

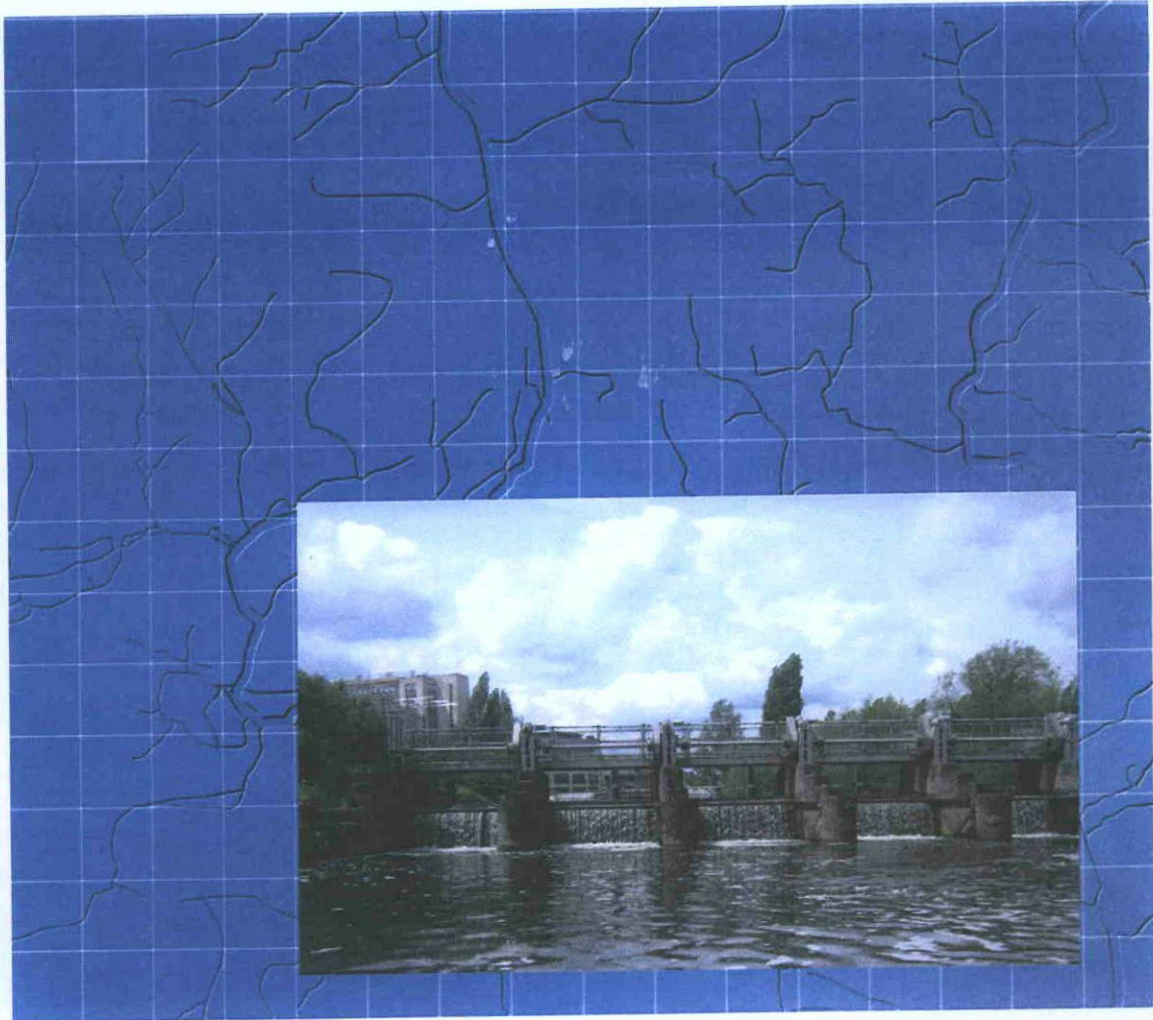
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PLANNING

eWaterpower Company Ltd

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Caversham Weir Habitat Impact Assessment



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WHS

Wallingford HydroSolutions Limited

eWaterpower Company Ltd

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For and on behalf of Wallingford HydroSolutions Ltd.

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Contents

1	Introduction	1
2	Methodology	2
2.1	Spawning Habitat Requirements	2
2.2	Survey Methodology	2
2.3	Habitat Mapping	3
3	Survey Results	3
4	Habitat Assessment	7
5	Assessment of Potential Effects	7
6	WFD Assessment	10
6.1	Baseline RBMP	10
Appendix 1	Sediment Sample Photographic Record	12

1 Introduction

Wallingford Hydrosolutions Ltd (WHS) were commissioned by eWaterpower Company Ltd, on behalf of Reading Sustainability, to conduct a survey of the weir pool of Caversham Weir to identify flow dependant coarse fish spawning habitats and assess the physical (geomorphological) impact of the installation and operation of a hydropower scheme.

The assessment of the flow dependant habitats requires the analysis of depth and velocity profiling together with sediment samples to indicate the value of the habitat for coarse fish spawning. These surveys were conducted in the main channel immediately downstream of the weir and the two bays on the north bank of the channel downstream of the weir. Electro-fishing surveys by the Environment Agency have been undertaken on fish populations between 2003 and 2013. The results of these surveys are summarised in Table 1. These surveys were conducted in weir pool and therefore provide an indication of the fish species present within the weir pool and reach immediately downstream. These surveys indicate that the most common coarse fish within the vicinity of Caversham weir are Chub and Pike.

Depth and velocity profiling as well as sediment sampling was undertaken on the 1st June 2015 by WHS. The methodology used is presented in section 2. The survey results are presented in Section 3 followed by an assessment on the quality of spawning habitats in Section 4. This is then followed by an assessment on how the operation of a hydropower scheme on this weir would physically impact on the identified habitats (see section 4) and how this relates to the WFD objectives (see section 6).

Table 1 – Caversham Weir Pool Electro Fishing Results (No/Mi) table for numbers

Species:	17/07 /2003	19/07 /2004	19/07 /2005	21/07 /2006	23/07 /2008	16/07 /2009	21/07 /2010	22/07 /2011	30/07 /2012	11/07 /2013
Bleak [<i>Alburnus alburnus</i>]	0.06	0	0.1	0	0	0	0	0	0	0
Chub [<i>Leuciscus cephalus</i>]	2.56	2.57	0.2	0.56	1	0.5	1.38	0.08	0.89	0.36
Dace [<i>Leuciscus leuciscus</i>]	0.06	0	0	0	0.38	0.25	0.63	0.08	0	0
Perch [<i>Perca fluviatilis</i>]	0.22	0.29	0.2	0.06	0.13	0	0.13	0	0	0
Pike [<i>Esox lucius</i>]	0.28	2.86	1.5	0.39	1.13	0.88	1.5	2.25	0.78	0.09
Roach [<i>Rutilus rutilus</i>]	0	0	0	0.11	0	0	0	0	0	0
Tench [<i>Tinca tinca</i>]	0.06	0	0.1	0	0	0	0	0	0	0

2 Methodology

2.1 Spawning Habitat Requirements

The spawning habitat requirements differ between different fish species. The degree of vegetation cover, water temperature, sediment type and oxygen levels all determine the suitability of the habitat. An assessment has been made to identify any suitable spawning habitats for the coarse fish present previously identified through electrofishing surveys. The habitat requirements are summarised in Table 2.

The most common species present Chub and Pike favour either shallow (<100 cm deep) gravel riffles or shallow (50-500 cm deep) weedy margins of very low velocities (<5 cm/s), respectively.

Table 2: Coarse fish species and spawning habitats¹

Species	Preferred Spawning Habitat	Preferred Water Depth (cm)	Preferred Water Velocity (cm/s)
Bleak [<i>Alburnus alburnus</i>]	Shallow riffles or along stony low velocity shores, occasionally above submerged vegetation		<20
Chub [<i>Leuciscus cephalus</i>]	Shallow gravel riffles	<100	5-75
Dace [<i>Leuciscus leuciscus</i>]	Clean shallow gravels	25-40	20-50
Perch [<i>Perca fluviatilis</i>]	Shallow calm margins with submerged plants and snags	200-300	
Pike [<i>Esox lucius</i>]	Shallow weedy margins	50-500	<5
Roach [<i>Rutilus rutilus</i>]	Exposed tree roots, weeds and submerged plants	15-45	>20
Tench [<i>Tinca tinca</i>]	Thick weed and dependant on temperature		<20

2.2 Survey Methodology

Detailed bathymetry survey data was available from the Environment Agency throughout the weir pool (see Figure 2). In addition, depth, velocity and sediment suitability spot samples were surveyed at 58 locations downstream of the weir, identified as Survey Locations in Figure 1. Measurements were taken at approximately 10 m intervals along two transects down the main channel and at locations marked within the two bays downstream of the weir.

Velocity and depth were measured using a hand held current meter and measuring stick. These data identify the velocity and water depth observed on that day. In situ observations were taken of the sediment on the bed of the river using a waterproof camera. Due to the depth at a number of locations (resulting in very low light conditions) and high turbidity, the quality of the videos and subsequent still photographs is reduced and at a number of the locations a photograph was not possible. The photographic record of the sediment is presented in Appendix 1.

¹ Cowx, G. I., Noble, R. A., Harvey, J. P., Welcomme, R. L. & Halls, A. S. (2004) Environment Agency Science Report SC010112/SR: Flow and Level Criteria for Coarse Fish and Conservation Species.

2.3 Habitat Mapping

An index was created to produce an overall habitat map to incorporate velocities, water depth and substrate suitability for spawning. These three parameters were classified as either suitable or unsuitable based on published habitat preferences¹. Conservative suitable parameter values were given as:

- Flow velocities between 0 and 0.75 m/s;
- Water depths between 0.1 and 1.3 m; and
- Substrate to have no greater than 30 % by area of fines (<2 mm) or presence of submerged plants or tree roots.

The velocity (v), water depth (d) and substrate suitability (s) parameters were each given a value of 1 (suitable) or -1 (unsuitable). The habitat index (I) was then calculated according to the following:

$$I=v+d+s$$

This allows for four index values to be considered; Good, Marginal, Poor and Very Poor quality, as identified in Table 3.

Table 3: Index Value Suitability

Index Value	Spawning suitability
-3	Very Poor
-1	Poor
1	Marginal
3	Good

3 Survey Results

Figure 2 presents the Environment Agency bathymetry data throughout the channel downstream of the weir and the suitability of the substrate for spawning at the survey locations. The velocity recorded at the survey locations is presented in Figure 3, along with the final habitat suitability index.

The data collected using the waterproof camera (appendix 1) was limited due to the depth of the water in many areas of the channel reducing the available light, combined with high levels of particulate matter within the watercourse. Conservative sediment analysis has been undertaken, such that when uncertain, the sediment has been labelled as suitable for fish spawning (see Figure 2). Note that some videos were significantly clearer than the stills that could be captured from the videos, and decisions on suitability were based upon the videos.

Channel depths in the vicinity of the weir, prior to the bend in the watercourse, varied from 5.5 m towards the outside of the bend to 1.61 m towards the opposite bank. Depths beyond the bend are shallower, with the shallowest depths of 0.3 m occurring in the two bays. Significant eddying was present in the deep pool immediately downstream of the weir, indicating the presence of erosive currents close to the weir.

The highest velocities were recorded close to the weir which gradually slows downstream. Velocities within the bays were the slowest, often <0.1 m/s. A shallower, lower velocity depositional area on the north bank of the river downstream of the weir contained more weeds and submerged plants.

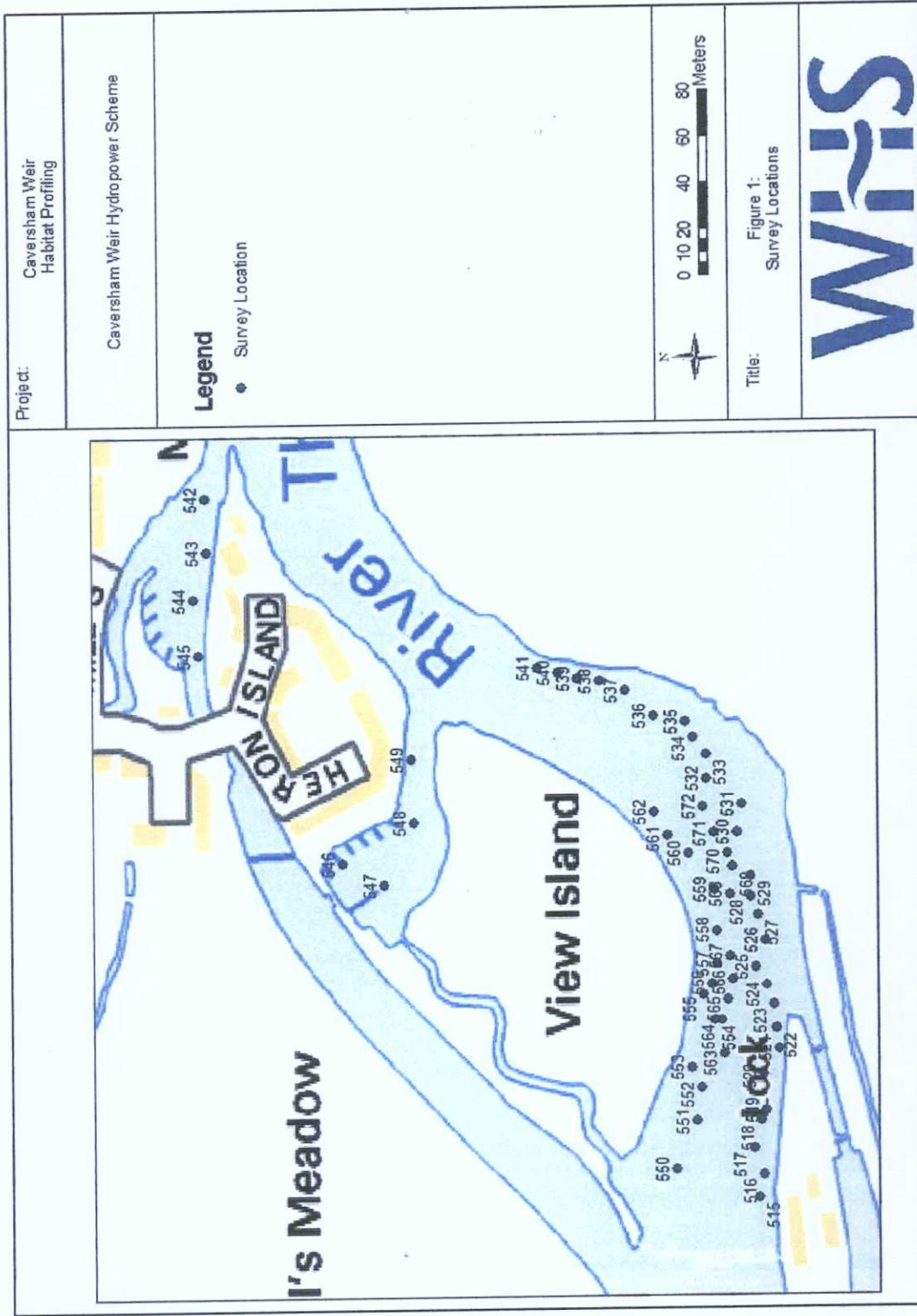


Figure 1: Survey Locations

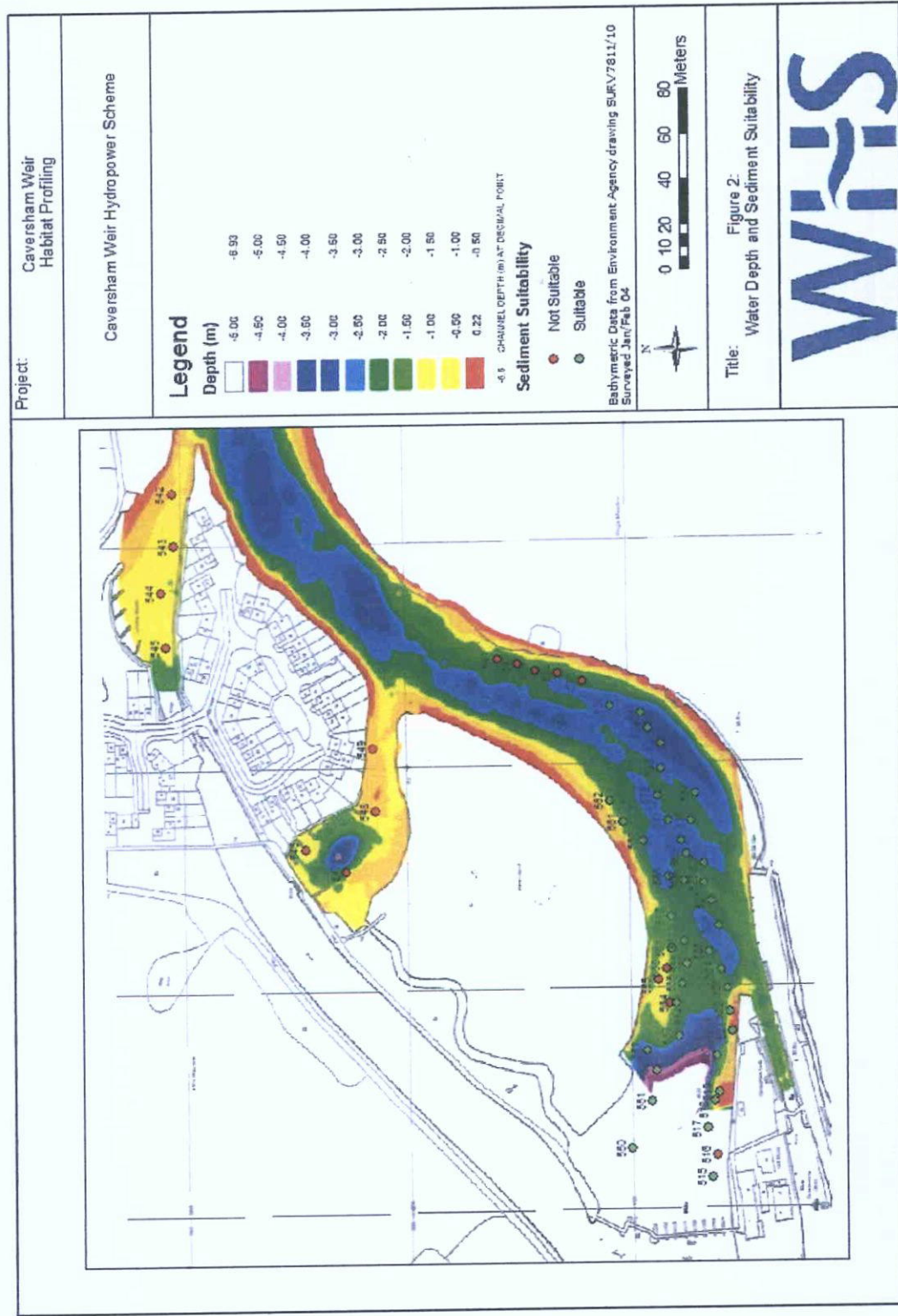


Figure 2: Water Depth and Sediment Suitability

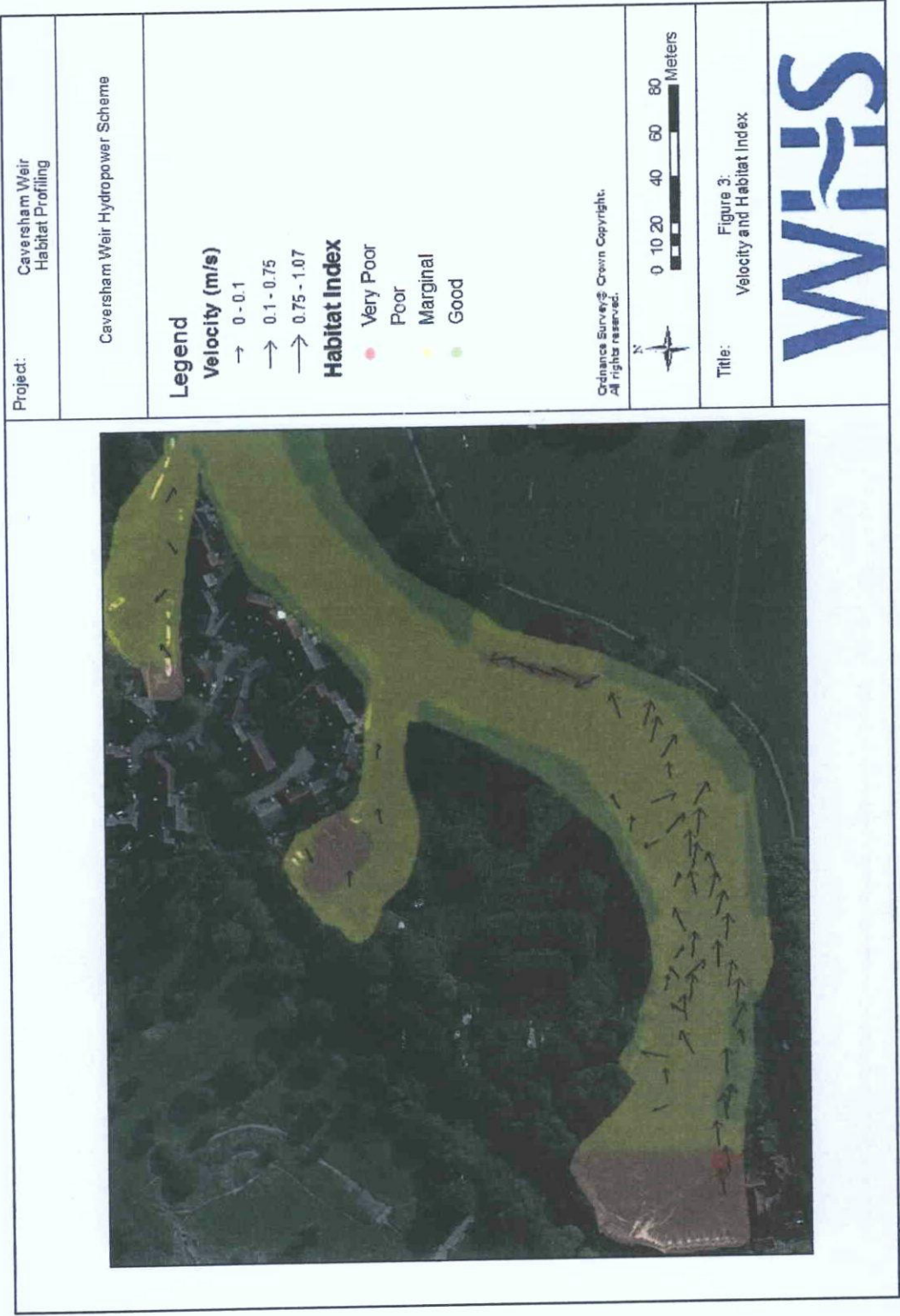


Figure 3: Velocity and Habitat Index Map

4 Habitat Assessment

A habitat map has been generated based on the habitat index calculated as a result of depth, velocity and substrate suitability (see Figure 3). This map identifies that the majority of the weir pool provides marginal habitat for coarse fish spawning, with some areas of poor habitat and small areas of good habitat in the margins of the river.

There is a depositional area downstream of the weir on the north bank, which was identified within the Environment Agency bathymetry map and spot depth measurements. In this depositional area the substrate was noted to have a high percentage of fines at the upstream point of the area (e.g. Waypoints 555 and 556). However, as you move further downstream the substrate is cleaner with some cobbles and submerged plants (growing densely in some areas).

The depositional area downstream of the weir on the south bank was also confirmed by spot depth measurements. The substrate in the main channel close to the weir was noted to contain many large (up to ~30 cm) rocks. These may be rip-rap, placed to reduce scouring of the banks. This was generally in the area along the sheet piling bank separating the main channel from the Caversham lock. Video still photographs, where available, show small weeds growing on and between these rocks. Therefore as a conservative measure this area has been considered suitable.

Substrate downstream within the main channel contained smaller sized sediment and slower velocities, however the depth of the water channel was often above the accepted threshold of 1.3 m in all but the margins.

Waypoints within the side channel bays recorded velocities and depths suitable for fish spawning. Limited video data recorded the presence of a high percentage of fines and visual observations made on the site visit recorded high levels of silts and sands. These bays are therefore not considered to be suitable fish spawning habitat on the basis of the substrate present.

5 Assessment of Potential Effects

The current weir consists of the following: Hand Radials 1-5, Large Radials 7-12, Buck Gates 13-20 and Gate 6 became the Fish Pass. The pulling order from fully closed is:

- Hand radials: 1-3-5-2-4
- Large Radials: 7-9-11-8-10-12
- Buck Gates: 13-20 (in order)

It is proposed that two Archimedes Screws are installed on the northern side of the weir as presented in **Figure 4**. The maximum take of the screws would be 5.6 m³/s and a comparison of the flow duration curves (FDC) for the current and residual flow over the weir is presented in Figure 5.

The operation of the weir under different flow conditions obviously changes the flows and downstream velocities across the cross section of the River Thames. Under average and low flow conditions the majority of the flow over the weir is generally concentrated in the northern half of the weir, as is illustrated within the aerial photography in Figure 3. The installation of the two screws will move a proportion of that flow from near the centre of the channel north further towards the bank (see **Figure 4**). This will to some degree 'dilute' the concentrated flow, providing a more even flow across the northern half of the weir.

The impact of the scheme is likely to increase velocities close to the northern bank and reduce velocities towards the centre of the weir, providing a more even flow in the northern half than the current operation of the weir under average flow conditions. As is demonstrated in Figure 2, the

pool immediately downstream of the weir is in excess of 5 m deep across the channel, demonstrating significant scour across the entire channel.

As shown within Figure 5, the screws represent a small proportion of the flow across the majority of the flow duration curve. At higher flows (e.g. Q10) the screws only represent 6% of the total flow, and it is at these higher flows that the significant erosive and depositional processes generally occur.

The species present within the weir pool favour shallow gravels or marginal exposed tree roots, weeds or submerged plants for spawning. The most common species present, Chub and Pike, favour either shallow (<100 cm deep) gravel riffles or shallow (50-500 cm deep) weedy margins of very low velocities (<5 cm/s), respectively. The good spawning habitat has therefore been identified in the margins of the River Thames, with depths within the centre of the channel providing only marginal habitat.

As this environment is heavily influenced by the operation of the weir the likelihood of useable habitat for spawning being available within close proximity to the weir is low. The majority of the marginal areas considered to be of Good habitat are far enough downstream and around the bend that the transfer of flows from central to the northern bank will have very little impact.

The depositional area on the inside of the bend may experience increased flows, but its position on the bend and the protruding bank just upstream (north of Waypoint 552) will protect it from significant increased scour. Due to the presence of fines in the upstream section of the depositional area, the good habitat begins beyond the apex of the bend. The marginal habitat with high fines at the upstream end may be improved with increased flow.

The good habitat on the southern bank between the weir and the junction with the lock, may experience reduced flows and potentially increased deposition. Given that the proportion of flow affected is not significant, it is not considered that this will significantly negatively affect any spawning in this area.

The changes in flow and velocity are considered to be no more significant than changes currently observed during changes in the operation of the sluices in the weir. As the type of scheme proposed on this weir is non-consumptive, the volume of flow will not be altered. There was very little flow through the upstream side channel and effectively no flow through the downstream channels (only leakage), therefore it is not considered that any small drawdown through the operation of the screws would affect these marginal channels. It is not considered that there would be any changes in wetted perimeter due to the presence of sheet piling along both banks immediately downstream of the weir.

The installation of a hydro scheme on the weir would therefore have limited potential impact upon any spawning coarse fish population.

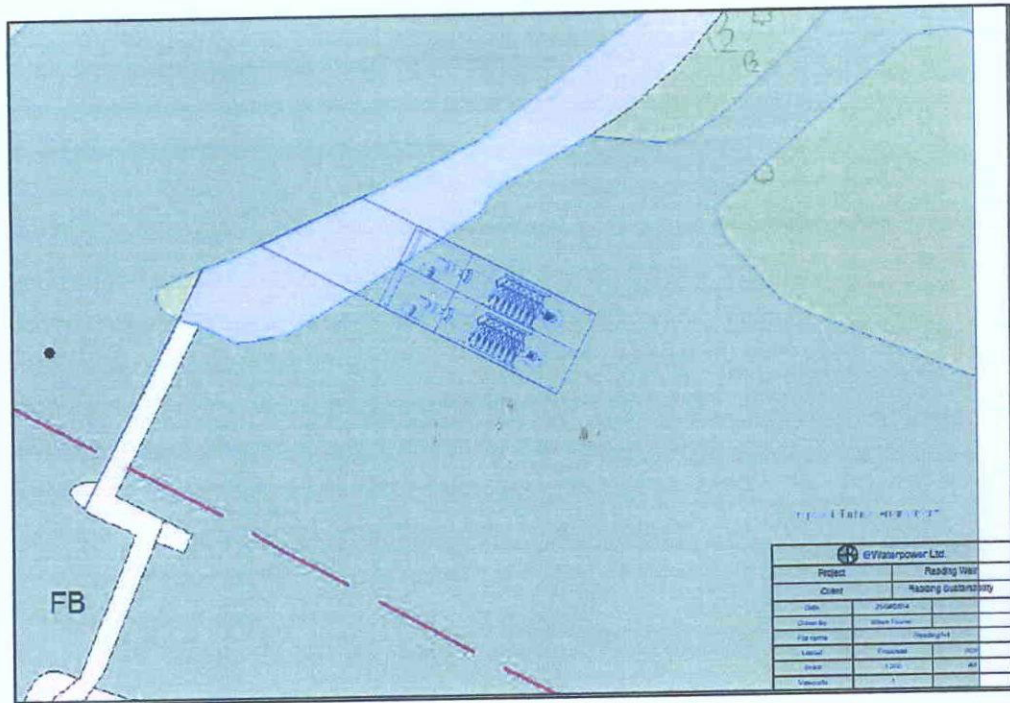


Figure 4: Hydropower Scheme Proposed Layout (provided by eWaterpower Ltd)

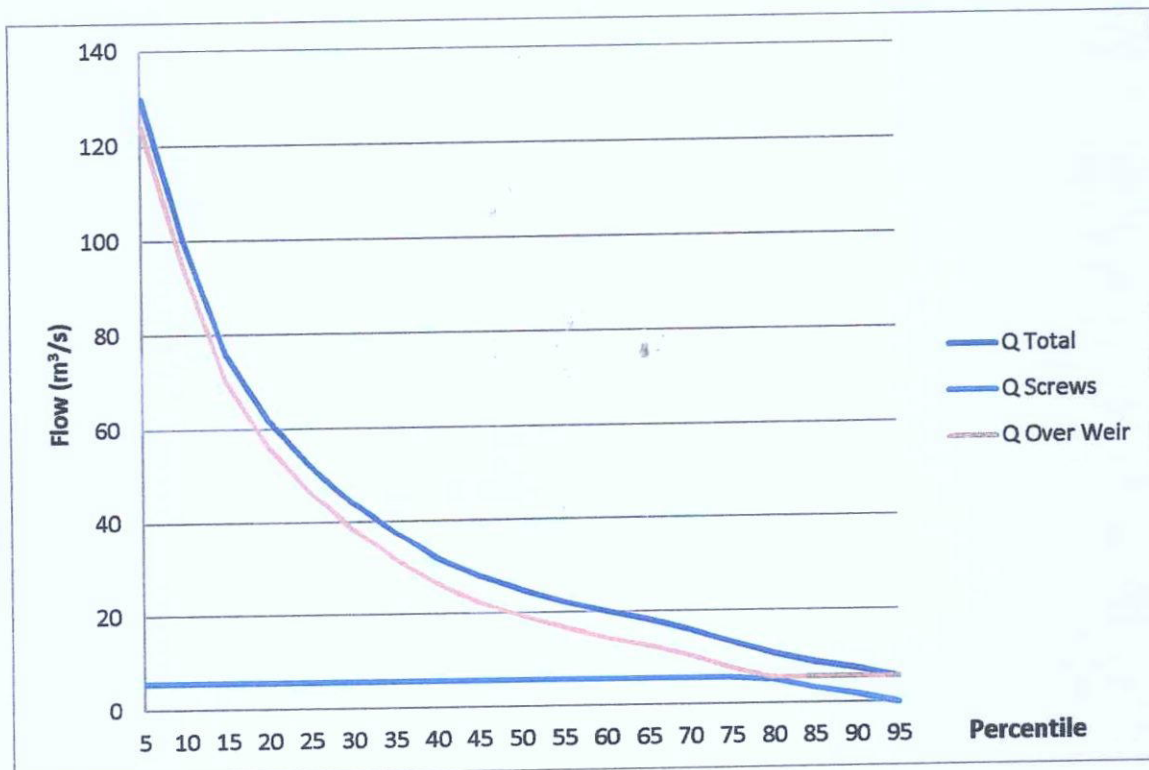


Figure 5: Modelled Flow Duration Curve (data provided by eWaterpower Ltd)

6 WFD Assessment

The EU Water Framework Directive was transposed into law in England and Wales by the Water Environment (Water Framework Directive) (England and Wales) Regulations 2003. The Directive requires that Environmental Objectives be set for all surface and ground waters in England and Wales to enable them to achieve Good Status (or Good Ecological Potential for Heavily Modified and Artificial Water Bodies) by a defined date.

This assessment will consider any potential impacts to the aquatic ecology of the waterbody against the main objectives of the WFD. Current EA guidance ⁽²⁾ notes that any hydropower scheme should demonstrate that the proposal will not:

- **Objective 1:** Contribute to a deterioration in the current status or potential of the waterbody or water bodies affected by your scheme
- **Objective 2:** Prevent the achievement of objective set for the waterbody or water bodies affected by your scheme

6.1 Baseline RBMP

Table 4: Current status of the River Thames (Wallingford to Caversham)

River Thames RBM	
Waterbody ID	GB106039030331
Waterbody Name	Thames Wallingford to Caversham
Management Catchment	Thame and South Chilterns
River Basin District	Thames
Typology Description	Low, Large, Calcareous
Hydromorphological Status	Heavily Modified
Current Ecological Quality	Moderate Potential
Current Chemical Quality	Good
2015 Predicted Ecological Quality	Moderate Potential
2015 Predicted Chemical Quality	Good
Overall Risk	At Risk
Overall Objective	Good by 2027
Protected Area	Yes
Number of Measures Listed (waterbody level only)	8

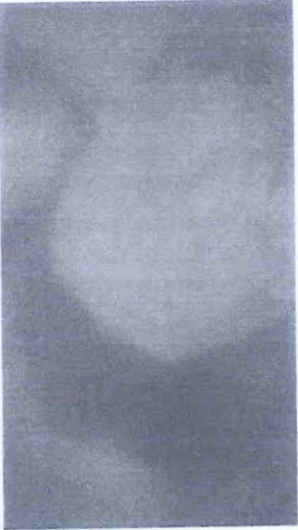
The Environment Agency requested that further assessments were undertaken regarding the flow dependant habitats within the weir pool. The table below presents the relevant elements of the WFD which are required to form part of the assessment.

² Environment Agency, Guidance for run-of-river hydropower: Water Framework Directive, nature conservation and heritage. December 2013.

Table 5: WFD Assessment

Will the Activity Affect?	Assessment	Compliance of Objective 1	Compliance of Objective 2
Hydromorphological Elements			
Quantity and dynamics of water flow in the watercourse	The two Archimedes Screws will discharge water to the northern side of the weir, moving a proportion of the water from the central northern area of the weir to the northern bank. The installation is unlikely to reduce the availability of the spawning habitat in the margins downstream of the weir. The proportion of water through the screws is small; less than 10% during the higher flows when the majority of scour and deposition occur. The changes in flow and velocity are considered to be no more significant than changes currently observed during changes in the operation of the sluices in the weir.	The installation of the two Archimedes Screws will not cause deterioration of the current status of the waterbody.	The installation of the two Archimedes Screws will not prevent the waterbody from reaching future objectives.
Biological Elements			
Flow dependant habitat	The majority of the channel is marginal spawning habitat due to the depth of the water. Any good spawning habitats are limited to the shallow margins and tree roots and submerged weeds and plants. The majority of these habitats identified are too far downstream and round the bend to be affected by the scheme. Those closest to the weir should not be significantly affected due to the small proportion of flow being moved to the northern bank.	The HEP scheme will not cause deterioration of the current status.	The HEP scheme will not prevent the waterbody from reaching future objectives.

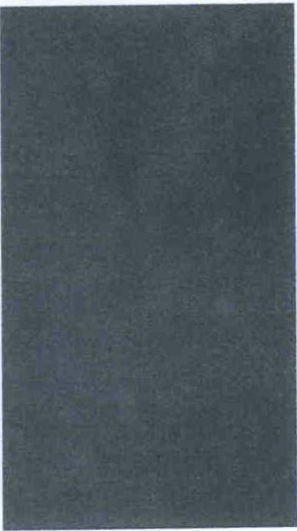
Appendix 1 Sediment Sample Photographic Record

Waypoint 515 	Waypoint 516 	Waypoint 517 
Waypoint 518 Not in focus	Waypoint 519 Not in focus 	Waypoint 520 
Waypoint 521 Not in focus	Waypoint 522 	Waypoint 523 

Caversham Weir Pool Habitat Impact Assessment

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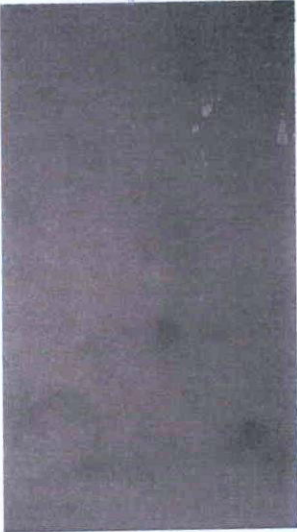
Caversham Weir Pool Habitat Impact Assessment

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Caversham Weir Pool Habitat Impact Assessment

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Caversham Weir Pool Habitat Impact Assessment

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Caversham Weir Pool Habitat Impact Assessment

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Caversham Weir Pool Habitat Impact Assessment

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