Fish Pass Advisory Service Sidmouth site visit

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Background

The lower river Sid in Sidmouth has a series of weirs and fords which represent significant obstructions to the passage of migratory fish. Views from the EA Fish Pass Advisory Service (FPAS) were sought by the local Environment Agency fisheries team, catchment coordinator and local stakeholder groups. The following notes represent a record of views and ideas expressed following a short site visit to these obstructions on the R. Sid in Devon. After initial introductions and expression of stakeholder background to the issues for the reach the group walked from Salcombe Rd upstream for a few hundred metres to view the nature of the river above the impounding effects of School Weir. The group then walked downstream to the sea front and discharge of the R. Sid into the sea.

Despite recent high regional rainfall, the R. Sid did not appear to be running at a high level which aided the inspection of the structures in the area of interest. Historic river levels (Nov 2012 – Jan 2023) however, suggest that the level of 0.080m represents the level exceeded approximately only 15% of the time [measured at the ford crossing, EA gauging site ID 45216 (OS Grid: SY127876)] .

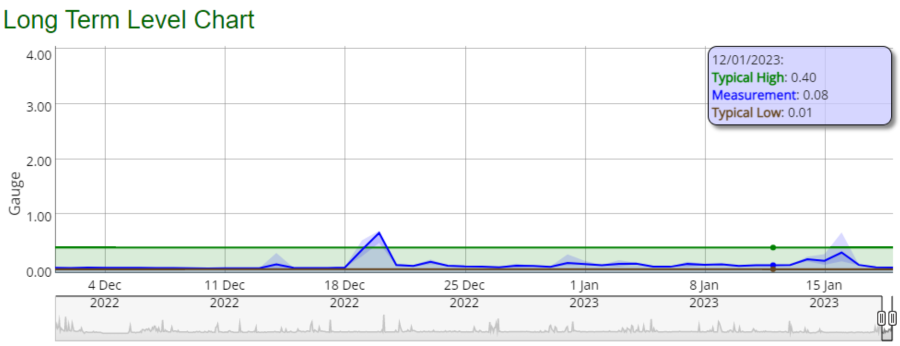

Figure 1 River Levels UK (Dec 2022- Jan 2023)[1]

[1] Data from River Sid at Sidmouth :: the UK River Levels Website (accessed 21-01-2023)

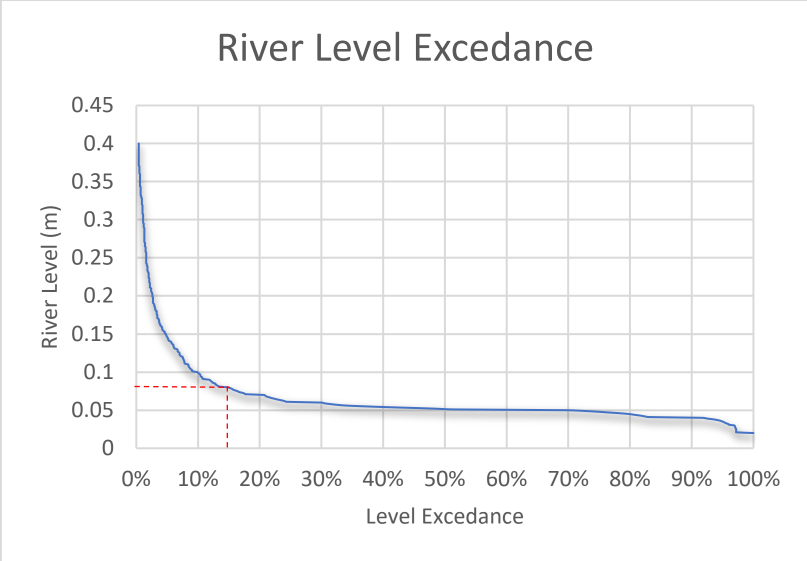

Figure 2 River Level exceedance (ID 45216)

This finding indicates that the river level at the ford was within about 20mm of the level exceeded only 10% of the time which would be a normal upper expectation of flow or level for migratory salmonids to migrate. Interpolating the "Low Flows" flow duration curve provided by Fishtek (assumes no abstraction upstream) the Q15 flow should be of the order of $1m^3s^{-1}$ or about six times the Q95 flow that might normally be associated with the minimum for fish pass operation. Eels on the other hand would normally be expected to migrate at lower flows between ~Q99 and Q70.

The Fishtek report of March 2022 describes two key options for improving fish passage at School Weir and outlines many of the constraints for the proposed options. The content of the report seems reasonable within the scope of investigation set. Clearly though, a number of other fish passage impacts downstream should be considered alongside measures to improve fish passage at School Weir.

The general focus of previous discussion has centred on the passage of migratory salmonids although other migratory fish, such as European Eel (*Anguilla Anguilla*), should be considered when evaluating options for fish passage improvement. Each site is discussed below moving downstream from the upper extent of the reach visited.

Above School weir

Upstream of School weir there was approximately 120m of river displaying the effects of impoundment by the weir and its' predecessor a few metres upstream. Above the impounded reach there was a reach of at least ~230m of cobble and small boulder which was shallow and fast flowing. Whilst no elevation measurements were taken the reach showed features typical of slopes around 1%. Passage of migratory salmonids is likely to be limited in low flow periods due to the shallow depths in such reaches. The passage of eel and elver is unlikely to be impacted by low flow periods in this reach.

Figure 3 Map from Salcombe Rd upstream

School Weir

School Weir is reported by the technical note by Fishtek Consulting[2] to have a head loss of approximately 3m making it a significant barrier to migratory salmonids and European eel. Options for improving passage at the weir were put forward by Fishtek including a two flight Larinier pass and a rock ramp type pass. Approximate costs for the options were provided but each had significant constraints that could alter the suggested costs significantly. These included the proximity of both sewer and high voltage services parallel to the river. At present, the depth of these services is unknown and therefore they represent a risk of impacting the viability of the options put forward. In addition, there are several mature trees lining the true left bank that form part of the character of the "Byes" park for local residents. Bank reinforcements or significant earthworks could require the removal of some of the trees or impact their survival.

Figure 4 School weir

The Fishtek note highlighted these constraints but there may be some scope to investigate approaches that attempt to limit the impacts on the reach upstream and utilise the structures that are already in place. For example, if the slope of the riverbed above the impounded reach was ~1% then there might be scope to regrade the reach upstream of the old weir so that this weir is approximately 1.2m lower. A standard notch for the passage of migratory salmonids would normally be designed to have a width of 0.3-0.6m and a depth of 0.25m. The Q95 flow for the R. Sid is estimated at 0.149 m^3s^{-1} by Fishtek which is slightly more than the calculated discharge for a 0.6m wide notch as described[3]. That would mean the weir "shoulders" would normally run a trickle of water except in very low flows. Some additional facilities to assist the passage of eel would also be required but could be incorporated at bank walls for easy maintenance.

Such weirs with notches would normally be designed to accommodate a fall in water level of no more than 0.45m. Depending on the construction of the main School Weir it may be possible to lower this weir to effectively form a pool between the old weir and the new weir. Another constraint

[2] Fishtek Consulting, (March 2022) Fish Passage Options Appraisal, School Weir, Sidmouth
[3]The shape of appropriate notches are described in the EA Fish Pass Manual. (FISH PASSES (ifm.org.uk))

normally considered when forming pools between weirs is the power density of the water in the receiving pool. That is related to the magnitude of the drop into the pool, the volume of the receiving pool and the range of discharge over which the structure is intended to operate over for fish passage. Normally the power density should not exceed 150 Wm^{-3} so that fish do not become confused by the turbulence in the pool. The lower weir might be expected to have a notch of the same dimensions as the notch in the upper weir so that water the water level in the pool rises in a similar fashion to the level above the upper weir.

Figure 5 School weir from downstream with access ramp and bedload accumulation

The upper weir also appeared to have a significant longitudinal dimension which may allow the formation of a chute as opposed to a notch in the weir. The advantage of creating a chute is that in such constrained conditions a greater head loss may be achievable in a single drop and still be passable for migratory salmonids. In such cases where the chute is possible then a difference in elevation 0.5m from the invert of the chute (highest point) to the downstream water level is allowable. The width of the chute should be designed so that at flows that fish can access the weir the depth of water in the chute is a minimum of 150mm and that the consequential water velocities do not exceed ~3ms^{-1}. Care should be taken that water does not spill laterally from the weir into the chute at discharge less than Q10. A consequence of this approach is that the likely range of operation of the chute would be limited to moderate to high flows which may be appropriate given the future passability of structures below School Weir. If these design limitations could be met, then potentially ~0.75m difference in water level could be possible. If the lower School Weir was also of sufficient “thickness” then a similar head loss might also be possible.

Figure 6 Historic weir a few metres upstream of School weir (source Fishtek 30-3-2022)

Drawing these considerations together then the combination of 1.2m of river regrading followed by two standard notch loss of elevation accounts for 2.1m of the required 3m of head loss. Thus an additional head loss of 0.9m would be required between the lower weir and the point where it is deemed that flood conveyance must be maintained upstream of the road bridge. We discussed on site the potential for "ArmorLoc" or similar products to be used to provide an engineered slight impoundment below the current school weir that could allow bed movement through the weir notches and past the "ArmorLoc" impoundment. Such an impoundment could be shaped to provide a lower section for low flows whilst not significantly impeding higher flows or sediment.

If it were possible to include two chutes into the lowered weirs in addition to the upstream river re-grading then perhaps 2.7m of head loss might be accommodated leaving only a more minor 0.3m of head loss to be found below the newer weir.

All these potential options would require consideration of the change in level between the existing paths and the river level and impacts on the mature riparian trees, as well as examine whether structurally the weirs can be lowered and notched.

If school weir could not be lowered but the historic one could along with some river regrading, then perhaps the single flight pass around school weir would be feasible. However, the combined cost of all these elements might still be high compared to the dual flight Larinier pass option and may mean that the aesthetic appeal of the skim of water over the weir is not normally present.

Discussion also considered re-meandering the river through the park to provide a more natural and continuous slope. This option could be considered a wider benefit to recreation in the park although might be impractical if the elevation of the identified services is too close to the surface. It is unlikely that a bypass channel could be constructed within the park as the available flow for this part of the river is insufficient to supply two channels with sufficient depth of water.

Where options include significant falls or higher water velocities then specific arrangements for the passage of Eel should be included. That may be by providing specifically roughened surfaces designed to be operational for eel passage at least between the Q99 and Q70 river flows.

Mill Street Ford Crossing

The ford crossing the River Sid (Mill Street) is approximately 200m downstream of School weir and represents a significant obstruction to fish passage for both migratory salmonids and eel. Two key features combine to impact fish passage, a steep (~ 1:2) sloping weir downstream of the ford (Figure 7) and a long horizontal concrete upper section of wide river channel over which vehicles cross the river at an oblique angle (Figure 8). This apron would be relatively shallow at all but moderate to high flows.

Figure 7 Sloping weir immediately downstream of the ford

Figure 8 Ford across the River Sid

Figure 9 Map of the Lower River Sid from School Weir to the sea

Downstream of the ford weir are both lateral and longitudinal structures that appear to occupy the extent of the anti-scour apron below the weir (see Figure 9). Migratory salmonids have been reported to accumulate below School Weir at high flows and so this demonstrates that the ford weir is passable at high flows. Measures to extend the flow range over which fish can surmount the ford weir should include a reduction of the head loss on the steep downstream face of the weir. Such mitigations may be possible by augmenting one of the lateral structures visible in the stilling basin (Figure 9, roughly indicated by the orange dashed line). The choice of positioning of the notch or gap could be influenced by the risk of erosion and the ease of maintenance. Normally the head loss associated with one pre-barrage fall would be limited to 0.45m and engineered to have an adherent nappe to limit air entrainment at the notch. It may be advisable to maintain sediment conveyance by designing a notch to extend to near the riverbed, but this will be dependent on the discharge range thought to be relevant to migratory fish access. The longitudinal structures may provide the opportunity to reduce head loss further by introducing another pre-barrage between the weir and the lateral structure mentioned above. Breaks in the longitudinal structures would be needed if they are not drowned by the downstream pre-barrage to allow free access to the pre-barrage notch.

The second feature that challenges migratory salmonid fish passage is the presence of a relatively wide and shallow apron above the weir. The aerial view suggests that the longitudinal length of the upper apron is approximately 30m long and is extensively used as a vehicle ford when water depths allow. Ideally, the relatively flat apron might be modified to provide a slightly deeper longitudinal route for fish that has sufficiently gently sloping sides to maintain the operation of the ford. It may be that the ford could be normally closed when salmonids are migrating and so it may be possible to avoid any requirement to provide a deeper channel for fish on the upper apron. There is a clear requirement to identify when migratory salmonids are likely to be able to access this reach of the river.

Eel passage may be possible over the lower half of the flow range by simply augmenting the sloping weir to near the crest on each of the sides of the weir to provide a climbing surface for juvenile eel. This could be a s simple as bonding suitable small pebbles to the sides of the weir face. Cleaning regimes should limit whole weir cleaning to ensure there is always a significant biofilm/algal surface to provide a more eel friendly surface for passage. The tops of these roughened areas should allow direct access to a low velocity path over the upper ford area even at low flows.

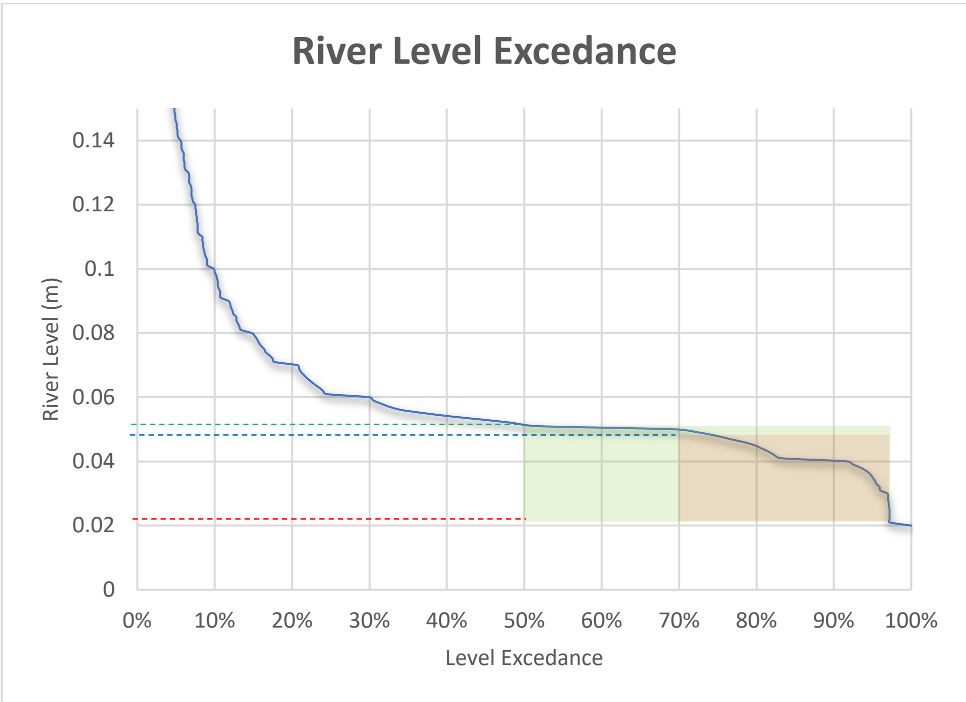

Figure 10 Detailed water level exceedance curve (ID 45216)

The curve above (Figure 8) shows more clearly that the change in water level at the Ford monitoring site from that exceeded 99% of the time to that exceeded 70% of the time is a difference of only ~30mm (orange area). Further to this, if the level exceedance is extended to 50% of the time (green area) the level difference is still only ~32mm suggesting that measures to enhance eel passage could operate over a wider range of flows than the minimum guidance with virtually no extra costs of implementation relating to water level.

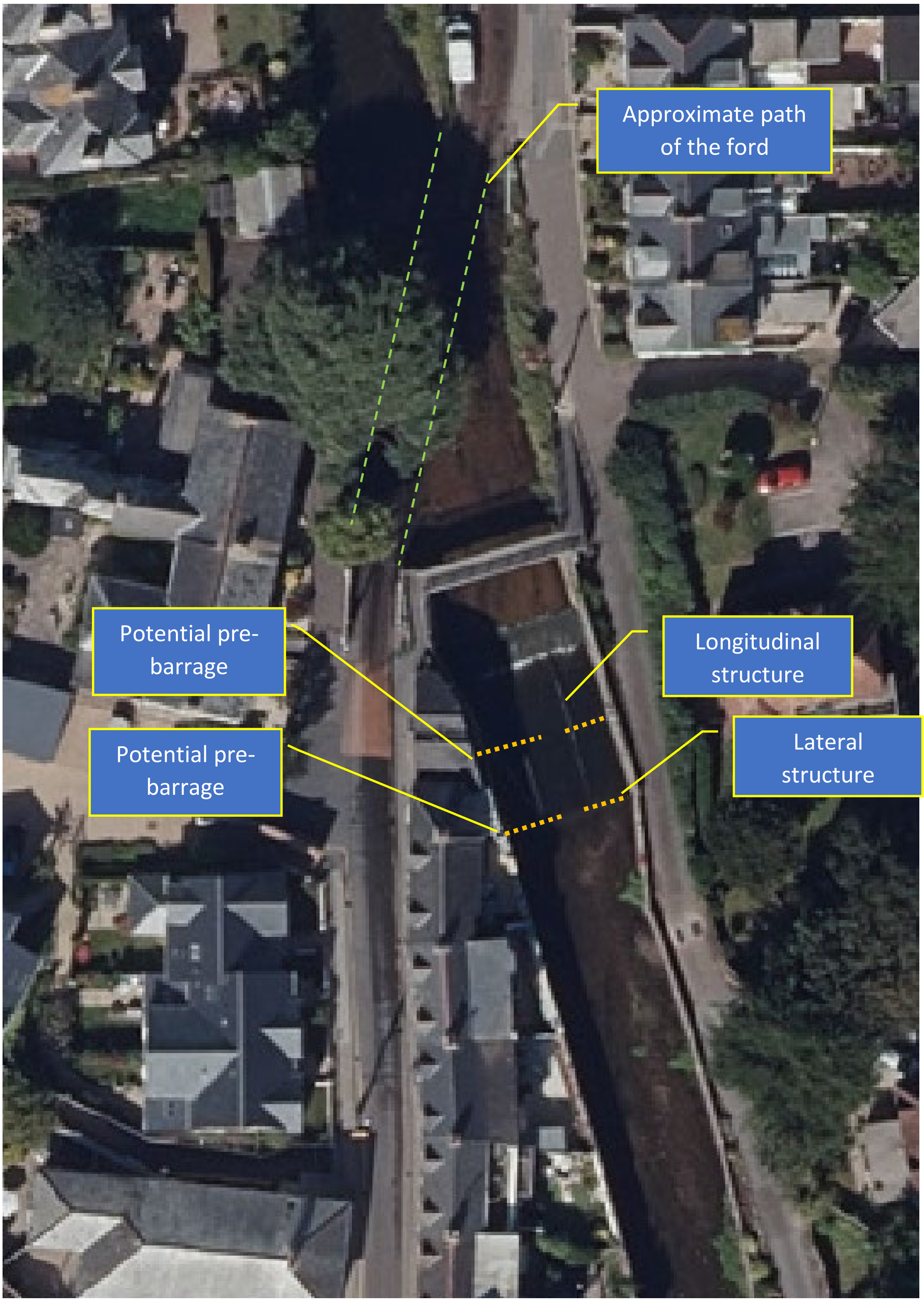

Figure 11 Ford weir aerial view

Lower weir (Tidal weir)

The lowest weir on the R. Sid is approximately 210m downstream of the ford weir and 155m upstream of the high-water mark on Sidmouth beach. The issues for fish passage are similar to the ford weir upstream but perhaps not as acute. The downstream face of the weir appears to have a steep gradient of perhaps 1:2 with a shallow apron upstream of the crest. The direction of the river changes at this point veering to the left looking upstream.

Figure 12 Lower weir (tidal weir) view from true right bank downstream

Figure 13 Lower weir (tidal weir) aerial view

The aerial picture (Figure 11) appears to show that at times the true left of the weir has a shallower approach with large boulders scattered to the true left of the channel. The downstream glacis of the weir is also longer on that side of the weir.

On the day of the site visit there was a clear region of low velocity approach to the true right side of the weir (see Figure 10). Local observations of when fish are in the vicinity should give useful evidence if a particular side of the weir is preferred. If the depth of water on the top of the weir is less than around 150mm when fish are known to run this reach then it may be useful to consider attaching low level timbers to the top apron of the weir to partially increase water depth.

It is sometimes possible to improve fish passage on triangular profile weirs with the addition of Low Cost Baffles (LCB's). These have been used with success but on weirs with a slope no greater that ~1:4. Therefore they are unlikely to be helpful here without a re-profiling of the downstream slope which is likely to be a significant cost. Alternatively, and with a likely lower effectiveness, would be the addition of a transverse baulk structure on the weir face to reduce the slope of the falling water and to increase depth on the weir face. They tend to be of low cost but have variable success depending on the nature of each installation. The actual degree of fish passage difficulty would depend to a significant extent on how much the downstream level is influenced by fluvial flow and tide level. It may be that the weir is not a significant impediment for a significant portion of the tide and therefore measures such as the installation of a baulk would still extend the period of time and the range of fish sizes that can overcome this weir. The influence of the beach management plan proposals could substantially also affect the nature and effectiveness of measures to improve fish passage at this weir.

Similar approaches for the improvement of eel passage discussed for the ford should apply to this weir. As the crest length of this weir is approximately the same as at the ford upstream (12m) the water level change estimated for the ford might be expected to be very similar to this weir.

Traversing the beach

On the day of the site visit the fluvial flow is thought to be ~Q15 (see Figure 1) with a sufficiently deep route from the head of the beach through to the lower weir (tidal weir) close to the true right bank.

Figure 14 River Sid immediately upstream of the beach

The aerial view at low tide shows however that the flow of the river over the current beach is likely to be too shallow for much of the tidal cycle. Tide marks on the true right wall (algae) and on the beach opposite (seaweed) (Figure 12) suggest that at high water there would be of the order of 0.5m extra depth of water on this area and likely to back up the water level to the tidal weir.

The beach management plan mentioned by Tony Burch may add a substantial elevation to the beach on transition to the sea and hence may mean that if the beach replenishment is largely impervious to flow due to finer sediment that the river would flow over the new beach and hence be accessible for a lower proportion of the time than at present.

If the beach replenishment was reasonably porous then the river may pass through the beach and hence be a complete block to fish except when fluvial flow and tide allow passage.

Since these changes could represent an increase to the impediment of migratory fish the changes suggested by the beach management plan should be evaluated to check compliance with the relevant environmental legislation to protect fish passage.

Figure 15 Aerial view of the mouth of the River Sid at low tide

Summary

Clearly there are a number of fish passage issues in the lower River Sid and therefore it would be advisable to consider them as part of a greater plan rather than as a single-issue site such as at School Weir.

Since many of the suggestions relating to fish passage through the reach depend upon the period of fish migration whether by season, river discharge or tidal level some investigation of when migratory fish have been found at School Weir should be used to inform any further options for fish passage improvement. Key information could be derived from past fish recovery incidents and examination of the previous few days water level information for the ford and the prevailing tides.

A short site visit to qualitatively assess the issues of the reach can only provide advice in broad terms without the provision of recent survey information. It would therefore be highly recommended that survey work is carried out for the entire reach and focussing on the specific obstructions. This will be necessary to evaluate which of the discussed possibilities may be viable. Further information on the location and depth of key services will be essential to assess the viability of options for Byes Park.

Evaluation of the current beach management plan proposals should show if there is likely to be an impact on fish passage into and out of the R. Sid. If the evaluation concluded that there was a risk of increasing obstruction to migratory fish, then the evaluation should be able to feed into the plan in order to avoid such risks.

Dr Karageorgopoulos and I would also like to thank the EA team for inviting us to visit the site and all participants for their candid and constructive contributions.