment of the estuary. This alignment of the tidal flows creates a slow circulating (anti-clockwise) eddy in the very southern corner of Port Hamble Marina, in the lee of the RAFYC. Blockages provided by various piles, pontoons and vessels within Port Hamble Marina (and within the RAFYC and RSrnYC) will have very

localised effects on tidal flows (particularly during the early stages of the flood tide, i.e. in shallower water). Towards the northern end of Port Hamble Marina, flood tidal flows are generally in a north-northeast direction (following the alignment of the estuary), with increased easterly orientation near the western bank (see Points C and D, Figure 5); whereby flows running through the deepened Port Hamble Marina are redirected towards the main channel due to the presence of a shallow intertidal area to the north of the marina. Flow velocities are likely to be high on the edge of the intertidal, due to the reduction in cross-sectional area (narrowing of the estuary); a small anti-clockwise eddy is also likely to be formed at the northern corner of the marina. Peak flood velocities at Points C and D are approximately 0.5 and 0.9m/s respectively (i.e. greater than those seen at Points A and B at the southern end of Port Hamble Marina), see Figure 4.

This period of peak flood flow is then followed by a reduction in flow speeds as a result of slack water for the 2-hour double HW period. Following HW slack, peak ebb flow velocities of around 0.75 and 1.05m/s are experienced at Points C and D respectively, occurring approximately 4 hours after the first HW (i.e. 2 hours after the extended HW slack). These increased ebb flow velocities, compared to that seen during the flood, are the result of tidal asymmetry in the estuary caused by the extended flood tide. The orientation of the ebb tidal flow is approximately the exact opposite to that seen during the flood tide, with a general attraction of the flows towards the western bank; due to the natural bend and the presence of the deepened berth pockets in Port Hamble Marina. As described for the flood tide, eddies are also likely to be formed at the northern and southern end of the marina during the ebb tide, although these will be slowly circulating in a clockwise direction; created through the redirection of flows from the main channel. At Points A and B, opposite the RSrnYC and RAFYC, peak ebb tide velocities are around 0.4 and 0.9m/s respectively

3.3 Waves

No wave measurements have been taken in the vicinity of the proposed works. However, the Hamble is relatively narrow, and therefore fetch limited, in which the largest fetch over which waves could be generated is approximately 5km in a direct line up the river from Calshot. Therefore only southerly wind conditions that could generate pronounced waves in the Hamble, and even under these conditions, significant wave heights are only likely to be in the order of 0.2m (Tosswell, 1984).

3.4 Sediments

Sediments in the vicinity of RSrnYC will predominantly be fine (mud), where the density of this material would be of the order of 1300kg/m^3 or greater due to the absence of dredging (ABPmer, 2011). The density of this mud is also likely to increase with distance up the intertidal (towards the bank), in an area of considerably less vessel activity; in which propeller wash may help remobilise fine sediments in the vicinity of the pontoons.

There is a scarcity of good quality suspended sediment data within the River Hamble, although it is acknowledged that concentrations are generally relatively low, as seen in the main body of Southampton Water. Tosswell (1984) measured and analysed flood and ebb tide concentrations within the Hamble over an extended duration between October 1980 and April

1982, and concluded that background concentrations were in the order of 15-30mg/l. Importantly, this work suggested that the main source of suspended sediments was from a seaward direction (i.e. from Southampton Water), in which the dominant mass was transported on the flood rather than ebb tide.

4. Impact Assessment

The baseline understanding developed in Section 3 indicates that the flow regime within the local vicinity of the RSrnYC is largely controlled by the bend of the estuary, and to a slightly lesser extent, the presence of the Port Hamble Marina; whereby tidal flows are generally pulled towards the western bank. Taking into account the location and scale of the proposed marine works relative to the main channel and the tidal frame (Figure 6), along with the existing tidal flows, all changes to the estuary dynamics will likely be confined to the intertidal and subtidal areas local the RSrnYC, i.e. extending no further than 100 to 200m along the western side of the estuary. These changes will be discussed in more detail in the following sections.

The scale of the impacts is generally assessed as undetectable to minor. Where effects are likely to be noticeable clear reference is made.

4.1 Tidal Effects

The proposed works, although more specifically the capital dredge and new pontoon/berth configuration, will have an effect on the tidal flows within the area of the RSrnYC. The main points that can be drawn from the proposed works, which will inherently have an effect on the tidal flows, are as follows:

- The proposed capital dredge will increase the cross-sectional area of the channel over the length of the RSrnYC facilities. Figure 6 shows a cross-sectional plot of the RSrnYC facilities (approximately at its centre), heading eastwards across the River Hamble (to the opposite bank); although not across its entirety due to the absence of bathymetric data. The position of this cross-section is shown in Figure 3. At this location, the proposed capital dredge increases the cross-sectional area by approximately 114m^2, which represents an increase in area for flow at MHWS, MLW and MLWS of about 9.6%, 18.9% and 20.0% respectively;
- Of this cross-sectional area increase, some 23.5m^2 is within the intertidal area (above MLW) at this location and will therefore have a small impact on the local tidal prism. Predicted intertidal dredging volumes of around 3,400m^3 (provided by Marina Projects Ltd) would relate to an increase in the spring tidal prism of the Hamble Estuary by the order of 0.05%. Furthermore, the intertidal area to be removed as part of the capital dredge is not designated for its conservation value either Nationally or Internationally;
- Whilst there is no overall increase in vessel numbers their distribution across the cross-section will change with potential for ten more boats to be situated along this cross-sectional profile compared to the existing layout; this distribution of vessels is representative of the new configuration in general. This additional blockage, in combination with new pontoon floats and piles required for the reconfigured pontoons

along this profile, will increase the blockage potential of the channel by up to *circa* 39m^2. This additional blockage will influence tidal flows throughout the tide, however, there is a general net increase of *circa* 51.5m^2 at MLW in the channel cross-sectional area as a result of the capital dredge; and

- An increase in the number of piles required from 25 to 32 will further provide blockage to the tidal flows. However, this change is minor when considered against the large cross-sectional gain achieved through the capital dredge.

4.1.1 Flood

Following the proposed works, the main channel flows in the vicinity of the RSrnYC will be drawn further towards the western bank over the flood tide, due to the increased cross-sectional area made available through the capital dredge that now needs to be filled. This process will lead to some very local redistribution of flows, which will be marginally increased at the edges of the dredge, as flow enters and exits the dredge area. As such, at higher states of the tide (i.e. above 2.0m CD), there is potential for a slight accelerated flow (discharge) across the edge of the intertidal area immediately to the south, i.e. between the RSrnYC and the Hamble Ferry Jetty. Peak flow velocities in the vicinity of Point A (see Figure 4 for location) are likely to be increased slightly due to its proximity to the dredge area; this increase could be in the order of 0.01 to 0.02m/s (over the baseline of 0.35m/s), thus representing an increase of less than 5%; it is unlikely that this change will be noticeable by small craft. However, peak flow velocities further across the channel (to the east), i.e. in the vicinity of Point B (see Figure 3 for location) will be expected to reduce very slightly from the 0.55m/s seen at present, and should have no adverse impact on navigation within the channel.

Within the RSrnYC, flow velocities are likely to be reduced (due to the increased depth/cross sectional area) compared to existing maximum flows (at shallower depths), with a formation of a slow circulating (anti-clockwise) eddy in the south west corner of the dredge pocket near to the proposed access bridge. The removal and replacement of the existing detached pontoon structures (which are aligned parallel to the bank) with the proposed walk-on finger pontoons will lead to an increase in flow blockage within the RSrnYC. However, similar localised flow increases will also be seen in the present pontoon configuration, and possibly to a greater extent, as the blockage-to-channel ratio is currently much greater; i.e. the proposed dredge will increase the cross-sectional area by much more than is lost through the increased blockage potential, thereby reducing the potential for localised flow velocity increases.

As the tide passes into Port Hamble Marina, the strength of the eddy presently occurring towards the southern end of the marina and in the area of the RAFYC facility over the flood tide (see Section 3.2.2) is likely to be reduced, if not fully removed. This change is due to the flow at this location becoming more aligned with the bank following the proposed capital dredge, whereby the uniformity in the bathymetry across the RSrnYC, RAFYC and Port Hamble Marina would result in the tidal flows being less obstructed (i.e. by the intertidal areas presently seen). In addition, small localised increases in flow velocities will be seen in this area, largely restricted between proposed dredge pocket and the first row of pontoons within Port Hamble Marina; however, these increases will have no adverse impact on navigation to and from the berths. Moving out from the shore (and into the main channel), no change is expected as a

result of the proposed marine works, with flow directions and velocities remaining consistent with those seen presently.

During the period of HW slack, occurring for approximately 2 hours due to the double HW, the proposed works will have no effect on the tidal flows.

4.1.2 Ebb

During the ebb tide, tidal flows beyond the middle of Port Hamble Marina (upstream) and in the main channel adjacent will not be affected by the proposed marine works.

The tidal flows to the very southern end of Port Hamble Marina and in the area of the RAFYC will continue to run parallel to the bank, whereas presently, the flows are redirected towards the main channel, particularly at lower states of the tide, due to the presence of the intertidal area in front of the RAFYC and RSrnYC; which will be removed as part of the capital dredge. This change in flow condition will result in an existing (clockwise) eddy seen at this location become reduced in extent, or completely stopped, leading to a noticeable change in this area. As a result, peak flow velocities along the bank are likely to be increased slightly, whilst flow velocities just outside Port Hamble Marina (in the main channel) will reduce slightly.

As the flows pass from Port Hamble Marina into the dredged area of the RSrnYC, peak flow velocities will be reduced. However, these velocities are still expected to be greater than those presently seen for most of the tide due to the sheltering nature provided by the flanking intertidal areas, which direct flows into the main channel and away from the RSrnYC. This being said, peak flow velocities are expected to be considerably less than those seen at Point A presently (see Figure 3 for location), i.e. much less than 0.4m/s, and more likely in the region of 0.2 to 0.3m/s. In addition, as described for the flood tide, blockages provided by the pontoons, boats and piles will also lead to very localised increases in velocity, however, these are likely to be similar to those presently seen.

Towards the southern end of the RSrnYC, the tidal flows will be forced away from the bank and towards the main channel due to the presence of the existing intertidal area to the north of the Hamble Ferry Jetty. This process, however, will lead to the formation of a small circulating (clockwise) eddy in the south west corner of the dredge pocket near to the proposed access bridge; the same as seen during the flood tide, but rotating in the opposite direction. Within this eddy, flow velocities will be significantly reduced.

In effect, the proposed works will shift the present (southern) Port Hamble Marina eddy further southwards into the RSrnYC area. In comparison, the redirected flows exiting the RSrnYC dredge area are likely to accelerate slightly, potentially leading to a slight increase in flow velocity over the end of the intertidal area immediately below and also in the vicinity of Point A; where peak velocities could potentially increase by around 0.02 to 0.04m/s (approximately 5 to 10%). This increase, however, will be of relatively short duration and pose no adverse impact to navigation in this area.

As tidal levels continue to fall over the ebb tide, these effects will be minimised as the flows exiting the RSrnYC will become more constrained to the main channel, and will not be able to accelerate across the higher elevated intertidal area. Impacts associated with the proposed works will likely be confined to less than 50m to the south of the RSrnYC over the ebb tide. Furthermore, during the period of LW slack, the proposed works will have no effect on the tidal flows.

4.2 Sedimentary Effects

Once the proposed marine works have taken place, there will be potential for both increased sedimentation and erosion in the vicinity of the RSrnYC depending on the change in tidal flows discussed in the previous section.

Under flood tide conditions, the proposed works will likely lead to a small amount of erosion to the lower intertidal area situated between the Hamble Ferry Jetty and the RSrnYC, driven by an increase in flow velocities as the streamlines are pulled further towards the western bank to accommodate the increase in tidal prism (created through the capital dredge). Any potential erosion of this undesignated intertidal will be very limited and may not be detectable (depending on both the density and type of material at the bed), in which a small change in elevation is likely to occur around LW, thus leading to a very small reduction in the undesignated intertidal area. Over a short period of time (i.e. after a number of tides) the flows within this area will find their course, and this erosion will cease.

Sedimentation is likely to occur in the south west corner of the RSrnYC, where the slow circulating (anti-clockwise) eddy will result in low flow velocities. In addition, the removal of the intertidal in front of the RSrnYC will further increase the efficiency of the tidal flows moving parallel to the bank. This change will effectively reduce (or remove) the eddy presently found at the south west end of Port Hamble Marina, thereby likely reducing the present sedimentation rates; in effect, the eddy is shifted downstream into the RSrnYC area.

During the ebb tide, the existing (clockwise) eddy seen at the very south west corner of the Port Hamble Marina (in the reverse direction to that seen during the flood), and affecting the RAFYC facilities, will be reduced in extent or completely stopped through the removal of the undesignated intertidal area in front of the RSrnYC and RAFYC berths. This will once again reduce present sedimentation rates, as the tide flows more efficiently along the bank (i.e. with limited obstruction, other than the blockages presented by the piles, pontoons and boats) towards the RSrnYC. This reduction in sedimentation, in addition to that seen on the flood tide, will potentially lead to a lesser maintenance dredge requirement for the RAFYC and Port Hamble Marina in this particular area. In contrast, a new (clockwise) eddy will be formed in the south west end of the RSrnYC, whereby there is likely to be increased potential for sedimentation, and therefore a likely requirement for future maintenance dredging. Outside of the dredge area, there is also likely to be some erosion of the undesignated intertidal to the south (between the RSrnYC and the Hamble Ferry Jetty) caused by an increase in flow velocity as tidal flows are redirected to the main channel, cutting across the end of the intertidal. As discussed above, erosion of this intertidal area will be limited in duration and scale.

In essence, the sediment budget in the vicinity of the proposed works is likely to remain the same, or in the worst case result in a very slight and undetectable increase (due to the increased tidal prism). A shift of sedimentation away from Port Hamble Marina and the RAFYC to the RSrnYC, due to the migration of eddies created during the flood and ebb tide, is likely to occur.

Based on the average maintenance dredge volumes for Port Hamble Marina (1986 to 2010), it is expected that this shift in sedimentation to the RSrnYC will result in an average annual maintenance dredge requirement in the order of 300 to 500m^3; this will be across the dredge pocket as a whole, although more concentrated at the south west end of RSrnYC. In scale terms, this amounts to around 2 to 3% of the annual maintenance dredging undertaken within the Hamble.

With respect to piling, the removal of existing piles will disturb sediment at the bed locally, with any change in suspended sediment concentrations (SSC) likely to be local to the proposed dredge area. A similar effect will also be seen during installation of the new piles, although to a slightly lesser extent. In both cases, any increase in SSC will be comparatively minor to the dredging effect. Once the piles are installed, there is likely to be a small amount of scour around the base of up to 0.2m, although this will largely be determined by the sediment type at the bed.

4.3 Geomorphological Effects

The stability of the intertidal and subtidal bedforms within the Hamble Estuary will be a function of natural long term trends in estuarine response (i.e. sea level rise) superimposed with more recent and ongoing adjustments to anthropogenic changes (reclamation, capital and maintenance dredging and marina development). Volumetric analysis of bathymetric charts covering the period 1965-1994 (ABP R&C, 1994a) suggested that overall there is a tendency for erosion in the channel towards the mouth with a positive balance upstream. However, over the shorter term, erosional and accretional patterns are variable with the channel being largely stable. In an effort to ascertain the impact of marina developments on flow patterns within the Hamble, numerical simulations were carried out for the pre-developed and post-developed Hamble bathymetries (ABP R&C, 1994b). This study suggested that changes to flow conditions were largely localised to the immediate vicinity of each marina and overall, the increase in tidal volume caused by marina construction manifested as a small increase in flow speeds on the ebb and flood tide near low water.

The capital dredge proposed as part of the marine works at the RSrnYC will increase the cross-sectional area of the channel by approximately 114m^2; taken across the channel in the middle of the RSrnYC. This change represents an increase in the area for flow at MHWS, MLW and MLWS of about 9.6%, 18.9% and 20.0% respectively. If MLW is considered the boundary between intertidal and subtidal, then 90.5m^2 is considered subtidal, and 23.5m^2 is considered intertidal. Based upon predicted intertidal dredging volumes of around 3,400m^3 (provided by Marina Projects Ltd), this would relate to an increase in the spring tidal prism of the Hamble Estuary in the order of 0.05%. Such small changes are negligible in geomorphological terms and well within the accuracy that the estuary-wide calculations can be made. Furthermore, in comparison to the total intertidal volume dredged as part of capital work schemes for the other

marinas within the Hamble Estuary, and the change this has had on the tidal prism, the proposed works would only account for approximately 1%; a relatively small amount compared to other capital works that have already taken place in the estuary to date.

4.4 Capital Dredging Effects

As discussed earlier in Section 2, it is believed that the capital dredging being undertaken as part of the proposed works will be achieved by a small backhoe dredger loading small self propelled barges, with the dredge material then disposed at a licensed deposit ground. Information provided by the River Hamble Maintenance Dredge (ABPmer, 2011) suggests that the rate of production using this methodology is likely to be in the order of 50m^3 *in situ* per hour (worst case), with the sediment released into the water column estimated at 25kg of dry solid for every m^3 *in situ* dredged. This disturbance rate represents a loss of about 5% of the material dredged to the water column, which is considered a representative amount. Taking these rates into account, as well as historic dredge volumes for the Hamble Estuary, this would indicate a realistic loss to the water column equivalent to *circa* 20 to 30m^3 (*in situ*) per day whilst dredging with a backhoe dredger. The average rate of supply equates to approximately 0.347kg/s of dry matter, predominantly from disturbance at the bed and wash-off/overspill from the bucket in transit to the surface. However, not all of the material lost to the water column during dredging will be dispersed and available for suspended sediment transport (within a plume); a proportion of consolidated material will fall directly to the seabed where it will then be available for re-dredging.

The extent to which dispersion of material will take place is dependent on the flow conditions at the dredge location, the settling velocity of the sediment, the height of disturbance in the water column and the net impact of the tidal propagation. Based upon the flow velocities prevalent at the RSrnYC, as well as information provided in ABPmer (2011), it is expected that any sediment plume created as a result of the capital dredge will decay to well below 100mg/l within 100m of the dredge location. Furthermore, it is expected that any sediment plume will reduce to 10mg/l (above background concentrations) within 400m in the flood direction, and 300m in the ebb. Beyond the extent of these plumes (i.e. below 10mg/l), and potentially to an even lesser extent, any increase in suspended sediment concentrations as a result of maintenance dredging will not be discernable from natural variability in concentrations along the Hamble. Due to the overall widespread distribution of sediment, dredging at the RSrnYC may temporarily increase the supply of material to Port Hamble Marina (whilst dredging takes place on the flood tide); however, these volumes will be insignificant and well within the natural variability which occurs within the estuary. In terms of sedimentation, the dispersal of sediment during the capital works will be indeterminable from natural sedimentation in the estuary, i.e. any sedimentation will be millimetric in scale.

5. Conclusions

An assessment of the effects of the proposed marine works at the RSrnYC has been made using available information, and further supported by previous studies.

The main conclusions from the assessment are:

- The capital dredge will have a small impact on local flow velocities in the vicinity of the RSrnYC and towards the RAFYC and southern end of Port Hamble Marina. The main channel flows in the vicinity of the RSrnYC will be drawn further towards the western bank over both the flood and ebb tide, leading to some minor local flow redistributions, in which flows will be marginally increased at the edges of the dredge, as flow enters and exits the dredge area. The most noticeable change will be the reduction (or removal) of the existing eddy in the south west corner of Port Hamble Marina (seen on both flood and ebb tides, although circulating in opposite directions), and the creation of an eddy in the south west corner of the RSrnYC. This will potentially lead to a lesser maintenance dredge requirement by Port Hamble Marina and the RAFYC, but increased potential for sedimentation within the RSrnYC area;
- Outside of the dredge area, there is also likely to be a minor amount of erosion potential to the undesignated intertidal to the south (between the RSrnYC and the Hamble Ferry Jetty) caused by an increase in flow velocities during both flood and ebb tides, whereby flows cut across the end of the intertidal. However, erosion of this intertidal area will be limited in scale and will occur shortly after completion of the dredge works;
- The proposed capital dredge will increase the cross-sectional area by approximately 114m^2, which represents an increase in area for flow at MHWS, MLW and MLWS of about 9.6%, 18.9% and 20.0% respectively. If MLW is considered the boundary between intertidal and subtidal, then 90.5m^2 of this cross-sectional increase is considered subtidal, and 23.5m^2 is considered intertidal;
- Predicted intertidal dredging volumes of around 3,400m^3 would relate to an increase in the spring tidal prism of the Hamble Estuary by the order of 0.05%. Such small changes are negligible in geomorphological terms and well within the accuracy that the estuary-wide calculations can be made;
- As a result of the new pontoon configuration, whilst there is no overall increase in vessel numbers, their distribution across the cross-section will change with potential for ten more boats to be situated along this cross-sectional profile compared to the existing layout. This additional blockage, in combination with new pontoon floats required for the reconfigured pontoons along this profile, will increase the blockage potential of the channel by up to *circa* 39m^2. This additional blockage will influence tidal flows throughout the tide, however, there is a general net increase in the channel cross-sectional area as a result of the capital dredge;
- An increase in the number of piles required from 25 to 32 will further provide blockage to the tidal flows. Again this change is small when considered with respect to the large cross-sectional gain achieved through the capital dredge;
- The sediment budget in the vicinity of the proposed works, extending to Port Hamble Marina, is likely to remain similar, or result in a slight increase (due to the increased tidal prism). A shift of sedimentation away from Port Hamble Marina and the RAFYC to the RSrnYC due to the migration of eddies created during the flood and ebb tide is likely to occur. It is expected that the RSrnYC will have an average annual maintenance dredge requirement in the order of 300 to 500m^3; this will be across the

dredge pocket as a whole, although more concentrated at the south west end of RSrnYC. In scale terms, this amounts to around 2 to 3% of the annual maintenance dredging undertaken within the Hamble;

- Any sediment plume created as a result of the capital dredge will decay to well below 100mg/l within 100m of the dredge location. Furthermore, it is expected that any sediment plume will reduce to 10mg/l (above background concentrations) within 400m in the flood direction, and 300m in the ebb; and
- Dredging at the RSrnYC may temporarily increase the supply of material to Port Hamble Marina (whilst dredging takes place on the flood tide); however, these volumes will be insignificant, and well within the natural variability which occurs within the estuary.

Overall, the effect of the proposed marine works on the marine environment is considered small and will be local to the RSrnYC, in which any change will not adversely affect the overall integrity or functioning of the estuary. Furthermore, the changes predicted to tidal flows will not adversely affect navigation along the River Hamble.

6. References

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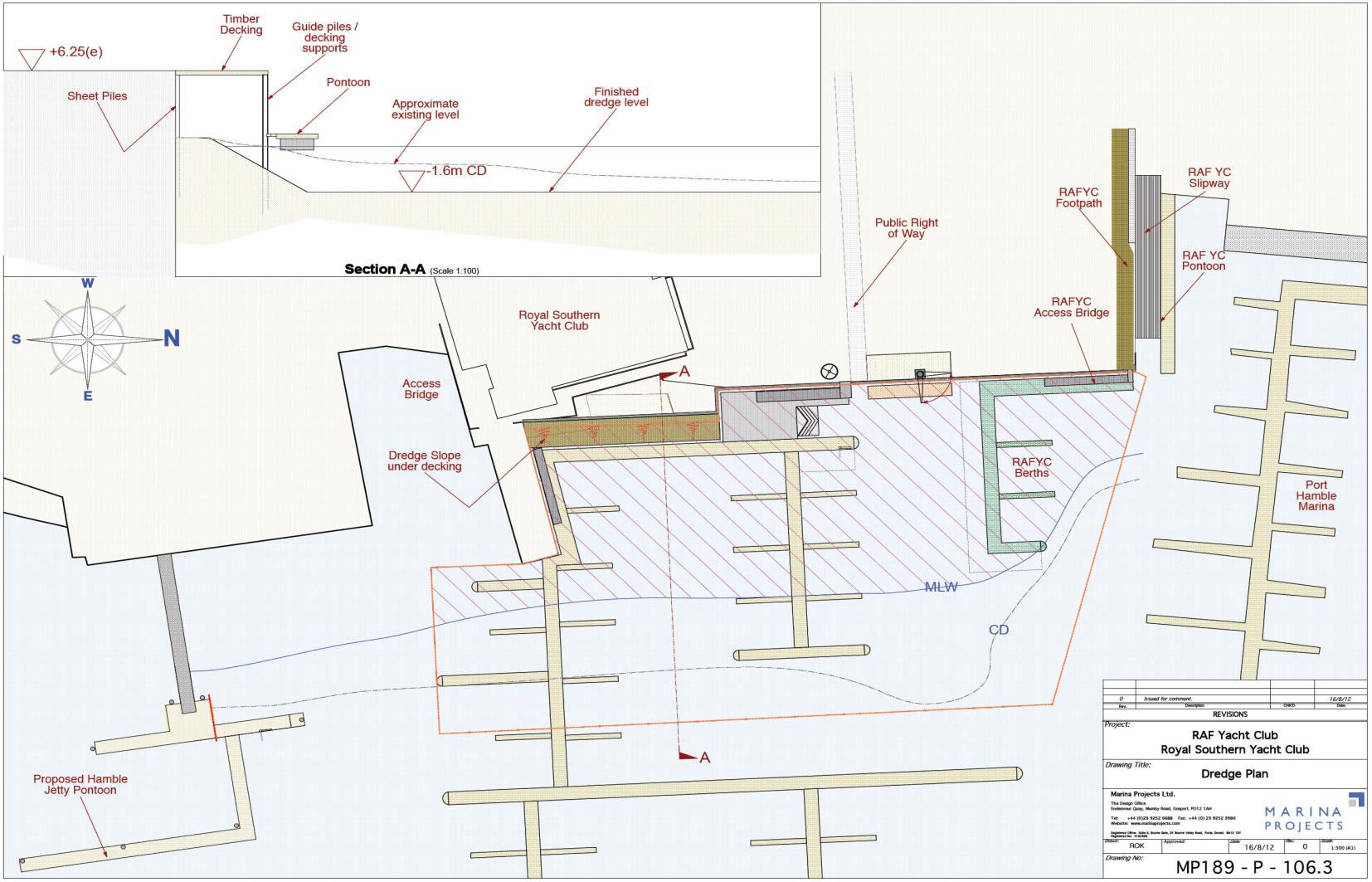
Figures



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Scale		n/a	
QA		PAW	
RSYC Figures.xls			
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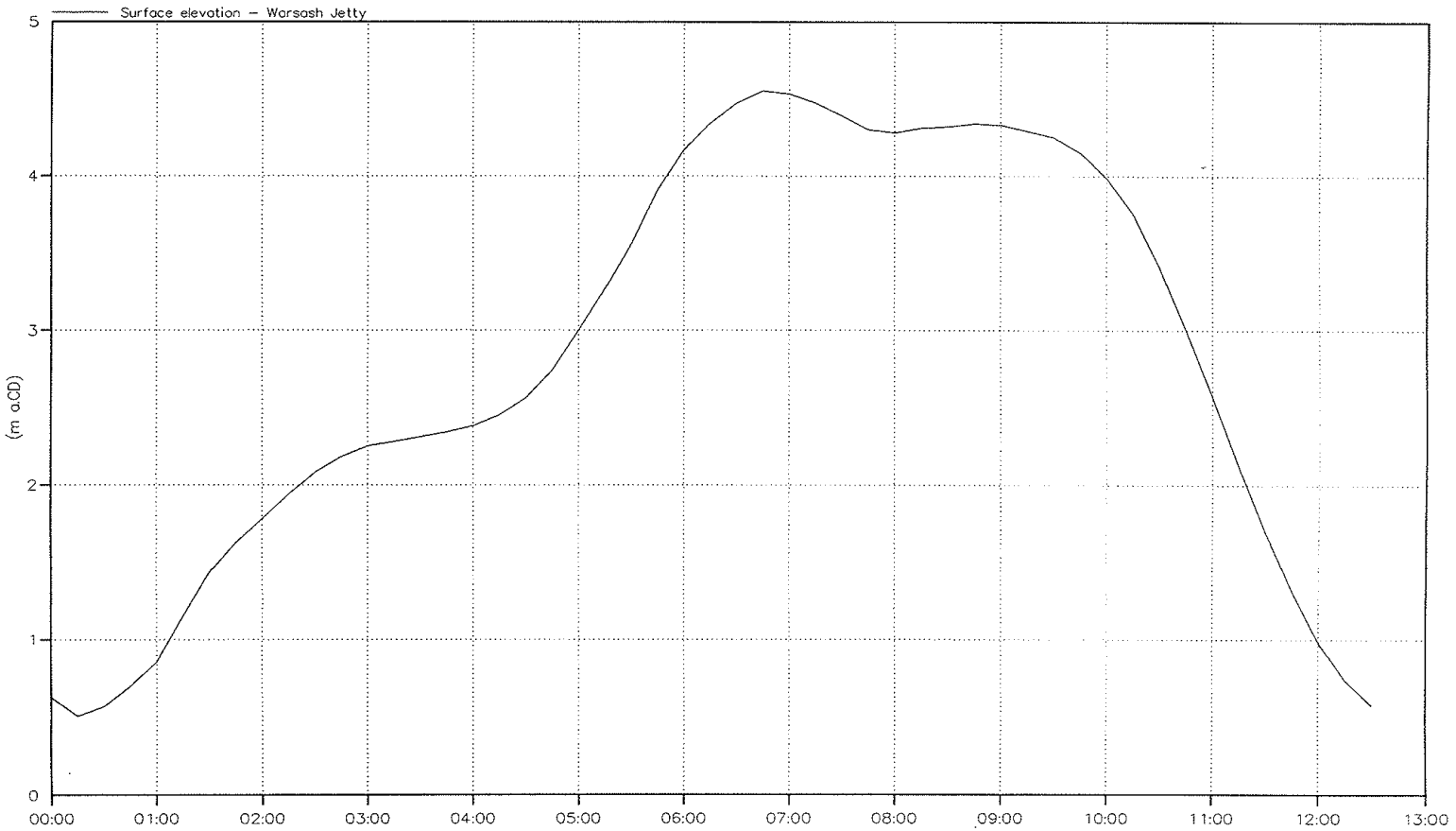
Proposed Marine Works at the Royal Southern Yacht Club

Figure 1

TIDE CURVE AT WARSASH JETTY



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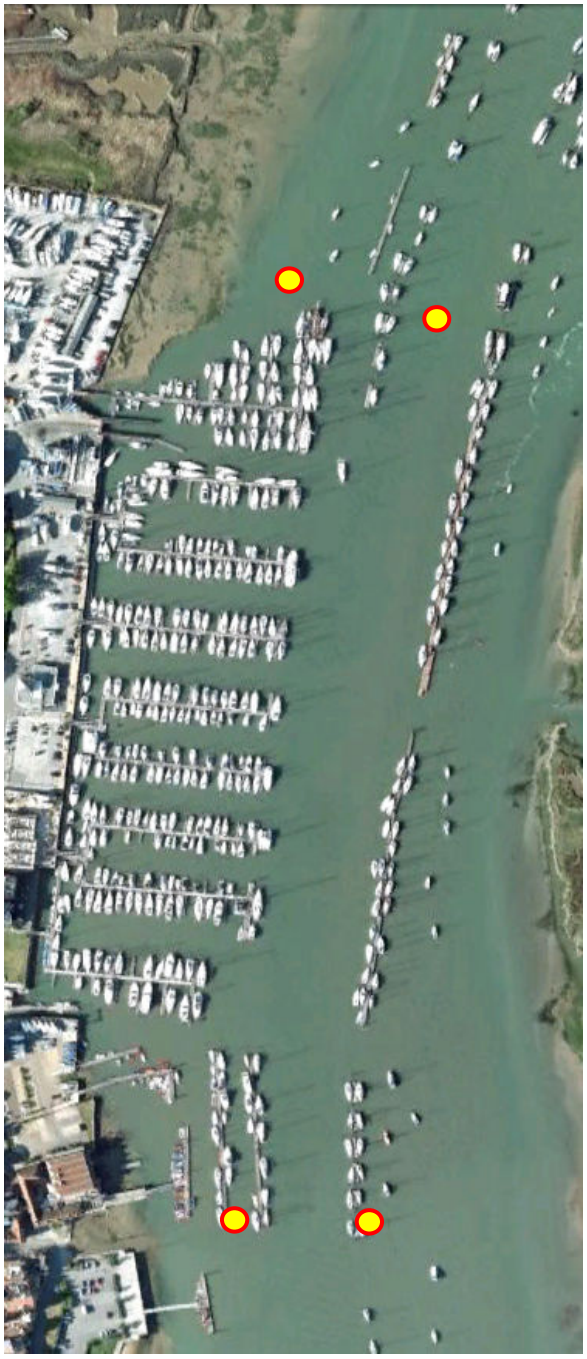
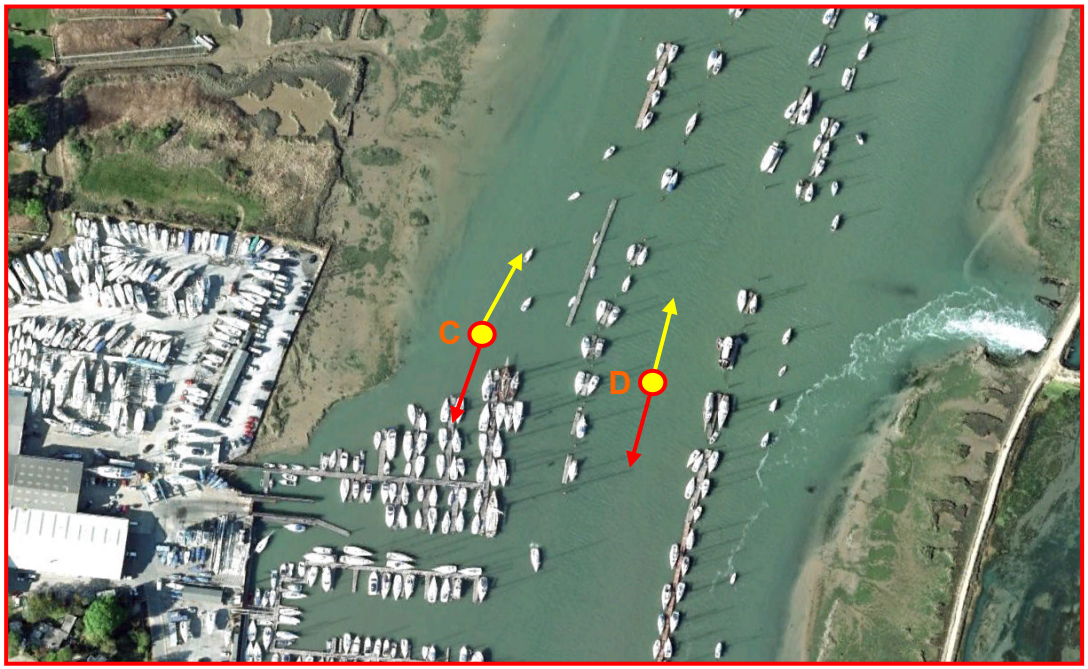
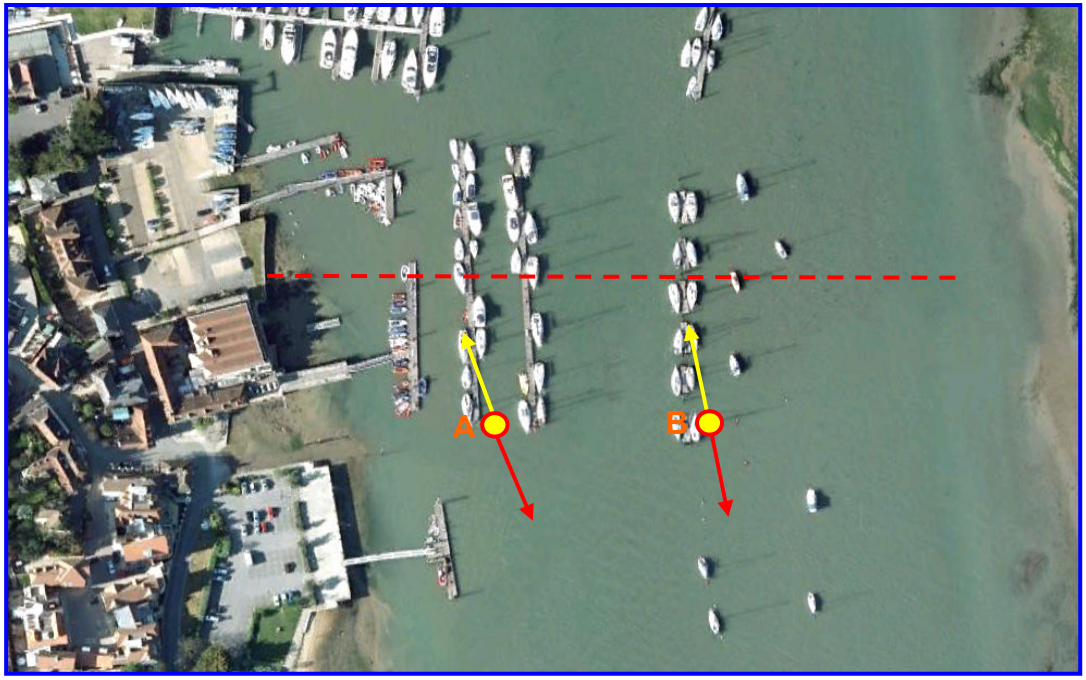
Typical Shape of the Tidal Curve at Warsash Jetty, River Hamble

Figure 2







- Flow velocity positions
- Flood flow direction (observed)
- Ebb flow direction (observed)
- Cross-section location

Date	By	Size	Version
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Projection		n/a	
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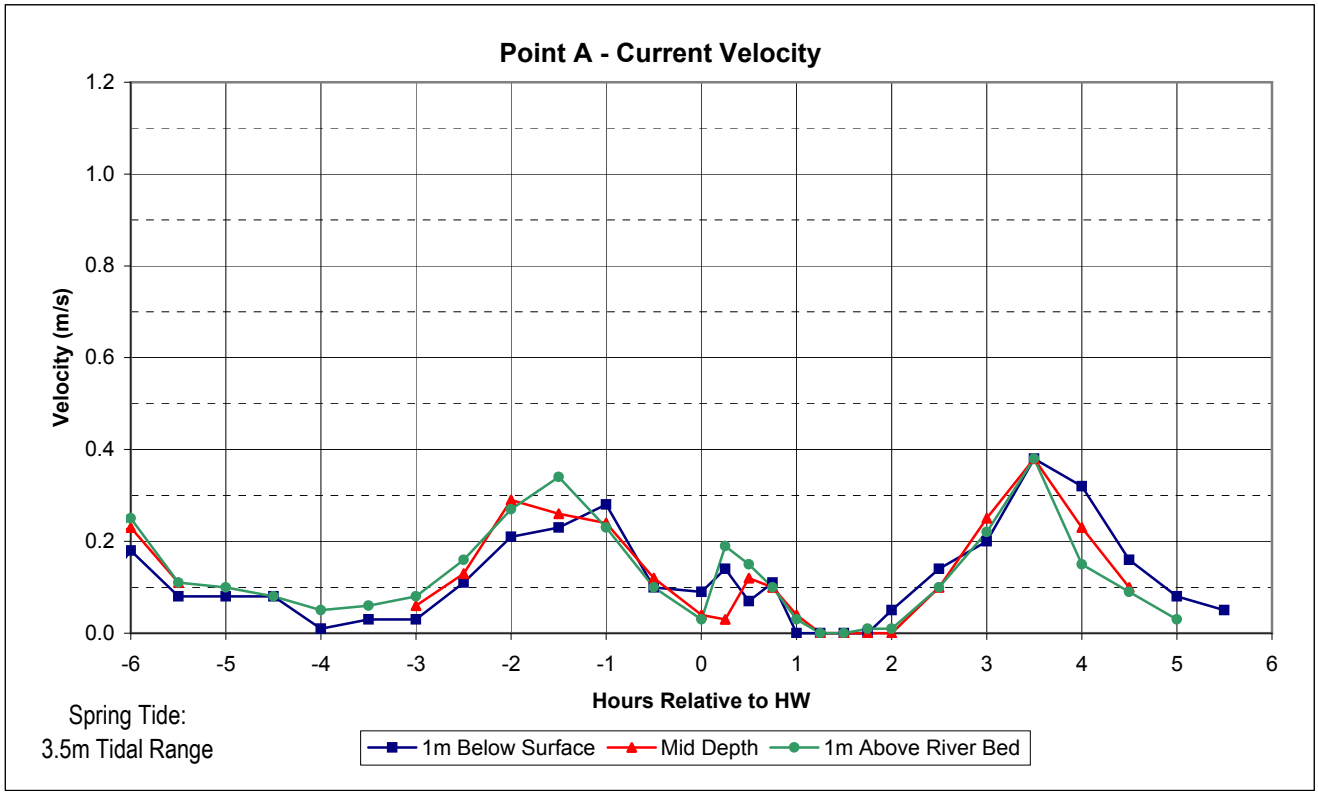
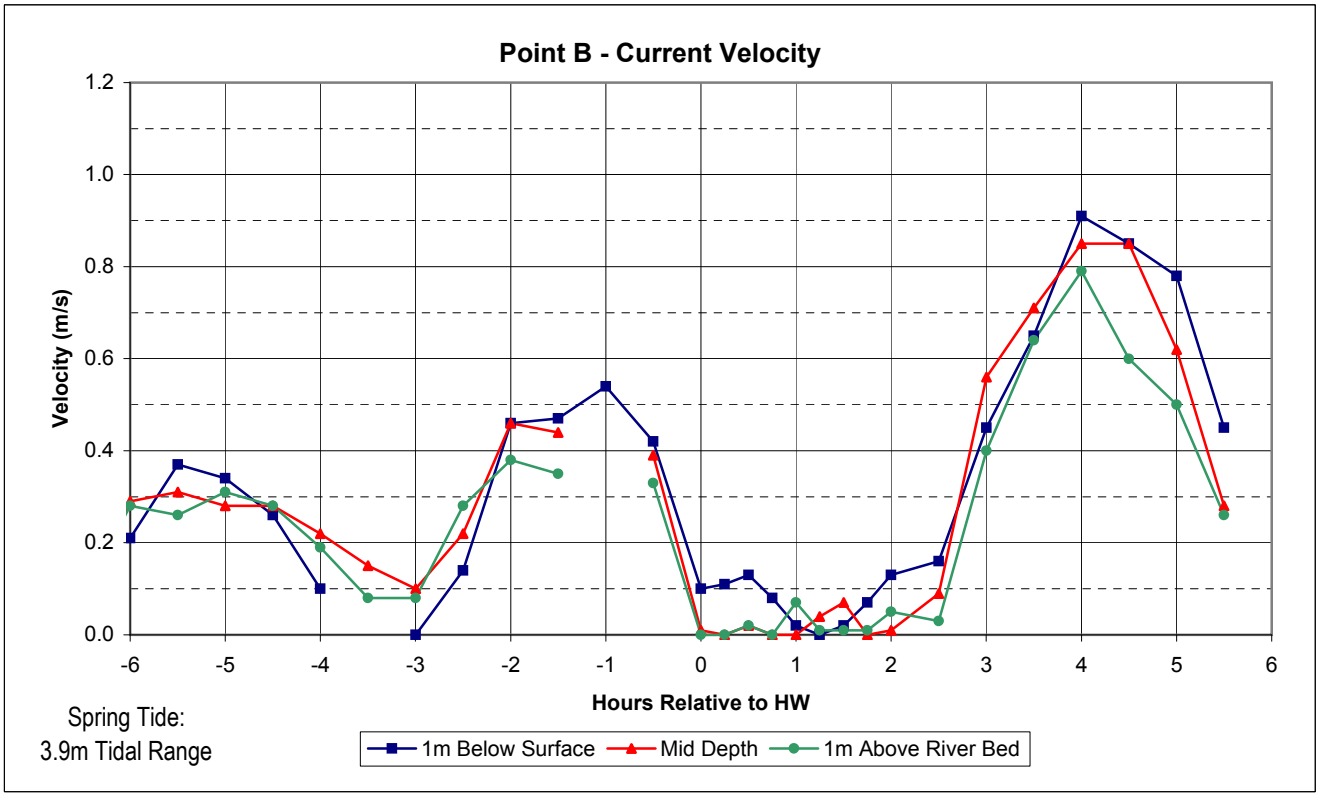
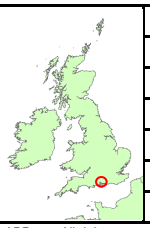
Cross-Section Location and Flow Velocity Positions with Directional Data

Figure 3







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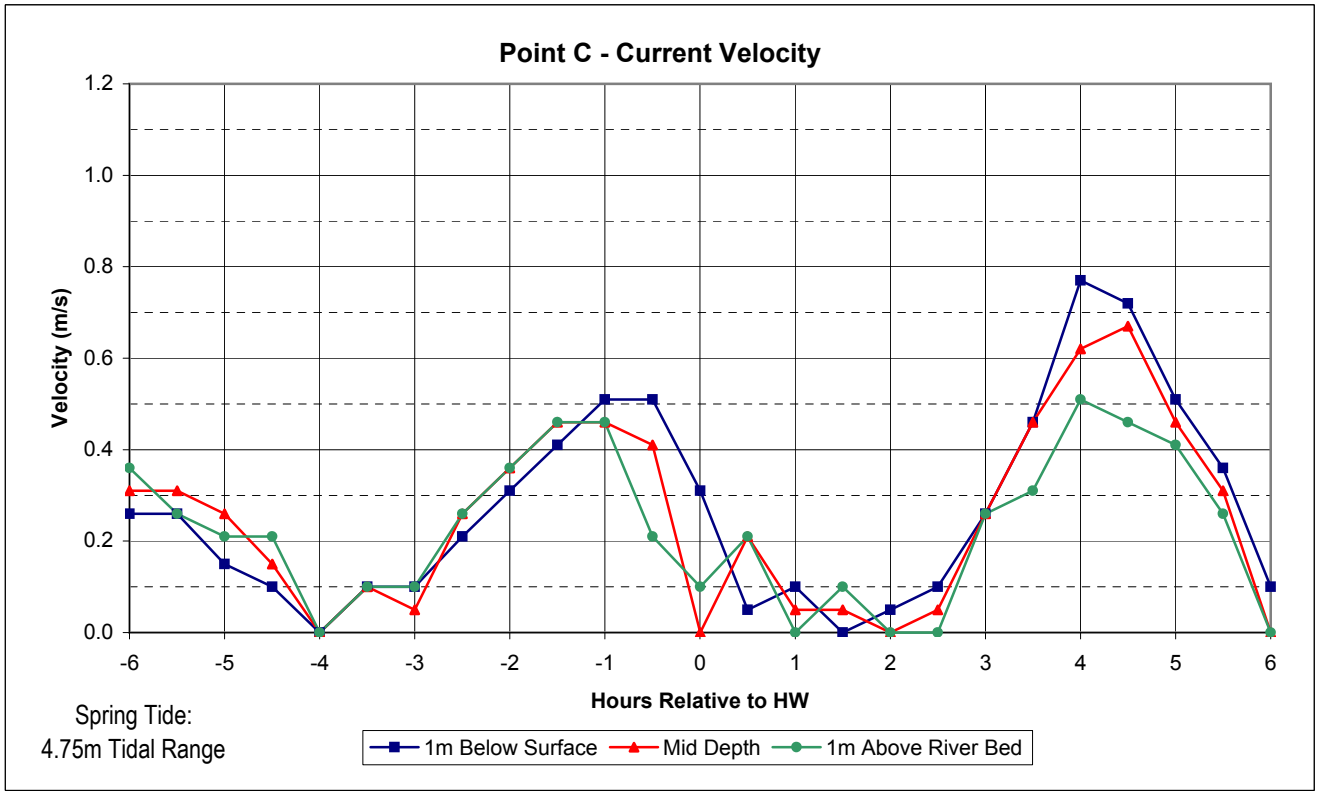
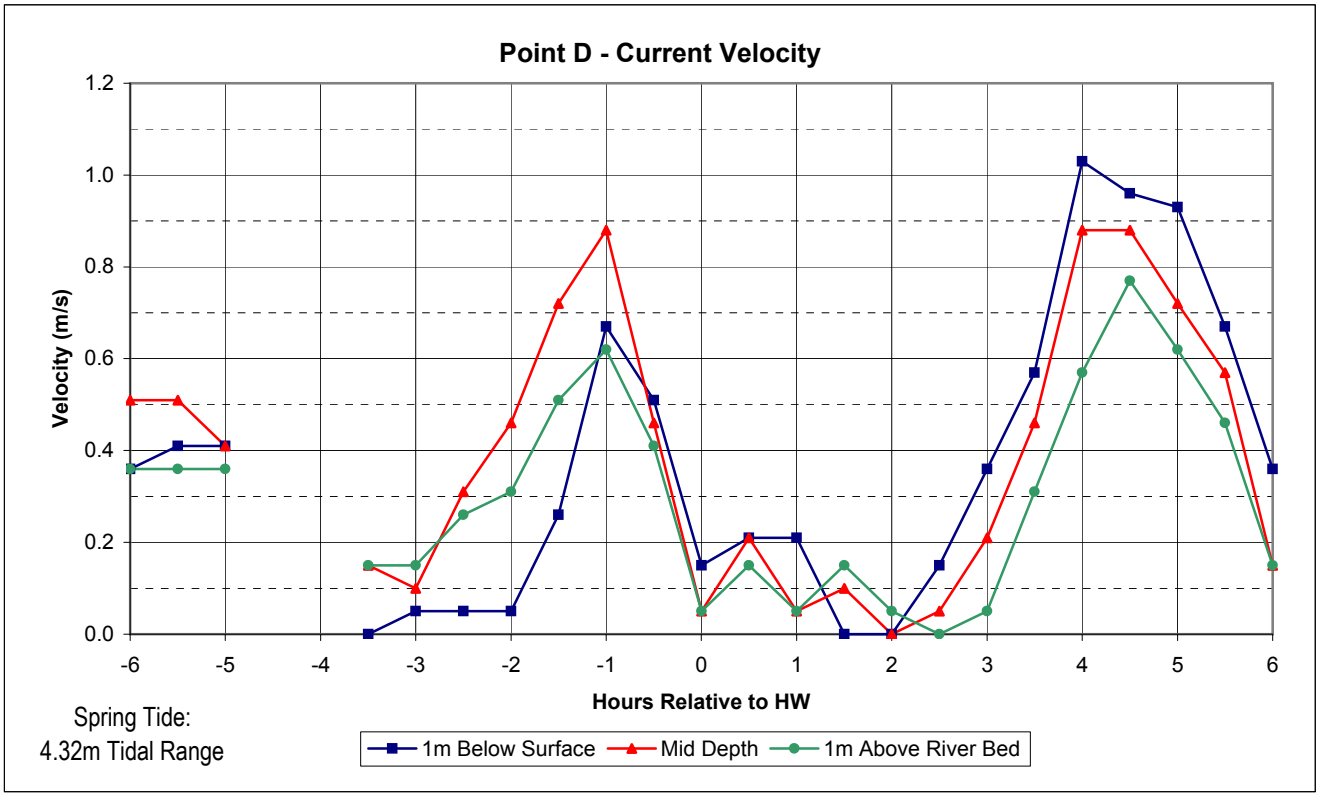
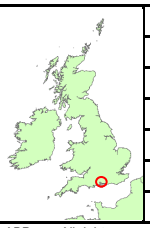
Flow Velocities taken Opposite the Royal Southern Yacht Club

Figure 4







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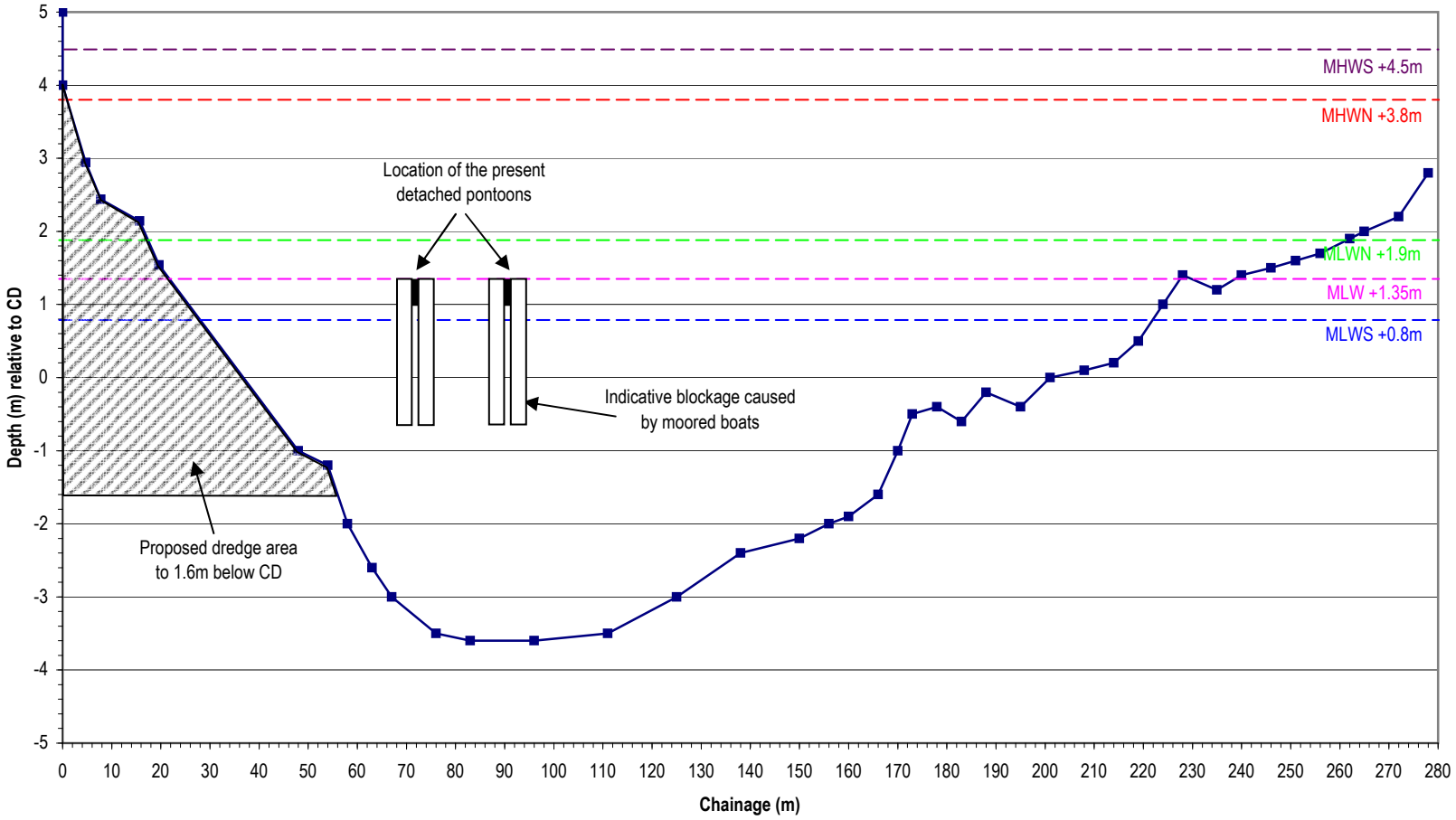
Flow Velocities taken Above Port Hamble Marina

Figure 5



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Indicative Cross-Sectional Profile of the River at the Royal Southern Yacht Club

Figure 6

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