Watermeads Weir Options Outline
Fish Passage - River Wandle

January 2018

heritage lottery fund
LOTTERY FUNDED

Living Wandle
Landscape Partnership

Wandle Valley

Contents

Introduction

This report is part of project to improve passage and access by migratory fish including eels between the Thames and the Wandle thereby improving ecological functionality, diversity and populations of migratory fish species in the Wandle. It was funded by the Heritage Lottery Fund as part of the Living Wandle Landscape Partnership Scheme (LWLPS), a programme that involves the local community in the understanding, restoration and enhancement of the River Wandle landscape.

Objectives

The objective of this report is to assess the weir structure, in regards to fish passage and make an assessment of the current outline options for addressing any issues identified, at Watermeads on the River Wandle, Morden, South West London. The report proposes the next steps required for option(s) development, in order for a solution to be taken forward to address the Wandle's current failing status as classified by the Water Framework Directive (WFD). Doing so will improve the resilience of the Wandle's fish community.

Site Location

Watermeads weir (Grid Reference: TQ 2744 6778) is located in the grounds of Watermeads Nature Reserve, a National Trust property in between Morden and Mitcham, South West London (*Figure 1*).

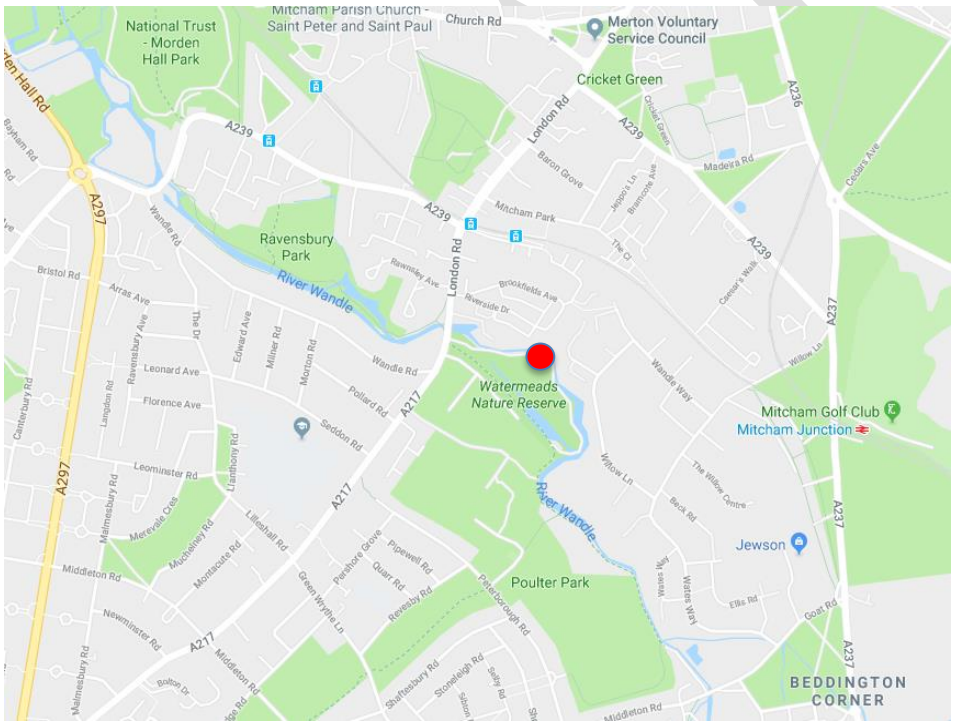


Figure 1. Location map of Watermeads structure (red dot) with in Watermeads nature reserve, South West London.

Site Description

The site is designated as a 'local nature reserve' and contains a number of different waterbodies and aquatic habitats which are a legacy from the Wandle Flour Mill which operated here. The layout of these is shown in *Figure 2*. and briefly summarised below:

The River Wandle runs for 600 m around the eastern boundary of the site with 400 m of this being impounded by Watermeads weir. This main channel carries approximately 80% of the flow under normal conditions with the remaining 20% conveyed by the Paper Mill Cut.

A control structure near the entrance to the Paper Mill Cut and a series of sluices allows for water levels in channels A & B to be managed as wetland habitat. The main river channel upstream of the weir is heavily impounded with water depths of 1.5 m and a significant depth of deposited silt. Downstream of the weir the channel has concrete bed and banks, and the river is much faster flowing with water depths of c. 400 mm under mean flow conditions.

A fixed crest weir (TQ 27282 67759) with a head drop of c. 1.5 m also maintains the head of water in the Paper Mill Cut and a 0.5 acre pond.

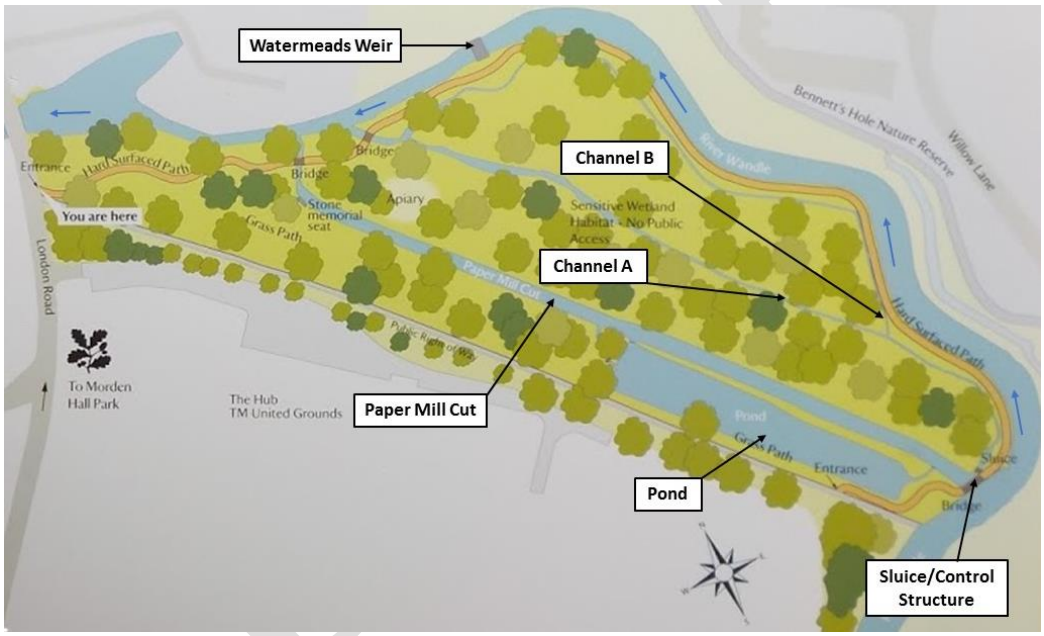


Figure 2: Site map showing location of Watermeads Weir and the River Wandle at Watermeads Nature Reserve.

Watermeads Weir

The current structure was constructed in 1964 and comprises a counterbalanced sluice gate and a fixed crest over-fall side weir. The sluice gate head comprises of a pair of wire ropes and rope drums supported by an overhead steel superstructure. A float located in an adjacent chamber automatically controls the sluice gate, which is regulated by upstream water levels. Upstream water levels are also monitored and logged via telemetry.

The fixed-crest weir provides fine control of upstream water levels during periods of low flow. The counterbalance sluice gate provides the bulk of the structures discharge capacity during periods of high upstream water levels. The sluice gate is of steel construction, 1220 mm high by 4570 mm wide and has an accompanying concrete counterbalance weight (9 tonnes). A concrete footbridge provides access to the structure for operational and maintenance requirements. (Environment Agency (2004) Watermeads Weir Operations Manual, EA, London).

The structure may not provide any flood risk benefits. Modelling has been undertaken by FCRM to test the impacts of the weirs failing opened and closed, although the results are yet to be published. (Environment Agency Operations Team & FCRM pers. comm.) It's likely that its only apparent function is to maintain historic upstream water levels, which are a legacy of milling at the site, and support water levels in adjacent waterbodies.

Ownership of the weir is still to be determined, although the Environment Agency Operations Manual (2004) states "The Environment Agency owns the land occupied by the structure and wholly owns the assets associated with Watermeads Weir". It is therefore understood that the Agency is the asset owner. Maintenance by the Environment Agency's Operations Team is undertaken every two months, which includes management of the surrounding vegetation for access and a manual test of the sluice operation.

The counterbalance sluice gate can be fully opened in five minutes and the upstream head of water can be drained down within one hour. A full inspection is undertaken annually. The current setup means the sluice gate begins to operate at a minimal increase in upstream water level.

Water Framework Directive (WFD) classification

Watermeads is in the 'Wandle' (Croydon to Wandsworth) waterbody and is classified as 'Heavily Modified'. The waterbody is failing its WFD targets in 2016, due to ecological failures for fish (Poor) and macroinvertebrates (Moderate) and a physio-chemical failure for Phosphate (Bad). Fish passage at Watermeads is being addressed in the context of providing access for multiple fish species to the upper reaches of the Wandle to increase the resilience of the river and its fish populations, to address the Fish failure. Confirmed reasons for failure for Fish include 'Physical modification - Barriers to fish migration'.

Upstream and downstream context

Watermeads weir is the first barrier downstream of the Beddington sewage treatment works effluent channel, which has seen a number of pollution events in recent history. The presence of the weir means in the there is no opportunity of natural reconolisation from downstream stock.

The next barrier upstream of Watermeads is at Goat Bridge, approx. 1.3 km. This tilting gate weir is impassable to all fish species, although it is envisaged that this site will be addressed and provide passage within the next couple of years.

Ravensbury Mill is a tilting gate weir located approximately 1.1 km downstream of Watermeads weir in Ravensbury Park. A pumped bristle pass allows eels/elvers to migrate upstream of this barrier although it is also presently impassable to other fish species. In 2015, a small stepped weir was removed from a side stream here to improve fish passage at the site, although further improvements would be beneficial to maximise the efficiency of the bypass channel.

Addressing fish passage at Watermeads would create a continuous length of river approximately 2.4 km in length.

Fisheries data

Environment Agency electric fishing survey data does not clearly demonstrate the barrier caused by Watermeads Weir. This true impact is masked by historical fish stocking of upstream and downstream reaches.

Flow / level data

Flow data for the South Wimbledon gauging station approximately 3.7 km downstream of Watermeads Weir is shown below. These flows are not reflective of those encountered at Watermeads due to the additional inputs further downstream.

Period of Record:	1962 - 2016
Percent Complete:	93 %
Base Flow Index:	0.87
Mean Flow:	1.881 m3/s
95% Exceedance (Q95):	0.753 m3/s
70% Exceedance (Q70):	1.44 m3/s
50% Exceedance (Q50):	1.73 m3/s
10% Exceedance (Q10):	2.82 m3/s

Table 1: Data for South Wimbledon from National River Flow Archive

Survey of structures

The weir structure was inspected, photographed and surveyed on 17th November 2017 during low to moderate flows. Dimensions were taken using a laser measure, tape measure and staff. Levels were taken using a dumpy level.

Utility searches and site observations

A desktop utilities search was undertaken in April 2017 by local Environment Agency staff. All utility maps are provided in *Appendix B*. Some discrepancies were observed between these search results and the services observed during the November 2017 site visits. These are discussed below:

- Electricity - No records are marked on the UK Power Networks utility map. Although an electricity kiosk is present on the right bank, 15 m away from the weir (*Figure 3 - left*).

- Internet - Records show a BT Openreach cable running from Riverside Drive to the weir.
- Water – No records are marked on the Thames Water utility map, although a surface water outfall is present 25 m downstream of the weir structure (*Figure 3 - right*). It is likely this conveys surface drainage from the Riverside Drive area.
- Gas – No records are shown on the Scotia Gas Networks utility map.
- Others – Linesearch indicates additional Gas providers within the site.

Figure 3. Photos of know utilities not highlighted by desk based utility search.

Structure dimensions and photographs

Dimensions recorded during site survey are provided in *Figure 4,* photographs of the structure are provided as *Appendix C.*

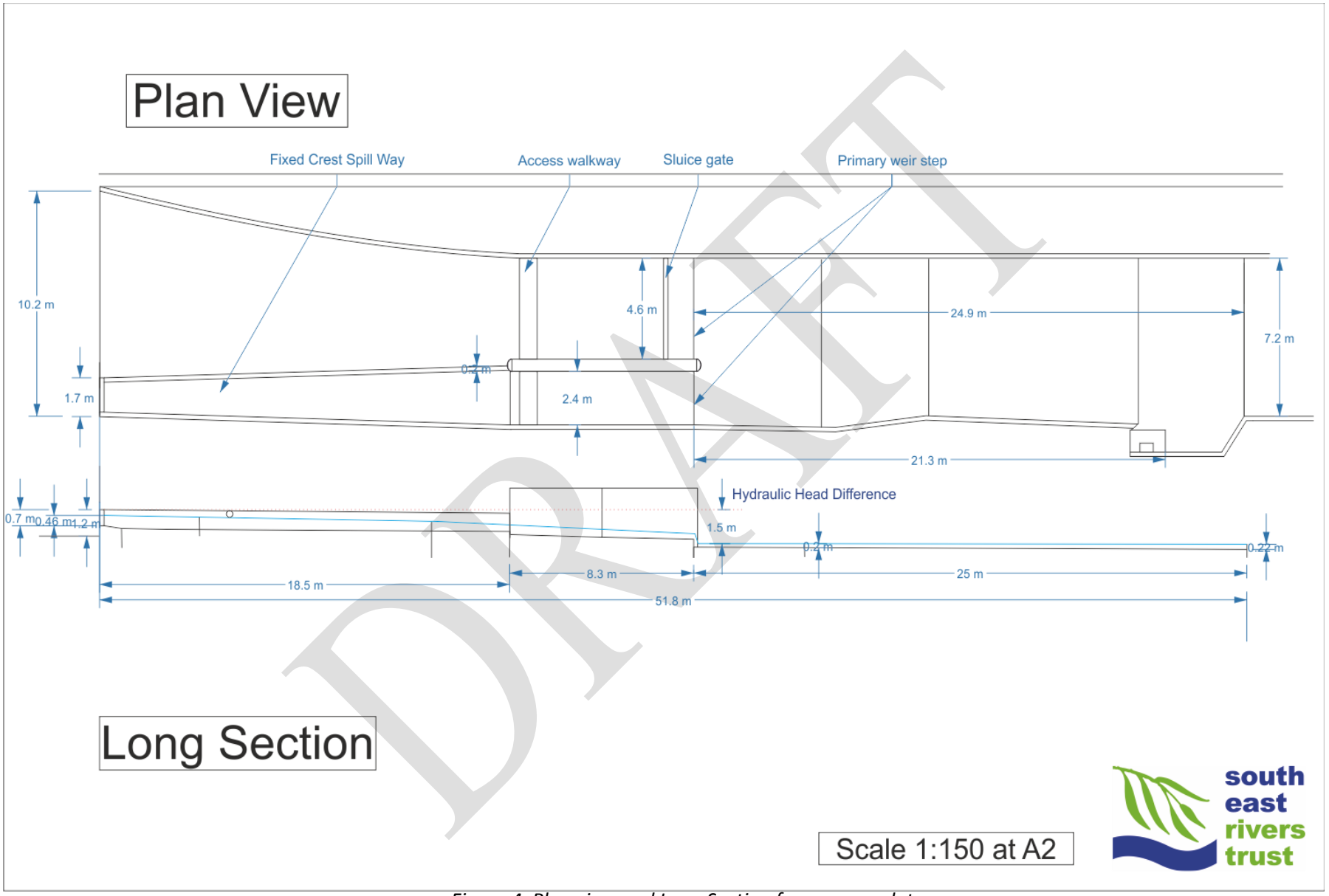


Figure 4. Plan view and Long Section from survey data.

Fish passage assessment

An assessment of passability for all species was carried out following the SNIFFER methodology (SNIFFER, 2012) on 14th November 2017 (2m/s – low to moderate flows). Water velocities were only taken through the fast water down the sloping weir and tail race, as they were observed to be high and potentially may limit fish passage by some species. Other sections of the structure were based on using water depths and the physical dimensions of the structure.

The barrier was divided in five separate transversal sections which included (from downstream), a long concrete plinth with a fast flow; followed by a small step weir onto a sloping weir; followed by another step weir into a turbulent pool; which exits into the upstream reach by another small step weir.

In summary, the SNIFFER assessment rated Watermeads as a partial barrier with high impact for adult salmonids and a complete barrier to adult grayling, cyprinids, adult lamprey, juvenile eel and juvenile salmonids (*Table 2*.). SNIFFER assessment forms are presented in *Appendix D*.

Despite the presence of an eel / elver pass, the assessment indicated that the weir presented a complete barrier to juvenile eel due to the high level of turbulence at the entrance and debris blocking the upstream exit. Improvement works were undertaken by SERT in March 2018 as part of the HLF Living Wandle Project, although these were after the November 2017 assessment. Conditions for passage are now favourable and the weir is now considered passable for eel passage.

	Upstream migration				Downstream migration			
	No barrier	Partial barrier (low impact)	Partial barrier (high impact)	Complete barrier	No barrier	Partial barrier (low impact)	Partial barrier (high impact)	Complete barrier
Adult Salmon			✓		✓			
Adult Trout			✓		✓			
Adult Grayling				✓			✓	
Cyprinids (coarse fish)				✓				✓
Adult Lamprey				✓				
Juvenile Eel				✓				
Juvenile Salmonids				✓			✓	
Juvenile Lamprey					✓			
Adult Eel					✓			

Table 2. Summary table of SNIFFER fish passage assessment of the Watermeads weir/sluice structure.

Options Screening

The screening process aims to justify and select those options that will progress to the appraisal stage. These are highlighted in green.

Option Description	Screening	Justification
No Active intervention Continue current management regime and associated costs for maintenance.	Remove option	Fish passage at this site needs to be achieved to meet WFD objectives/targets.
Full removal of structure	Remove option	Although the main objective of fish passage and the removal of the impoundment would be achieved, lowering upstream water levels would dry out the existing pond and adjacent waterbodies. This would affect the ongoing management on the reed bed habitat undertaken by the National Trust. Morden Hall Park Angling Club who have fishing rights for the pond would likely have a strong objection.
Permanent raising of sluice	Remove option	Similar problems to those mentioned above. A significant pre-barrage structure would need to be installed downstream of the weir to drown out the main step to achieve fish passage.
Borehole installation with (a) Full removal of structure or (b) Permanent raising of sluice with pre-barrage.	Progress to appraisal stage	Main objective of fish passage would be achieved. Additional benefit of removing/reducing the impoundment without negative effects on adjacent waterbodies.
Full removal of structure with rock ramp installation	Progress to appraisal stage	Would address key objective and maintain water levels in adjacent waterbodies, whilst potentially un-impounding (approximately 250m of the River Wandle)
Modification of existing structure	Progress to appraisal stage	With some modifications the existing structure provides a good base for a technical fish pass. Would address key objective and maintain water levels in adjacent waterbodies. There would be no reduction in the impoundment length (approximately 250m of the River Wandle) and therefore no further environmental/ecological benefits would be realised.
Install bypass channel around structure Utilising section of adjacent channel.	Progress to appraisal stage	Would address key objective and maintain water levels in adjacent waterbodies. There would be no reduction in the impoundment length (approximately 250m of the River Wandle) and therefore no further environmental/ecological benefits would be realised.

Table 3. List of options, screening and justification.

Options outline

The options progressed from the initial screening are assessed in more detail below. Options have NOT been fully assessed nor developed to detailed design. Options presented are intended to promote further discussion and inform future investigations, which will be required to determine the preferred final option. The following options will be discussed:

- Option 1. (a & b). Borehole pump
- Option 2. Rock ramp
- Option 3. Modification of existing structure
- Option 4. Bypass channel

Option 1.(a) - Borehole pump with full removal of structure

Full removal of the Watermeads weir structure would achieve fish passage, remove the impoundment and restore the natural geomorphology to this stretch of the Wandle. However, doing so would likely result in the adjacent waterbodies drying out due to the loss of head created by the weir crest which currently supplies the required flow.

A potential solution to mitigate for this effect could be to install a borehole water pump to maintain water levels. Further investigations would be required to determine the flow requirements, in addition to whether the groundwater source is a viable donor for the augmentation. A recent quote from a nearby site provided indicated costs ranging from £50,000 for 20c/m³ to £150,000 for 1000 c/m³, respectively. The location of the infrastructure, ownership, permission (abstraction license) and responsibility for ongoing maintenance costs would need to be agreed. This option would have the added benefits of providing a cleaner water supply to the wetlands with an improvement in invasive species control.

Channel narrowing upstream of the weir in the impounded reach would be required in order to adjust channel dimensions to suit the lowered water level. In addition to this, a replacement bridge (pedestrian access as minimum) and a new bank to seal off the upstream end of the Papermill Cut would be required.

If the structure were removed, mobilisation of the silt accumulated over 100+ years in the upstream impoundment could be a major concern and a risk to downstream wildlife. Any silt present could be used in the channel narrowing works and reduce the need to import new materials to the site. A detailed silt survey should be undertaken to inform the silt quantities present.

Benefits		**Negatives**	
Fish passage	Achieved	**Associated cost**	High
Removal of impoundment	Achieved	**Fine adjustment for flood control**	Lost
Restore natural processes & geomorphology	Achieved	**Reliance on pumps to maintain adjacent waterbodies**	Yes
Remove responsibility, operation and maintenance costs of weir	Achieved	**Uncertainty of water supply required**	Yes
Potential for improved water quality in adjacent waterbodies	Yes	**Continual running and maintenance costs for pump.**	Yes

Better control of invasive species in wetlands	Yes	**Potential impacts on landowner**	High
		Access bridge replacement	Yes
Project work up – 30k, Modelling – 20k, Weir removal – 70k, Bridge Replacement – 20k, New bank to close off Papermill Cut – 15k, Channel narrowing – 20k, Borehole installation – 150k **Total Estimated cost £300-400k**			

Option 1.(b) - Borehole pump with permanent raising of sluice

Permanent raising of the sluice gate would open the left-hand-channel through the structure. Doing so would promote fish passage and would remove a significant length of impoundment. Leaving the majority of the structure in place would eliminate the need to replace the access bridge and would keep delivery costs to a minimum.

A pre barrage structure similar to that shown in Figure 5 would need to be installed downstream of the weir in order to raise the tailwater level above the 0.4 m step which makes up part of the weir.

All the works associated with the borehole pump installation as described in option 1 (a) would be required.

Although the costs of weir demolition would be saved, the ongoing liability, operating and maintenance costs for the Environment Agency would continue.

Figure 5: An example of a pre barrage used by Environment Agency to 'drown out' a weir - CT Construction Ltd.

Benefits		Negatives	
Fish passage	Achieved	**Associated cost**	High
Removal of impoundment	Partially Achieved	**Fine adjustment for flood control**	Lost
Restore natural processes & geomorphology	Partially Achieved	**Reliance on pumps to maintain adjacent waterbodies**	Yes
Reduced operation / maintenance of weir	Not Achieved	**Uncertainty of water supply required**	Yes
Potential for improved water quality in adjacent waterbodies	Yes	**Continual running and maintenance costs for pump.**	Yes
		Potential Impacts on landowner	High
Project work up – 30k, Modelling – 20k, Pre barrage installation – 15k, New bank to close off papermill cut – 15k, Channel narrowing – 20k, Borehole installation – 150k = 200k **Total Estimated cost £250-270k**			

Option 2. – Rock ramp with full removal of structure

A large rock ramp structure similar to that shown in Figure 6 could be installed across the full width of the channel in order to maintain the water levels in the adjacent waterbodies. The preferred location would be directly downstream of the entrance to the Papermill Cut. Delivery this solution would enable over 250m of the channel to be unimpounded and restored.

In order to be passable to coarse fish, the ramp would be required to be c.30m in length (gradient 1:20). The logistics of bringing in such large amounts of material for the construction of a rock ramp at this site would be a challenge, likely requiring a temporary trackway.

More detailed investigations would be required to determine the potential hydraulic implications on the adjacent waterbodies if the rock ramp was installed anywhere upstream of the current weir location. Potential locations for a rock ramp are shown in Figure 7.

Figure 6. Rock ramp structure on the Hogsmill River near Kingston, London.

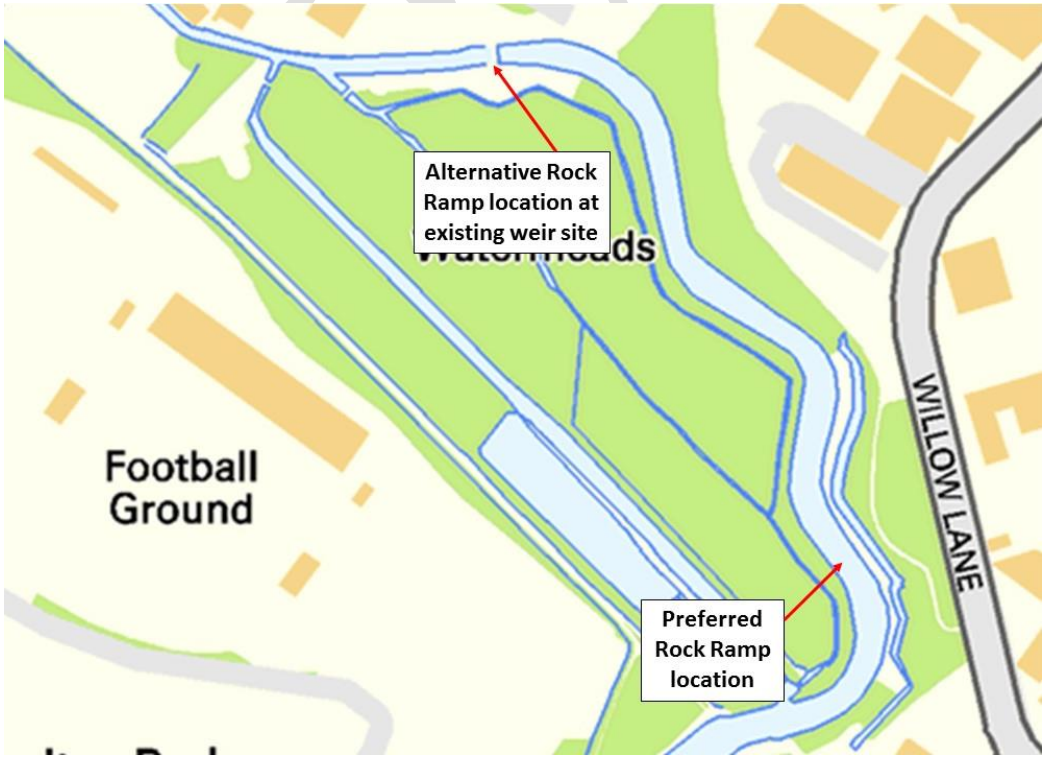


Figure 7: Potential locations for rock ramp.

Benefits		Negatives	
Fish passage	Achieved	**Associated cost**	High
Removal of impoundment	Partially Achieved	**Fine adjustment for flood control**	Lost
Restore natural processes & geomorphology	Partially Achieved	**Delivery Implications**	Yes
Remove responsibility, operation and maintenance costs of weir	Achieved	**Potential Impacts on landowner**	High
Reliance on pumps to maintain adjacent waterbodies	No	**Access bridge replacement**	Yes
Uncertainty of water supply required	No		
Project work up – 30k, Modelling – 20k, Rock ramp installation – 70k, Weir removal – 70k, Bridge Replacement – 20k, Channel narrowing – 30k = £170k			
Total Estimated cost £250-350k			

Option 3. Modification of existing structure

The channel through the structure, along the right-hand-bank created by the fixed crest weir presents an opportunity for a potential technical fish pass solution.

The overall slope and channel widths suggest a Hassinger Bristle pass (*Figure 8*.) would be the preferred option. With some minor modifications to the existing concrete structure *(Figure 10)*, a series of bristle rows could be extended all the way through the structure.

If after further investigations the hydraulic considerations prevent its use, a Larinier pass *(Figure 9)* could be explored. This option would require a pre barrage to be installed at the downstream end and may also require resting pools within the structure. Although passage could be achieved with a Larinier it is less desirable because it would not function for smaller fish species.

Figures 8 & 9. Examples of a Hassinger bristle pass (left) and a Larinier superactive baffle fish pass on the Wandle at Carshalton (right).

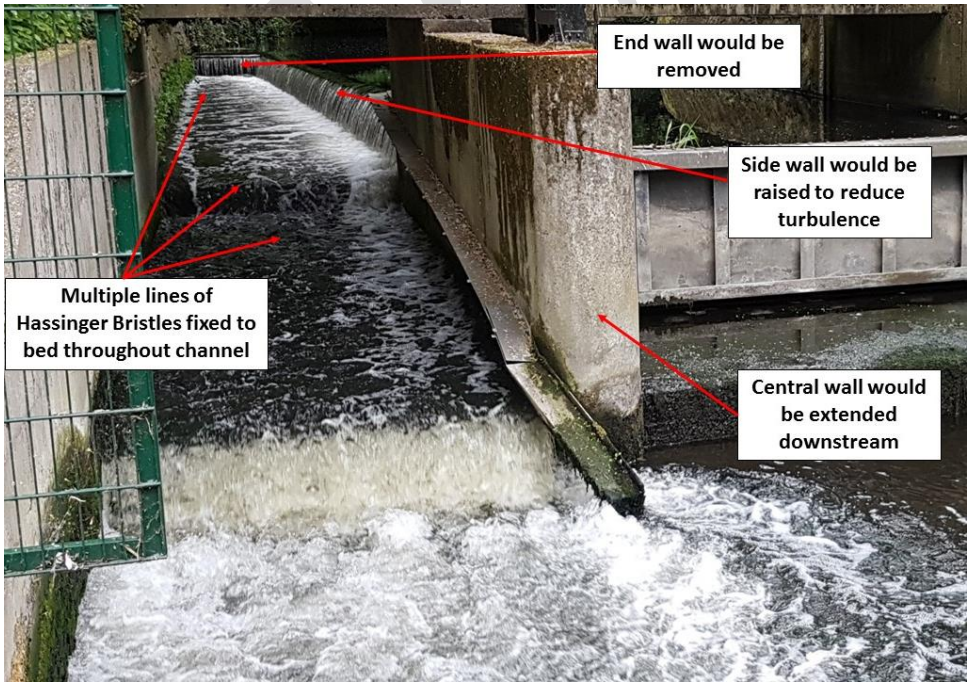


Figure 10: Potential modifications to fixed crest spillway.

Benefits		Negatives	
Fish passage	Achieved	**Removal of impoundment**	Not Achieved
Prohibitive cost	Low	**Restore natural processes & geomorphology**	Not Achieved
Delivery Implications	Low	**Remove responsibility, operation and maintenance costs of weir**	Not Achieved
Potential Impacts on landowner	Low		
Project work up – 30k, Modelling – 10k, design 5k, Hassinger bristles & installation – 25k, Weir modifications – 35k **Total Estimated cost £90-130k**			

Option 4. Bypass channel

A 'close to nature' bypass channel around the structure is an option, but due to the required head drop to be a stable channel without the need for an engineered hydraulic control this would require channel length of c.260 m (at 1:175).

A more viable shorter bypass channel *(Figure 11)* could be achieved using a more engineered approach. This could be using a series of steps/pools, to create in effect a nature like pool pass. The majority of the head could be rapidly dropped using a Hassinger pass(esS) with a 'natural' channel in between. Additional footbridges to maintain access routes and works to stabilise the newly cut banks would be required.

Both of these solutions would require modifications to the adjacent channel which is currently used for the wetland management. Further discussions with National Trust are required to see if this option could be explored further.

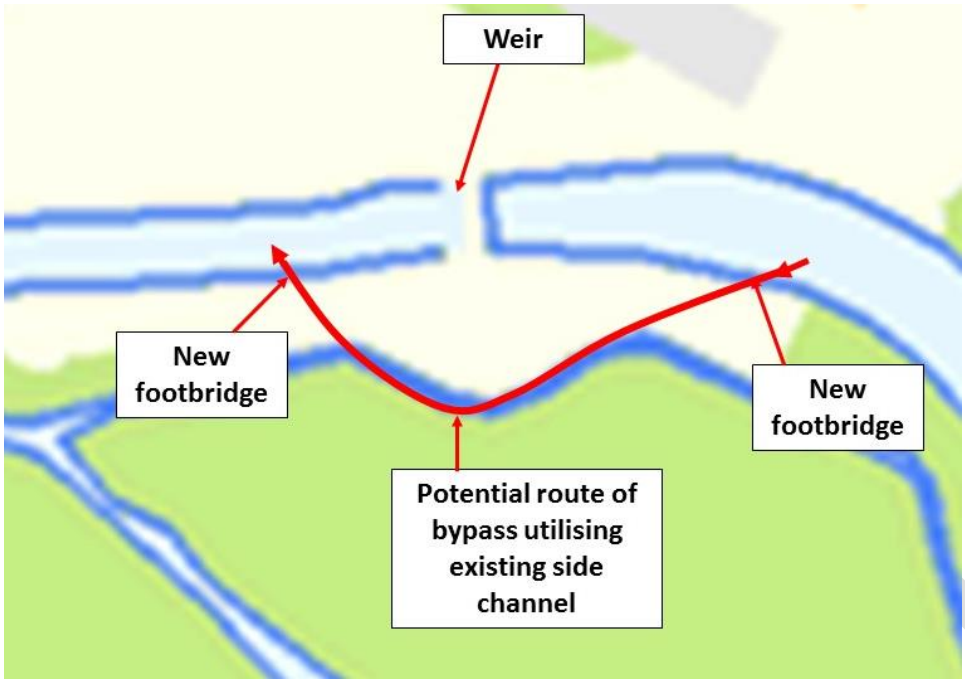


Figure 11: Potential modifications to fixed crest spillway.

Benefits		**Negatives**	
Fish passage	Achieved	**Prohibitive cost**	Potential
Creation of additional habitat	Achieved	**Removal of impoundment**	Not Achieved
Prohibitive Cost	Medium	**Restore geomorphology**	Not Achieved
		Reduced operation / maintenance	Not Achieved
		Potential Impacts on landowner	Medium/High
		Delivery Implications	Yes
Project work up – 30k, Modelling – 10k, design 5k, Hassinger bristles & installation – 25k, bank – 40k **Estimated cost £150-200k**			

Selection of preferred option

A summary of the options appraisal is shown in Table 4 below. Based on the options appraisal the preferred option is to modify the existing structure and install a Hassinger bristle fish pass (Option 3). This option has been selected as it meets the objectives of the project by achieving fish passage for all life stages and species.

Although Options 1a and 1b would achieve a greater number of benefits in terms of river restoration, they were not selected due to uncertainties over the viability of installing the borehole pump. Further investigations and discussions with stakeholders would be required to determine if this is feasible.

Option 2 was not selected due to the delivery implications of the weir demolition and rock ramp construction. The constraints of maintaining the upstream water levels, may not justify the amount of work required.

Option 3 was selected over Option 4 due to the existing structure and slope only requiring some minor modifications to create suitable conditions for installation of a technical fish pass. Estimated costs, potential risks and impacts on the current site management would also be significantly less.

	Project Requirements									
Option	**Fish Passage**	**Impoundment removed**	**Weir removal**	**New access bridge**	**Borehole pump**	**Pre Barrage**	**Channel narrowing**	**Impact on landowner**	**Impact of environment**	**Estimated Cost**
Option 1.(a) Borehole pump with full removal of structure	Achieved	Yes	Yes	Yes	Yes	No	Yes	High	High	£300-400k
Option 1.(b) Borehole pump with permanent raising of sluice	Achieved	Yes	No	No	Yes	Yes	Yes	High	Medium	£250-270k
Option 2. Full removal of structure with rock ramp installation	Achieved	Partially	Yes	Yes	No	No	Yes	High	High	£250-350k
Option 3. Modification of existing structure	Achieved	No	No	No	No	Possible	No	Low	Low	£90-130k
Option 4. Bypass channel	Achieved	No	No	Yes	No	No	No	Medium	Medium	£150-200k

Table 4. Comparison of options with project requirements.

Preferred Option

This section provides additional detail on the implementation of the preferred option (Option 3) and presents a conceptual design drawing *(Figure 12)* to assist with the progression of the options to detailed design.

The existing fixed crest spillway has a suitable structure in terms of width and gradient to allow for the installation of Hassinger bristles. If the downstream step of the weir was filled in the slope/gradient would be within the required range of 1 in 12.5.

An estimation of 300 l/s would be required for a 0.5m deep 1.3m wide pass which is clearly available from the local flow data . The upstream wall would need to be modified or replaced with a control structure to throttle the water entering the new pass.

The hydraulic conditions created by the bristles should allow uninhibited passage and habitat for all classes and fish species and macroinvertebrates. Water velocities and turbulence are much lower than in other fish pass solutions as the energy is dissipated within the brushes. Up to 30 lines of bristles may be required to drop the head over 40-50mm increments. The long side wall of the fixed crest weir may need to be raised to prevent water overtopping as it does in the current situation.

No significant changes in maintenance requirements are expected other than occasion litter clearance. Risks of debris jams are low due to the bristles ability to flex. The estimated lifespan of the bristles are 10-20 years and can be easily replaced if required. Environment agency staff have highlighted the current lack of safe access into the fixed crest spillway which could easily be improved as part of the project.

Adjustments would be required to the current setup involving the float chamber and sluice. The local Environment Agency hydrology and telemetry team would be able to advise on how much work this would involve.

Consultation and agreements would be required with the following key stakeholders: National Trust, Environment Agency, Tooting and Micham Community and Sports Club, Morden Hall Park Angling Club, upstream landowners,and the General Public.

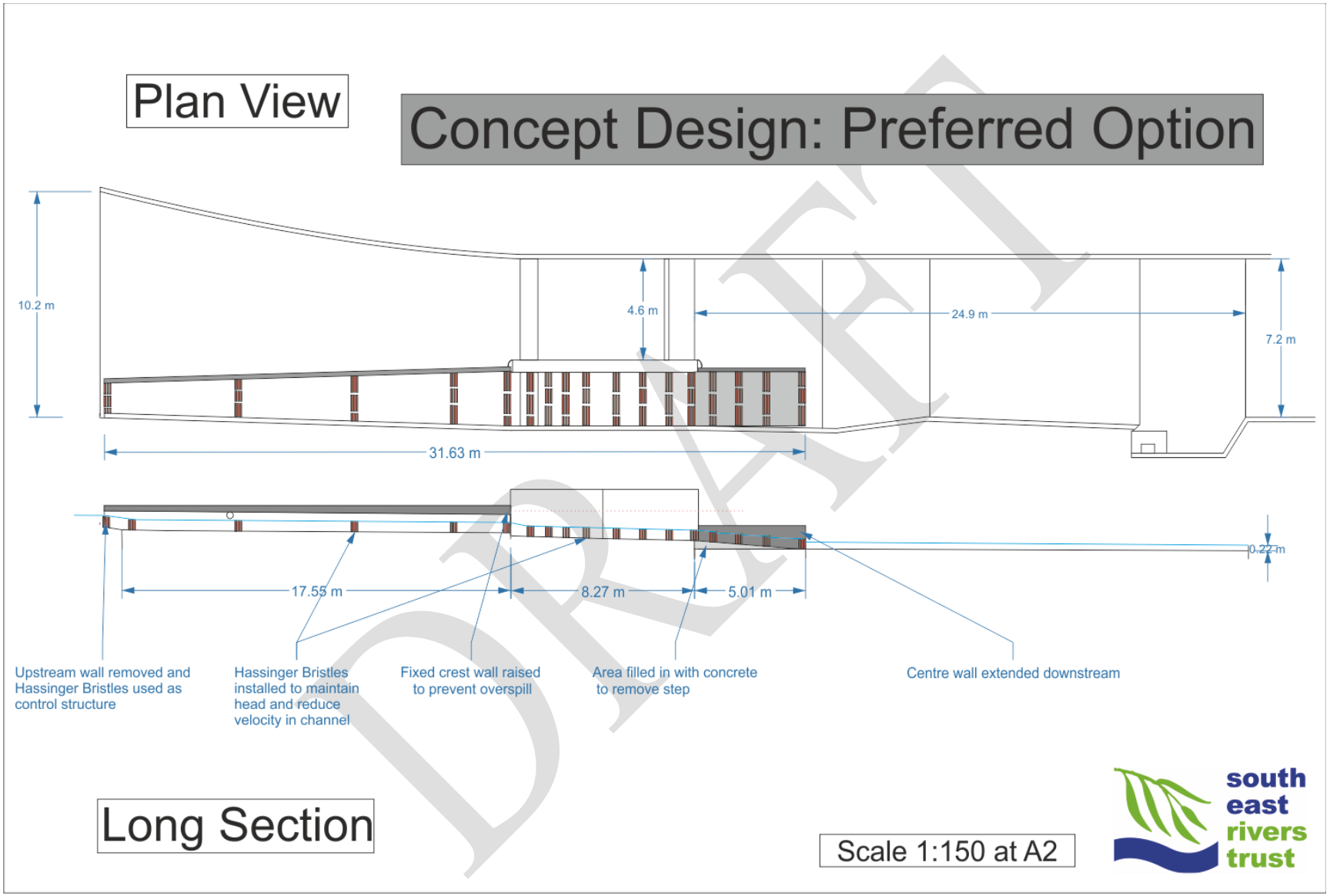


Figure 12: Concept design for preferred option.

Next steps

1. Consultation with stakeholders and landowners.
2. Input from Environment Agency Regional Fisheries Technical Specialist.
3. Discuss preferred option with Dr Hassinger, Kassel University, Germany.
4. Assessment of water requirements of adjacent waterbodies (pond and Channels A & B), including wetland response test.
5. Undertake a detailed silt survey through the main channel upstream of the weir.
6. Work with local FCRM Environment Agency staff to complete.
7. Full options appraisal, including flood risk modelling of options to assess impacts/benefits.
8. Detailed design and costings of preferred option.

References

SNIFFER (2012) WFD111 (2a) Coarse resolution rapid-assessment methodology to assess obstacles to fish migration - Field manual level A assessment. SNIFFER, Edinburgh, 78pp. http://www.sniffer.org.uk/files/7113/4183/8010/WFD111_Phase_2a_Fish_obstacles_manual.pdf

Solomon, D.J. (2010) *Fish passage on the River Wandle*. Report for Environment Agency, Thames Region. Redlynch, Wilts, pp. 119.

Environment Agency (2004) Watermeads Weir Operations Manual, EA, London.

Dr.-Ing. Reinhard Hassinger; Daniel Kraetz, University of Kassel, Germany
The Canoe-Fishway - A Combination of Fish Migration Facility
and Canoe Passage in the same Channel Hydraulics Laboratory and Testing Facilities, Dept. of Civil Engineering.

Appendix A – Wandle Fish Passage Report, Solomon (2010) pages 67-70.

5.4 Watermeads

Structure details

1. *Structure name*:- Watermeads Weir and Papermill Cut Weir
2. *Location (NGR)*:- TQ 27518 67662; TQ 27283 67769
3. *Brief description*:- Head retaining structures for mills on parallel channels.
4. *Distance from Thames confluence*:- 11093 m (Watermeads Weir).
5. *Area of freshwater habitat downstream*:- 123,884 m^2.
6. *Area and quality of habitat upstream (including tributaries)*:- 67,170 m^2.
7. *Distance to next structure downstream*:- 1549 m (Ravensbury Mill)
8. *Number of structures downstream (direct route to Thames confluence)*:- 10
9. *Distance from next structure upstream*:- 852 m (Goat Bridge Mill)
10. *Plan of site*:- None included.
11. *Structure dimensions (including crest height AODN, head drop at time of survey, width)*:-

    This reach of river was once the head pond for the Wandle Felt factory (Crown Mill) and the Wandle Flour Mill (Grove Mill), but since the demolition of those works the channel has been re-aligned and the head loss from the mills concentrated at Watermeads Weir. This comprises a large undershot gate (Figure 5.18) and a sloping channel fed by a long weir (Figure 5.19). The lifting sluice gate is 4.58 m wide, and its cill is at 18.58 m AODN. The crest of the long weir is at 19.62 mAODN, and is about 20 m in length. The lip of this channel at its downstream end is at 18.28 m AODN, and its width increases from 1.7 m at the upstream end to 2.46 m at the downstream end.

    The total head loss at this site was 1471 mm at the time of the site survey on September 18 2009, which probably represents a total obstruction to the passage of the local fish community.

    The Papermill Cut channel diverts from the main river about 380 m upstream of the main weir, and rejoins it about 75 m downstream of the weir. The stream has a good flow and the head drop (1513 mm on September 18 2009) is accommodated in a single fall shortly before it rejoins the main river (Figure 5.20). The weir crest is at 19.59 m AODN, and the channel at this point is 1.85 m in width.

12. *Impact of the structure on habitat*:- The head retaining structures cause backing-up for several hundred metres, creating a deep, slow flowing reach which is well suited to more sedentary coarse fish. Retaining the head creates wetland habitat throughout much of the site.

Figure 5.18. Undershot sluice at Watermeads Weir. The outfall from the sloping channel (Figure 5.20) can be seen on the left of the picture.

Figure 5.19. Sloping channel fed by long-crested weir, Watermeads.

Figure 5.20. Old wheel pit on Papermill Cut. This rejoins the main river 20 m behind the camera position.

Ownership and function

1. *Landowner and operator*:- Weir is maintained and operated by the Environment Agency. Other structures and land owned by National Trust.
2. *Original purpose of structure*:- Head retaining structures for mills.
3. *Current uses and value of structure*:- Water level management for visual amenity and conservation.

Upstream fish passage assessment

1. *Passability for elvers*:- Virtually impassable; possible routes via ditches.
2. *Passability for small eels*:- As for elvers.
3. *Passability for salmonids*:- Virtually impassable.
4. *Passability for rheophile coarse fish (eg dace)*:- Virtually impassable.
5. *Passability for more sedentary coarse fish (eg pike)*:- Virtually impassable.

Options for fish passage improvement

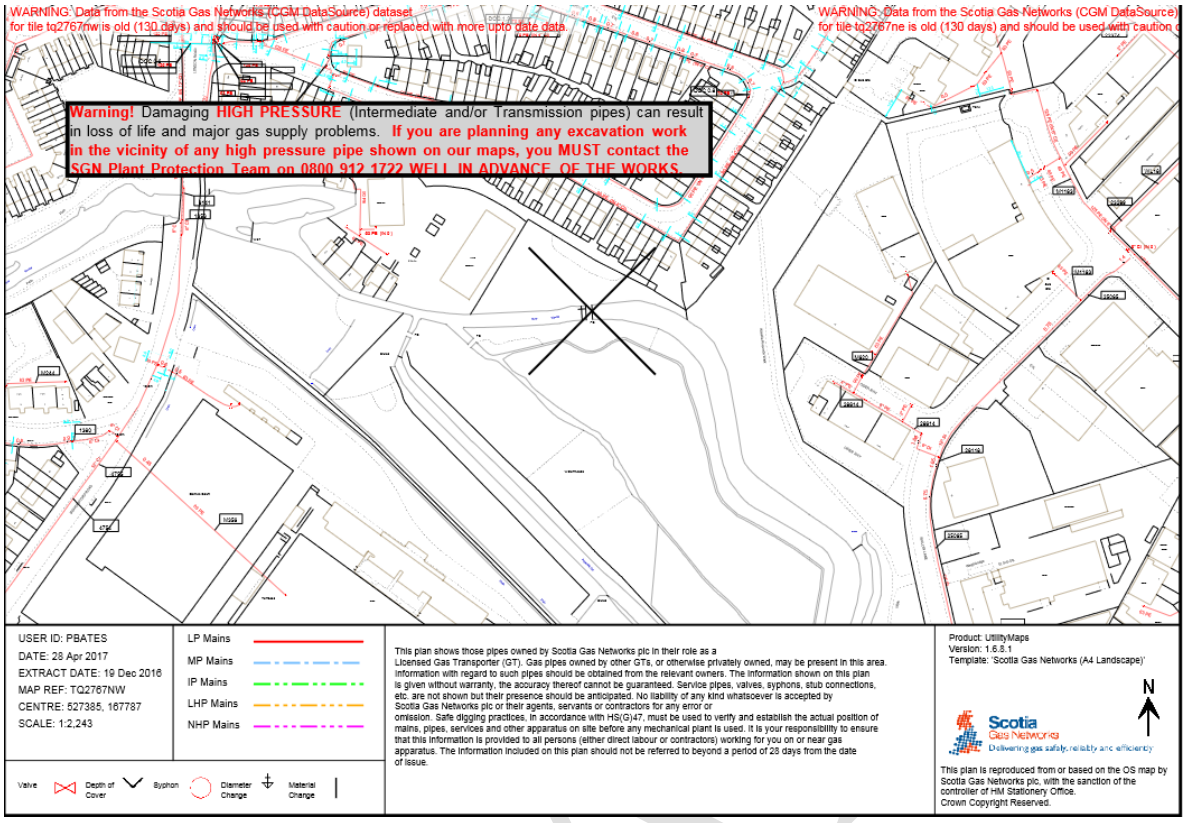
1. *Priority for action*:- High

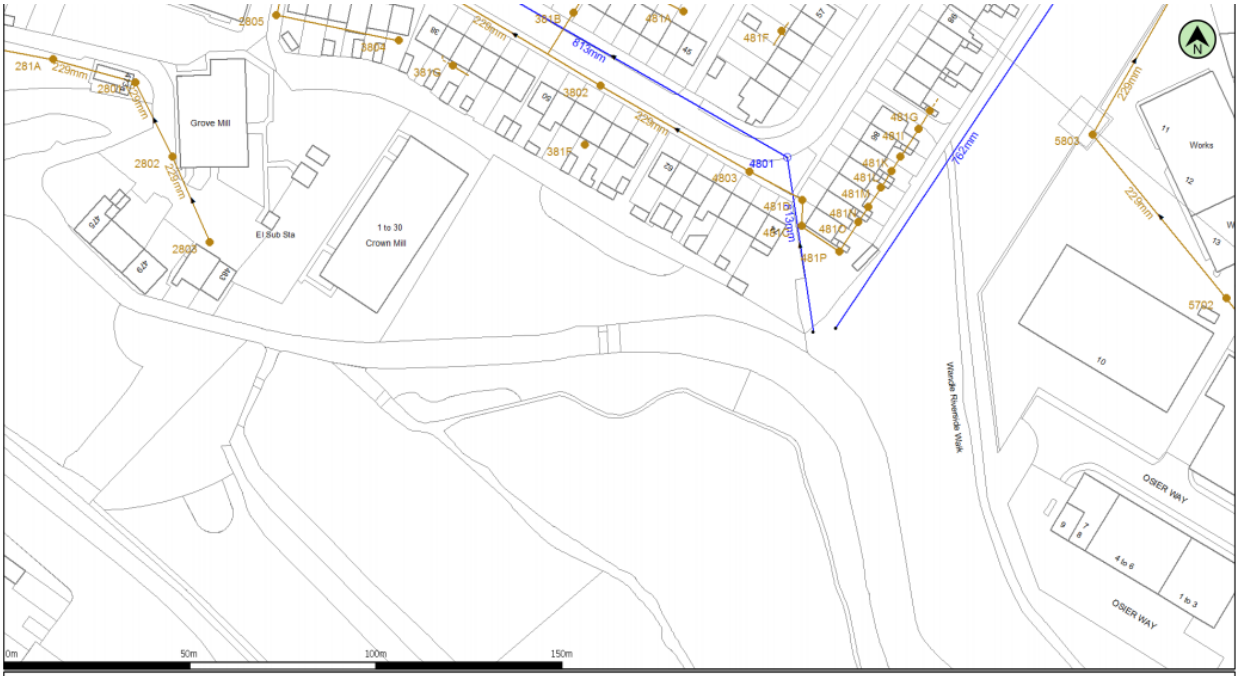
2. *Consideration of options (removal, technical fish pass, alternative routes, easement etc) including assessment of incidental impacts eg visual, water level, amenity etc*:- Removal or substantial lowering of the weir is not considered a viable option as it would preclude flow down the Papermill Cut and would dry-out the ditch system and wetlands on the site. These are considered important as water-vole habitat.

   The most appealing solution may be to install a rock ramp in the long sloping channel on the right bank. As at Trewint Street, it would be prudent to avoid damaging the channel bed during installation, which suggests that an artificial substrate would be most appropriate – see Section 8.1. The slope of the channel bed is very gentle; of the order of 1: 50, and only accommodates about one third of the head drop across the whole structure. The remainder of the head drop occurs in two distinct steps which would need to be overcome. The first is the fall at the top of the channel, but this can be readily covered by careful fixing of the invert level of the uppermost traverse, gradually absorbing the head over the next few traverses. More of a problem would be the fall at the downstream end. Extending the sloping bed downstream to accommodate a longer ramp is a possibility, but this may take the pass entrance downstream from the optimal location close to the weir. A better alternative would be to raise the tail water level by about 300 mm by the installation of one of more blockstone pre-barriers a short distance downstream.

   An alternative route altogether could be developed using the Papermill Cut. The weir at the old wheel pit (Figure 5.20) could readily be fitted with a Larinier Pass. However, its location, downstream of the main weir, is not ideal and this option should only be considered if facilities at the main weir prove to be impractical.

Appendix B – Environment Agency Utility Search Information - April 2017





(c) Crown copyright and database rights 2017 Ordnance Survey 100019345 | Date: 28/04/17 | Scale: 1:1195 | Map Centre: 527385,167787 | Data updated: 01/02/17 | Wastewater Plan A4

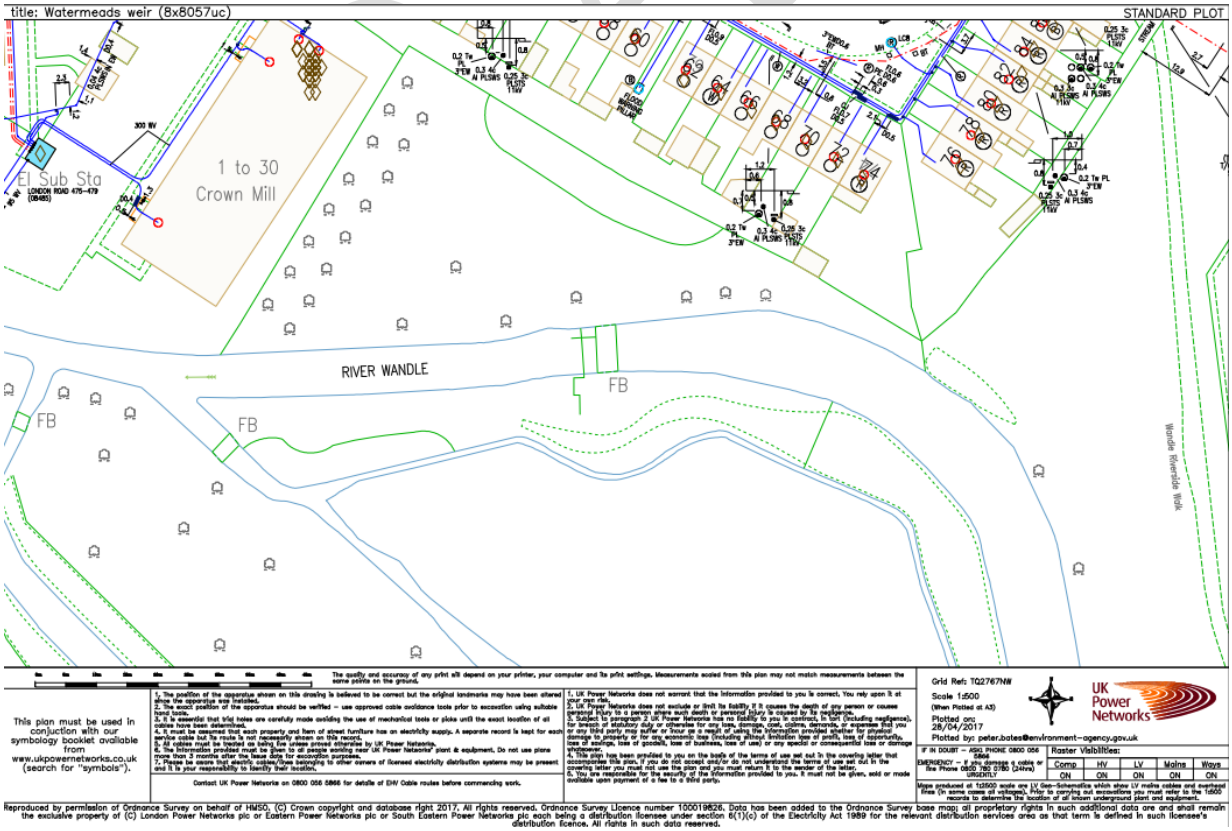
This plan is produced by Thames Water Utilities Ltd (c) Crown copyright and database rights 2017 Ordnance Survey 100019345. This map is to be used for the purposes of viewing the location of Thames Water plant only. Any other uses of the map data or further copies are not permitted. The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. This information is valid for the date printed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified on site before any works are undertaken.

Foul Sewer	Foul Manhole
Surface Sewer	Surface Manhole
Combined Sewer	Combined Manhole
Abandoned Sewer	Abandoned Manhole
Pressure Main	Other Manhole
Private Asset (Colour denotes effluent type)	End Item
Proposed Asset (Colour denotes effluent type)	S104 Boundary

peter.bates@environment-

Watermeads weir

Thames Water



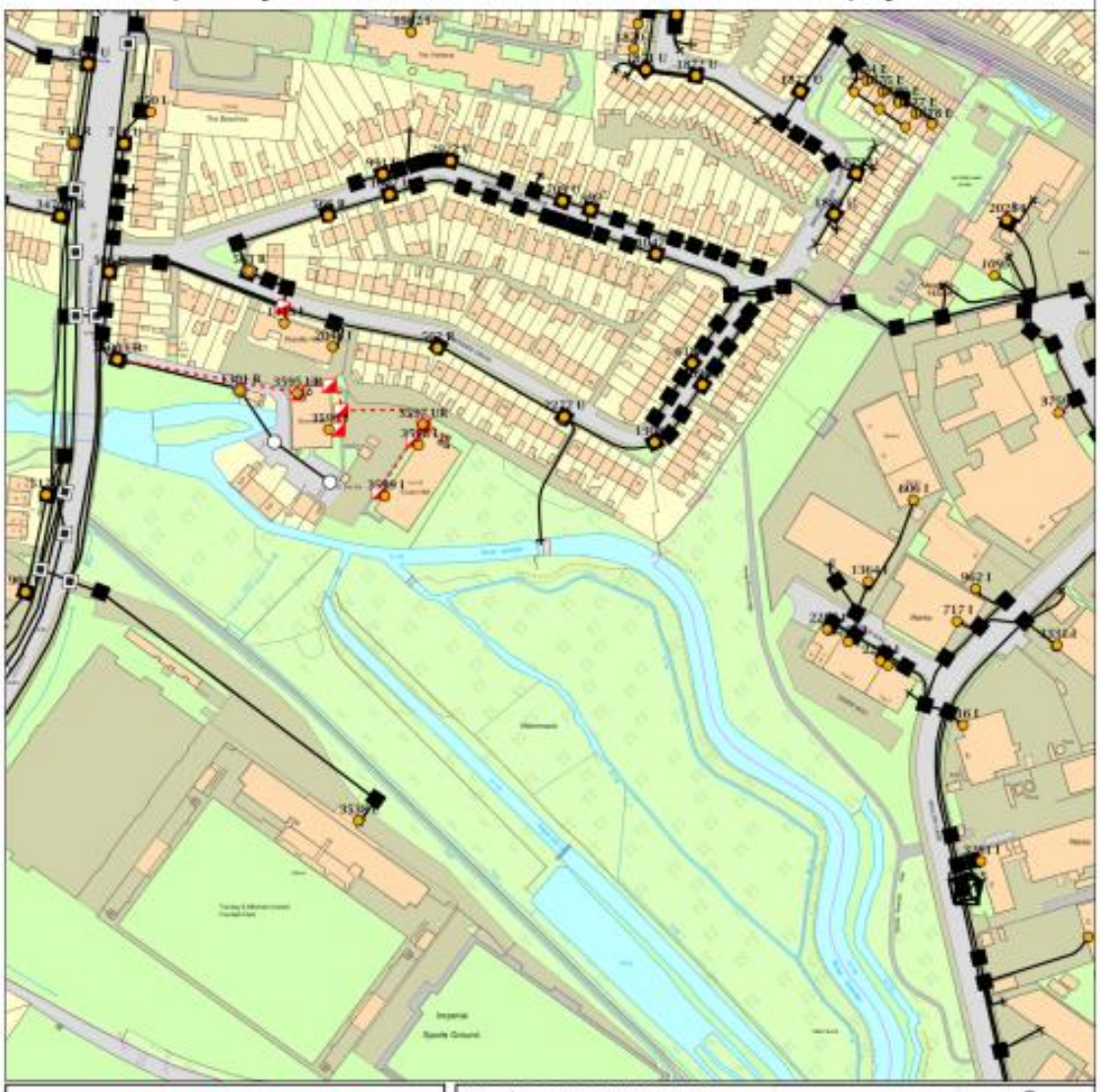
This plan must be used in conjuction with our symbology booklet available from www.ukpowernetworks.co.uk (search for "symbols").

Grid Ref: TQ2767NW
Scale 1:500
(When Plotted at A3)
Plotted on: 28/04/2017
Plotted by: peter.bates@environment-agency.gov.uk

UK Power Networks

Reproduced by permission of Ordnance Survey on behalf of HMSO. (C) Crown copyright and database right 2017. All rights reserved. Ordnance Survey Licence number 100019626. Data has been added to the Ordnance Survey base map; all proprietary rights in such additional data are and shall remain the exclusive property of (C) London Power Networks plc or Eastern Power Networks plc or South Eastern Power Networks plc each being a distribution licensee under section 6(1)(c) of the Electricity Act 1989 for the relevant distribution services area as that term is defined in such licensee's distribution licence. All rights in such data reserved.

Maps by email Plant Information Reply



IMPORTANT WARNING

Information regarding the location of BT apparatus is given for your assistance and is intended for general guidance only. No guarantee is given of its accuracy. It should not be relied upon in the event of excavations or other works being made near to BT apparatus which may exist at various depths and may deviate from the marked route.

openreach

CLICK BEFORE YOU DIG

FOR PROFESSIONAL FREE ON SITE ASSISTANCE PRIOR TO COMMENCEMENT OF EXCAVATION WORKS INCLUDING LOCATE AND MARKING SERVICE

email cbyd@openreach.co.uk

ADVANCE NOTICE REQUIRED
(Office hours: Monday - Friday 08.00 to 17.00)
www.openreach.co.uk/cbyd

KEY TO BT SYMBOLS

DP		Pole	
Planned DP		Planned Pole	
PCP		Joint Box	
Planned PCP		Change Of State	+
Built		Split Coupling	X
Planned		Duct Tee	▲
Inferred		Planned Box	
Building		Manhole	
Kiosk	K	Planned Manhole	
Hatchings		Cabinet	
		Planned Cabinet	

Other proposed plant is shown using dashed lines.
BT Symbols not listed above maybe disregarded.
Existing BT Plant may not be recorded.
Information valid at time of preparation

openreach
a BT Group business

BT Ref : ROZ01035P
Map Reference : (centre) TQ273856778
Easting/Northing : (centre) 527385,167
Issued : 28/04/2017 13:03:46

WARNING: IF PLANNED WORKS FALL INSIDE HATCHED AREA IT IS ESSENTIAL BEFORE PROCEEDING THAT YOU CONTACT THE NATIONAL NOTICE HANDLING CENTRE. PLEASE SEND E-MAIL TO: nnhc@openreach.co.uk

Linesearch before dig

Enquiry Confirmation

LSBUD Ref: 10332156

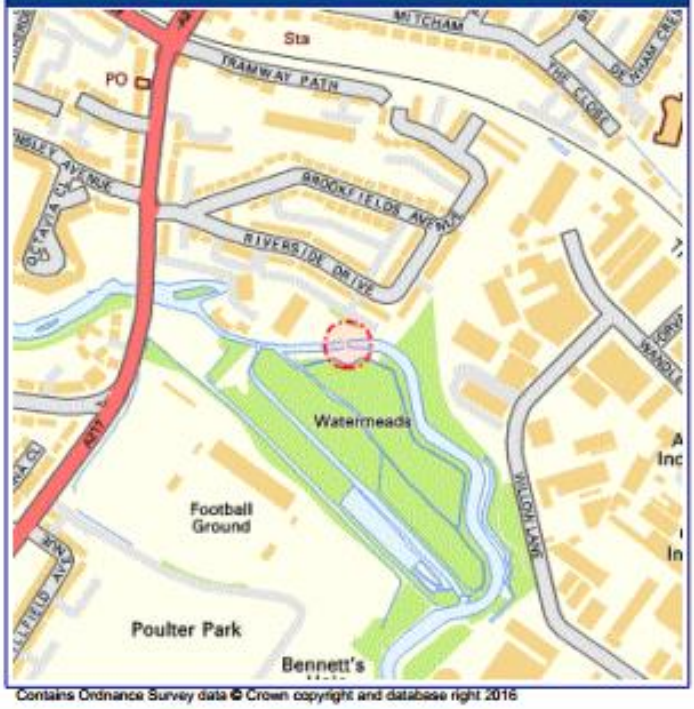
Date of enquiry: 28/04/2017
Time of enquiry: 15:06

Enquirer			
Name	Mr Peter Bates	Phone	07920 531526
Company	Environment Agency	Mobile	Not Supplied
		Fax	Not Supplied
Address	Medway House Powdermill Lane Leigh, Tonbridge Kent TN11 9AS		
Email	peter.bates@environment-agency.gov.uk		
Notes	Please ensure your contact details are correct and up to date on the system in case the LSBUD Members need to contact you.		

Enquiry Details			
Scheme/Reference	Watermeads weir		
Enquiry type	Planned Works	Work category	Watercourses/Canals/Drainage
Start date	01/05/2017	Work type	Bank Works
End date	31/12/2017	Site size	50 metres diameter
Searched location	XY= 527385, 167787 Easting/Northing	Work type buffer*	25 metres
Confirmed location	527385 167787		

* The WORK TYPE BUFFER is a distance added to your search area based on the Work type you have chosen.

Site Map



V3.3.2

Linesearch before dig

Enquiry Confirmation
LSBUD Ref: 10332156

Date of enquiry: 28/04/2017
Time of enquiry: 15:06

LSBUD Members who have assets registered on the LSBUD service within the vicinity of your search area.

List of affected LSBUD members			
Asset Owner	**Phone/Email**	**Emergency Only**	**Status**
National Grid Gas (Above 7 bar), National Grid Gas Distribution Limited (Above 2 bar) and National Grid Electricity Transmission	0800688588	Gas 0800111999 Electricity 0800404090	Await response
SGN	08009121722	0800111999	Await response

LSBUD members who do not have assets registered on the LSBUD service within the vicinity of your search area. Please be aware that LSBUD members make regular changes to their assets.

List of not affected LSBUD members		
AWE Pipeline	Esso Petroleum Company Limited	Petroineos
BOC Limited (A Member of the Linde Group)	Fulcrum Pipelines Limited	Phillips 66
BP Midstream Pipelines	Gamma	Premier Transmission Ltd (SNIP)
BPA	Gateshead Energy Company	Prysmian Cables & Systems Ltd (c/o Western Link)
Carrington Gas Pipeline	Gigaclear PLC	Redundant Pipelines - LPDA
CATS Pipeline c/o Wood Group PSN	Humbly Grove Energy	RWEnpower (Little Barford and South Haven)
Cemex	IGas Energy	SABIC UK Petrochemicals
Centrica Energy	Ineos Enterprises Limited	Scottish Power Generation
Centrica Storage Ltd	INEOS Manufacturing (Scotland and TSEP)	Seabank Power Ltd
CLH Pipeline System Ltd	Intergen (Coryton Energy or Spalding Energy)	Shell (St Fergus to Mossmorran)
Concept Solutions People Ltd	Lark Energy	Shell Pipelines
ConocoPhillips (UK) Ltd	Mainline Pipelines Limited	Total (Finaline, Colnbrook & Colwick Pipelines)
DIO (MOD Abandoned Pipelines)	Manchester Jetline Limited	Transmission Capital
Dong Energy (UK) Ltd	Manx Cable Company	Uniper UK Ltd
E.ON UK CHP Limited	Marchwood Power Ltd (Gas Pipeline)	Vattenfall
EirGrid	Melbourn Solar Limited	Veolia ES SELCHP Limited
Electricity North West Limited	Northumbrian Water Group	Western Power Distribution
ENI & Himor c/o Penspen Ltd	NPower CHP Pipelines	Wingas Storage UK Ltd
ESP Utilities Group	Oikos Storage Limited	Zayo Group UK Ltd c/o JSM Group Ltd
ESSAR	Perenco UK Limited (Purbeck Southampton Pipeline)	

Appendix C – Watermeads Weir – Site Photos November 2017

Figure ……

Figure ……

Figure ……

Figure …

Appendix D – Sniffer Assessment Forms – Jan 2017

RIVERINE FISH BARRIER ASSESSMENT TOOL: COARSE RESOLUTION (LEVEL A)

Site ref no: Watermeads WB ID and name	Date: 23/1/2017	Time: 2pm	Surveyor names: CE NH

1. SURVEY SITE DETAILS

River/stream name	Wandle
Tributary to:	Thames
GPS co-ordinates	
No. photos taken:	
Photo id no range:	
Ownership (if known)	
Access notes:	

Antecedent conditions (circle one)	1	2	3	4	5
Flow conditions (circle one):	Bankfull	Elevated	summer low level		
Adverse conditions impeding survey?	Y	N			
If yes, describe:					

2. STRUCTURE OF CONCERN

2.1. General characteristics

Type		
Weir	Vertical	
	-Notched	
	Sloping	
	- Crump	✓
	- Flat-V	
	- Flume	✓
	Stepped	✓
Ford		

Bridge footing		
Natural barrier	Waterfall	
	Rapid	
	Debris dam	
Dam		
Culvert		
Sluice		
Abstraction off-take		

Material

PCC	TMB	PVC	SPS
SST	CPC	MRY	OTH:
SPA	CAL	CST	

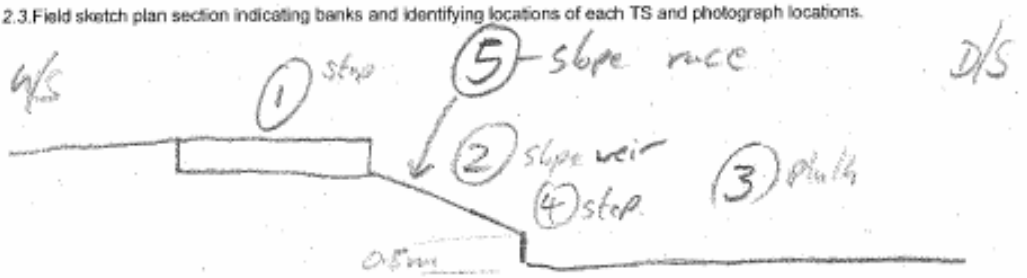
Total width of barrier along crest (m):		
Total width of channel (m):		
Total wetted width at barrier crest (m)		
Is structure drowned presently?	Y	(N)
Is structure currently dry?	Y	(N)

2.2. Transversal sections (TS) including barrier parts or passage ways across total width of channel

Number of identified transversal sections (TS) across the total width of the channel	

TS description **Tick box if feature is present in the TS and enter the order the features are encountered by fish moving upstream across the barrier**	***Vertical drop:*** *(weir, outlet drop, waterfall overshot sluice)* *JUMP AND/OR DEPTH BARRIER*	***Slope:*** *(sloping weirs, fords, culverts, sloped fishway, rapids, chutes)* *SWIM AND/OR DEPTH BARRIER*	***Steps:*** *(stepped weir, box-pass fish ways, complex rapids* *SWIM AND JUMP AND/OR DEPTH BARRIER*	***Other:*** *Complex waterfalls, debris dams or combinations* *SWIM AND/OR JUMP / DEPTH BARRIER*	***Estimate of % of total channel flow going through TS at time of survey***
TS 1	x	x	x		
Order (from downstream)	3	2	1		100
TS 2					
Order (from downstream)					
TS 3					
Order (from downstream)					

2.3. Field sketch plan section indicating banks and identifying locations of each TS and photograph locations.



SECTION 7 FINAL PASSABILITY ASSESSMENT FOR SITE

COMPLETE AS AN OVERALL PASSABILITY SCORE TO INCLUDE INFORMATION FROM ALL TRANSVERSAL SECTIONS

Site ref no: Watermouls

		UPSTREAM MIGRATION							DOWNSTREAM MIGRATION						
						Degree of estimation							Degree of estimation		
		No barrier 1.0	Partial barrier Low impact 0.6	Partial barrier High impact 0.3	Complete barrier 0.0	All measurements undertaken	Measurement partially undertaken	All measurements estimated	No barrier 1.0	Partial barrier Low impact 0.6	Partial barrier High impact 0.3	Complete barrier 0.0	All measurements undertaken	Measurement partially undertaken	All measurements estimated
Adult Salmon (AS)	current conditions			✓					✓						
	high flows														
Adult Trout (AT)	current conditions			✓					✓						
	high flows														
Adult Grayling (AG)	current conditions				✓						✓				
	high flows														
Cyprinids (C)	current conditions				✓							✓			
	high flows														
Adult Lamprey (AL)	current conditions				✓										
	high flows														
Juvenile Eel (JE)	current conditions				✓										
	high flows														
Juvenile Salmonids (JS)	current conditions				✓						✓				
	high flows														
Juvenile Lamprey (JL)	current conditions								✓						
	high flows														
Adult Eel (AE)	current conditions								✓						
	high flows														

Additional notes of relevance to fish passage (i.e. observations or information from other sources, and details of dry channels)

Note: Only complete scores for fish species that are known to be present in the catchment

See Appendix 2

4. PHYSICAL ATTRIBUTES FOR AN INDIVIDUAL TRANSVERSAL SECTION (TS) | **Site ref no:** watermeads | **TS ID:** 1 + 2

4.1. FOR BARRIERS PRESENTING A VERTICAL DROP: WEIRS, CULVERT, FORD OR BRIDGE FOOTING OUTLETS, OVERSHOT SLUICES, WATERFALLS AND DEBRIS DAMS

(1) Vertical Drop

TS		Vertical hydraulic head (m)	Eff. pool depth(m)	Effective resting locations? (Y,N)	Lip (Y,N) crest	Lip (Y,N) foot	Standing wave (Y,N)	Levels of turbulence (H, M, L)	Debris blocking structure? (Y,N) US	Debris blocking structure? (Y,N) DS	Structures damaging to DS migrants present? (Y,N) DS
	measure	0.24m	0.46m	Y			N	H	N		N
1	AS	1.0	1.0	1.0				0.3	1.0	1.0	1.0
2	AT	1.0	1.0	1.0				0.3	1.0	1.0	1.0
3	AG	0.6	1.0	1.0				0.0	1.0	1.0	1.0
4	C	0.3		1.0				0.0	1.0	1.0	1.0
	AL	0.6		1.0				0.0	1.0		
	JE							0.0	1.0		
5	JS	0.6	1.0					0.0	1.0	1.0	1.0
	JL										1.0
	AE										1.0

4.2.FOR BARRRIERS PRESENTING A SLOPE: WEIRS , CULVERTS, FORDS BRIDGE FOOTINGS , RAPIDS ,CHUTES AND DIVERSION CHANNELS

(2) Sloping w.r.

TS		Total hydraulic head (inlet-outlet, m)	Effective length(m)	% Slope	Eff. pool depth (m)	Effective resting locations? (Y,N)	Lip (Y,N) crest	Lip (Y,N) foot	Standing wave (Y,N)	Levels of turbulence (H, M, L)	Debris blocking structure? (Y,N) US	Debris blocking structure? (Y,N) DS	Structures damaging to DS migrants present? (Y,N) DS
	measure		8.3		0.18	n	n	n		H	N		N
1	AS		1.0			0.3				0.3	1.0	1.0	1.0
2	AT		1.0			0.3				0.3	1.0	1.0	1.0
3	AG		0.6			0.3				0.0	1.0	1.0	1.0
4	C		0.3			0.3				0.0	1.0	1.0	1.0
6	AL		0.6			0.3				0.0	1.0		
	JE		0.3							0.0			
5	JS		0.6			0.3				0.0	1.0	1.0	1.0
	JL												
	AE												

4.3.FOR BARRIERS PRESENTING STEPS: STEPPED WEIRS, BOX-TRAVESRSE TYPE FISHWAYS OR COMPLEX WATERFALLS

		Total Hydraulic head (m)	Effective length (m)	Eff. pool depth (m)	Step water depth(m)	Height of step(m)	Length of the step(m)	Number of steps	Effective resting locations? (Y,N)	Lip (Y,N) crest	Lip (Y,N) foot	Standing wave (Y,N)	Levels of turbulence (H, M, L)	Debris blocking structure? (Y,N) US	Debris blocking structure? (Y,N) DS	Structures damaging to DS migrants present? (Y,N) DS
	measure															
	AS															
	AT															
	AG															
	C															
	AL															
	JE															
	JS															
	JL															
	AE															

Note: only complete tables in sections 4 and 5 for juvenile eels (JE) if NO climbing substrate is present

3. VELOCITIES AND DEPTHS FOR AN INDIVIDUAL TRANSVERSAL SECTION (TS)
(except for abstraction points)

Site ref no: watermeads

TS ID: 3

		Outlet / Foot (only if applicable)					Mid-Point (only if applicable)					Inlet / crest					Depth / Veloc. assessment			
Wetted width (m)		LB				RB	LB				RB	LB				RB	No barrier	Partial barrier Low impact	Partial barrier High impact	Complete barrier
Transect point		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5				
DEPTH (M)				0.2					0.2					0.2						
VELOCITY	0.6 depth			2.4					2.4					2.4			1.0	0.6	0.3	0.0
	Streambed																			
Adult Salmon (AS)				1.0					1.0					1.0			≥ 0.30 m	0.11 - 0.14 m	0.06 - 0.1 m	≤ 0.07 m
	US			DS			US			DS		US			DS					
use velocities at 0.6 depth		1.0					1.0					1.0			1.0		≥ 2 m/s	2.1 - 2.5 m/s	2.6 - 2.9 m/s	≥ 3 m/s
Adult Trout (AT)				1.0					1.0					1.0			≥ 0.1m	0.075 - 0.09 m	0.06 - 0.074 m	≤ 0.05 m
	US			DS			US			DS		US			DS					
use velocities at 0.6 depth		1.0					1.0					1.0			1.0		≤ 2 m/s	2.1 - 2.5 m/s	2.6 - 2.9 m/s	≥ 3 m/s
Adult Grayling (AG)				1.0					1.0					1.0			≥ 0.1m	0.075 - 0.09 m	0.06 - 0.074 m	≤ 0.05 m
	US			DS			US			DS		US			DS					
use velocities at 0.6 depth		0.3					0.5					0.3			0.3		≤ 1.5 m/s	1.6 - 1.9 m/s	2 - 2.5 m/s	≥ 2.6 m/s
Cyprinids (C)				1.0					1.0					1.0			≥ 0.1m	0.075 - 0.09 m	0.06 - 0.074 m	≤ 0.05 m
	US			DS			US			DS		US			DS					
use velocities at 0.6 depth		0.0					0.0					0.0			0.0		≤ 1 m/s	1.1 - 1.5 m/s	1.6 - 1.9 m/s	≥ 2 m/s
Adult Lamprey (AL)				1.0					1.0					1.0			≥ 0.06 m	0.05 - 0.079 m	0.04 - 0.059 m	≤ 0.03 m
	US			DS			US			DS		US			DS					
use velocities at streambed		0.0					0.0					0.0					≤ 0.6 m/s	0.6 - 0.99 m/s	1 - 1.4 m/s	≥ 1.5 m/s
Juvenile Eel (JE)				1.0					1.0					1.0			≥ 0.05 m	0.03 - 0.049 m	0.021 - 0.03 m	≤ 0.02 m
	US			DS			US			DS		US			DS					
use velocities at streambed climbing substrate *		0.0					0.0					0.0					≥ 0.3 m/s	0.31 - 0.49 m/s	0.5 - 0.79 m/s	≥ 0.8 m/s
Juvenile Salmonid (JS)				1.0					1.0					1.0			≥ 0.08 m	0.06 - 0.079 m	0.031 - 0.059 m	≤ 0.03 m
	US			DS			US			DS		US			DS					
use velocities at 0.6 depth		0.3					0.3					0.3			0.3		≤ 1.5 m/s	1.51 - 1.9 m/s	2 - 2.5 m/s	≥ 2.6 m/s
Juvenile Lamprey (JL)																	≥ 0.02 m	0.015 - 0.019 m	0.009 - 0.01 m	≤ 0.008 m
																	US		DS	
																	n.a.	n.a.	n.a.	n.a.
																			1.0	
Adult Eel (AE)																	≥ 0.06 m	0.05 - 0.079 m	0.031 - 0.059 m	≤ 0.03 m
																	US		DS	
																	n.a.	n.a.	n.a.	n.a.
																			1.0	

* Is there suitable wetted climbing substrate on face or edges for juvenile eels? If PRESENT enter 1.0. If ABSENT enter 0.0

Notes:

For Upstream passability assessment:

1. Use both the **depth** and relevant **velocity** data.

2. Choose the **most limiting factor** that applies to the species/guild = either velocity or depth (e.g. for adult salmon (AS) if velocity is < 2.0 but depth is 0.09m then score for this point is 0.3).

3. Scan through the scores and circle the **maximum passability** score for each applicable location (inlet, midpoint, outlet)

For downstream passability assessment:

1. Only compete for **Inlet**

2. Use only the **depth data** to determine the passability score

3. Scan through the scores and circle the **maximum passability** score

4. PHYSICAL ATTRIBUTES FOR AN INDIVIDUAL TRANSVERSAL SECTION (TS) | **Site ref no:** | **TS ID:**

4.1. FOR BARRIERS PRESENTING A VERTICAL DROP: WEIRS, CULVERT, FORD OR BRIDGE FOOTING OUTLETS, OVERSHOT SLUICES, WATERFALLS AND DEBRIS DAMS

	Vertical hydraulic head (m)	Eff. pool depth(m)	Effective resting locations? (Y,N)	Lip (Y, N)		Standing wave (Y,N)	Levels of turbulence (H, M, L)	Debris blocking structure? (Y,N)		Structures damaging to DS migrants present? (Y,N)
				crest	foot			US	DS	DS
measure	0.43	0.17	Y	N	N	N	H	N		N
AS	1.0	0.3	1.0	1.0	1.0	1.0	0.3	1.0	1.0	1.0
AT	0.6	0.3	1.0	1.0	1.0	1.0	0.3	1.0	1.0	1.0
AG	0.0	0.3	1.0	1.0	1.0	1.0	0.0	1.0	1.0	1.0
C	0.0		1.0	1.0	1.0	1.0	0.0	1.0	1.0	1.0
AL	0.0		1.0	1.0	1.0	1.0	0.0	1.0		
JE							0.0			
JS	0.0	1.0		1.0	1.0	1.0	0.0	1.0	1.0	1.0
JL										
AE										

4.2.FOR BARRRIERS PRESENTING A SLOPE: WEIRS , CULVERTS, FORDS BRIDGE FOOTINGS , RAPIDS ,CHUTES AND DIVERSION CHANNELS

	Total hydraulic head (inlet-outlet, m)	Effective length(m)	% Slope	Eff. pool depth (m)	Effective resting locations? (Y,N)	Lip (Y, N)		Standing wave (Y,N)	Levels of turbulence (H, M, L)	Debris blocking structure? (Y,N)		Structures damaging to DS migrants present? (Y,N)
						crest	foot			US	DS	DS
measure												
AS												
AT												
AG												
C												
AL												
JE												
JS												
JL												
AE												

4.3.FOR BARRIERS PRESENTING STEPS: STEPPED WEIRS, BOX-TRAVESRSE TYPE FISHWAYS OR COMPLEX WATERFALLS

	Total Hydraulic head (m)	Effective length (m)	Eff. pool depth (m)	Step water depth(m)	Height of step(m)	Length of the step(m)	Number of steps	Effective resting locations? (Y,N)	Lip (Y,N)		Standing wave (Y,N)	Levels of turbulence (H,M,L)	Debris blocking structure? (Y,N)		Structures damaging to DS migrants present? (Y,N)
									crest	foot			US	DS	DS
measure															
AS															
AT															
AG															
C															
AL															
JE															
JS															
JL															
AE															

Note: only complete tables in sections 4 and 5 for juvenile eels (JE) if NO climbing substrate is present

17.11.17

3. VELOCITIES AND DEPTHS FOR AN INDIVIDUAL TRANSVERSAL SECTION (TS)
(except for abstraction points)

Site ref no:

TS ID:

Wetted width (m)		Outlet / Foot (only if applicable)					Mid-Point (only if applicable)					Inlet / crest					Depth / Veloc. assessment			
		LB				RB	LB				RB	LB				RB	No barrier	Partial barrier Low impact	Partial barrier High impact	Complete barrier
Transect point		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5				
DEPTH (M)				0.1					0.1					0.1						
VELOCITY	0.6 depth			2.4					2.4					2.4			1.0	0.6	0.3	0.0
	Streambed																			
Adult Salmon (AS)									0.3					0.3			≥ 0.45 m	0.11 - 0.44 m	0.09 - 0.1 m	≤ 0.07 m
		US		DS			US		DS			US		DS			≤2 m/s	2.1 - 2.5 m/s	2.6 - 2.9 m/s	≥ 3 m/s
use velocities at 0.6 depth							1.0							1.0						
Adult Trout (AT)									1.0					1.0			≥ 0.3 m	0.075 - 0.09 m	0.06 - 0.074 m	≤ 0.05 m
		US		DS			US		DS			US		DS			≤2 m/s	2.1 - 2.5 m/s	2.6 - 2.9 m/s	≥ 3 m/s
use velocities at 0.6 depth							1.0							1.0						
Adult Grayling (AG)									1.0					1.0			≥ 0.1m	0.075 - 0.09 m	0.06 - 0.074 m	≤ 0.05 m
		US		DS			US		DS			US		DS			≤1.5 m/s	1.6 - 1.9 m/s	2 - 2.5 m/s	≥ 2.6 m/s
use velocities at 0.6 depth							0.3							0.3						
Cyprinids (C)									1.0					1.0			≥ 0.1m	0.075 - 0.09 m	0.06 - 0.074 m	≤ 0.05 m
		US		DS			US		DS			US		DS			≤1 m/s	1.1 - 1.5 m/s	1.6 - 1.9 m/s	≥ 2 m/s
use velocities at 0.6 depth							0.0							0.0						
Adult Lamprey (AL)									1.0								≥ 0.08 m	0.06 - 0.079 m	0.04 - 0.059 m	≤ 0.03 m
		US		DS			US		DS			US		DS			≤ 0.5 m/s	0.6 - 0.89 m/s	1 - 1.4 m/s	≥ 1.5 m/s
use velocities at streambed							0.0													
Juvenile Eel (JE)									0.0								≥ 0.06 m	0.03 - 0.049 m	0.021 - 0.03 m	≤ 0.02 m
		US		DS			US		DS			US		DS						
use velocities at streambed climbing substrate *							0.0										≤ 0.3 m/s	0.31 - 0.49 m/s	0.5 - 0.79 m/s	≥ 0.8 m/s
Juvenile Salmonid (JS)									1.0					1.0			≥ 0.08 m	0.06 - 0.079 m	0.031 - 0.059 m	≤ 0.03 m
		US		DS			US		DS			US		DS			≤1.5 m/s	1.6 - 1.9 m/s	2 - 2.5 m/s	≥ 2.6 m/s
use velocities at 0.6 depth							0.3							0.3						
Juvenile Lamprey (JL)														1.0			≥ 0.02 m	0.015 - 0.019 m	0.005 - 0.01 m	≤ 0.005 m
												US		DS			n.a.	n.a.	n.a.	n.a.
														1.0						
Adult Eel (AE)														1.0			≥ 0.08 m	0.06 - 0.079 m	0.031 - 0.059 m	≤ 0.03 m
												US		DS			n.a.	n.a.	n.a.	n.a.
														1.0						

* Is there suitable wetted climbing substrate on face or edges for juvenile eels? If PRESENT enter 1.0. If ABSENT enter 0.0

Notes:

For Upstream passability assessment:

1. Use both the **depth** and relevant **velocity** data.

2. Choose the **most limiting factor** that applies to the species/guild = either velocity or depth (e.g. for adult salmon (AS) if velocity is < 2.0 but depth is 0.09m then score for this point is 0.3).

3. Scan through the scores and circle the **maximum passability** score for each applicable location (inlet, midpoint, outlet)

For downstream passability assessment:

1. Only compete for **inlet**

2. Use only the **depth data** to determine the passability score

3. Scan through the scores and circle the **maximum passability** score